PLANNING AND MANAGEMENT OF BIKE SHARING SYSTEMS FOR SUSTAINABLE URBAN TRANSPORT: KONYA, KAYSERİ AND İSTANBUL CASES

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ABSTRACT

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Considering the problems of traffic congestion, energy dependency and air pollution depending on excessive use of private car, different transport alternatives to ensure sustainable urban transportation have come into question. Particularly in some European countries, bicycle use, which does not create any pollution and uses resources and road space at a minimum, has appeared as a sustainable alternative for urban transportation and besides, recently bike-sharing systems have contributed to this process positively. Bike-sharing systems, which introduce a number of bike stations in urban areas to encourage citizens to take a bike from one station and then leave it at any other one, further promotes the usage of bikes for urban transport purposes. The system has numerous examples today in Europe, Asia, and North and South America. It has recently been launched in some Turkish cities too, while many other cities are planning to introduce this system.

This research analyzes the planning and operating approaches in bike-sharing implementations. The worldwide experiences in this new approach are reviewed, and best practices in the world will be studied with a view to reveal some criteria for the successful planning and operation of these systems in Turkey. The first three bike-sharing systems, those in Kayseri, Konya and Istanbul will be assessed. The underlying objectives are to provide a better understanding of the current experience in bike-sharing systems in Turkey, to reveal the strengths and weaknesses of the systems implemented so far, and to provide recommendations for the planning, implementation and operation of future systems.

Keywords: Bike-sharing, cycling, sustainable transport, planning.

ÖZ

SÜRDÜRÜLEBİLİR ULAŞIM İÇİN PAYLAŞIMLI BİSİKLET SİSTEMLERİNİN PLANLAMA VE İŞLETMESİ: KONYA, KAYSERİ VE İSTANBUL ÖRNEKLERİ

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Aşırı otomobil kullanımına bağlı olan trafik sıkışıklığı, enerji bağımlılığı ve hava kirliliği problemleri dikkate alınarak, farklı ulaşım alternatifleri sürdürülebilir kentsel ulaşımı sağlamak üzere gündeme gelmiştir. Özellikle bazı Avrupa ülkelerinde, hiçbir kirlilik yaratmayan ve kaynakları ve yol kapasitesini asgari seviyede kullanan bisiklet kullanımı kentsel ulaşım için sürdürülebilir bir alternatif olarak ortaya çıkmıştır, ve bunun yanında, son zamanlarda paylaşımlı bisiklet sistemleri bu sürece olumlu katkı yapmıştır. Kentsel alanda insanları bir istasyondan bisiklet alıp sonrasında herhangi başka bir istasyona bırakmasına cesaretlendiren, belli sayıda bisiklet istasyonunu sunan paylaşımlı bisiklet sistemleri bunun ötesinde bisikletin kentsel ulaşım aracı olarak kulanılmasını sağlar. Sistem günümüzde Avrupa'da, Asya'da, ve Kuzey ve Güney Amerika'da çok sayıda örneği bulunmaktadır. Türkiye'de de son zamanlarda birçok kent bu sistemi başlatmayı planlarken, bazı kentlerde bu sistem başlamıştır.

Bu araştırma, paylaşımlı bisiklet sistemi uygulamalarındaki planlama ve işletme yaklaşımlarını analiz etmektedir. Bu yaklaşımdaki dünya genelindeki deneyimler incelenmiştir, ve dünyadaki en iyi uygulamalar, bu sistemlerin bazı başarılı planlama ve uygulama kriterlerini ortaya çıkarmak üzerine bir bakış açısıyla

araştırılacaktır. Kayseri, Konya ve İstanbul'daki paylaşımlı bisiklet sistemlerinin ilk üç örneği değerlendirilecektir. Temel amaçlar, Türkiye'deki paylaşımlı bisiklet sistemlerinin güncel deneyimlerini daha iyi anlamayı sağlamak, şimdiye kadar uygulanan sistemlerin güçlü ve zayıf yanlarını ortaya çıkarmak, ve gelecekteki sistemlerin planlama, uygulama ve işletmesi için politika önerileri sağlamaktır.

Anahtar Kelimeler: Paylaşımlı bisiklet sistemi, bisiklete binme, sürdürülebilir ulaşım, planlama.

To *My Dear Fiancée…*

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CHAPTER 1

1. INTRODUCTION

Urban mobility is an indispensable need, which can be realized with different modes such as private cars, buses, urban rail systems and non-motorized modes, i.e. walking and cycling. In the last century, automobile use has increasingly dominated urban transport, and many cities have been restructured as a result of policies and projects that aimed at accommodating the increasing car traffic in cities. These projects included the construction of new roads or grade separated junctions, widening of existing roads at the expense of pedestrian sidewalks, and conversion of urban space, as well as public space, into car parks. These projects created automobile-oriented urban areas, which brought along the problems of traffic congestion, energy dependency, air pollution as well as social inequalities in accessibility.

Automobile appears as an attractive urban transport mode since it provides door-to-door transport, and relatively more comfort, privacy and convenience. In addition, urban transport policy plans and investments in the past supported the growth of automobile use by trying to provide for more and more road capacities to meet the increasing car traffic demand. Road-oriented urban transport systems and the rapid expansion of cities due to new roads and more automobile use created car-dependent urban areas and car-dependent life-styles. However, in recent decades, it has been realized that automobile dependent urban transport behavior cannot be sustained anymore due to its environmental, economic and social consequences. The world has been subject to severe environmental pollution that cause not only local deterioration of air quality but also global climate change; and the transport sector, particularly car use, play an important role in this trend due to the CO2 emissions created. Extensive usage of the car also brings economic problems since it fosters petrol dependency and rapid depletion of resources. Car-dependency also causes economic losses for individuals due to accidents, energy costs, taxes, and time costs because of congestion. Furthermore car-dependent urban areas create inequality in

accessibility for those who do not use cars, which includes not only lower income but also the elderly and children. It is accepted today that all these trends are unsustainable and therefore the increase in car usage cannot be sustained.

In order to make urban transport more sustainable, two main solutions are adopted by policy makers. First, urban transport modes that are alternatives to the car must be developed. Infrastructure and quality of public transport, walking and cycling must be improved. Secondly automobile use must be restricted in urban areas, particularly in city centers, so that its extensive usage is discouraged. Automobile use can be discouraged in urban areas through capacity reductions, parking restrictions, taxes, extra charging and traffic calming tools; however, these applications should be supported with improvements in public transport, walking and cycling.

While improvement of all these modes of transport is crucial, there has been a particular increase in projects that develop, improve and encourage bicycle use. Bikes, which do not create any pollution and use resources and road space at a minimum, have appeared as a sustainable alternative for urban transportation. In the years of the production of bicycle, it was considered just as a tool to support sport or entertainment activities. However, the potential of responding to short or medium-distance travel demands of people as an almost cost-free transport mode made bikes an increasingly preferred way of travel for users and policymakers. Recently, cycling has become one of the main components of urban transport plans and infrastructures in many cities in which bicycle use has been encouraged by the construction of different cycling infrastructure such as bicycle roads or lanes, bicycle parks, and public transport integration mechanisms enabling bicycles to be carried in public transport vehicles.

In the mid-20th Century, an innovative program for the use of cycling emerged in Amsterdam: bike-sharing systems, which refers to publicly provided and serviced bicycles in urban area. In this system, bikes can be picked up from any bike station and returned to any other station positioned in different demand-responsive locations in the city. Bike-sharing systems enable people to cycle for daily

mobility and help strengthen the role of cycling in urban transport. The main components of these systems are bicycles, docking stations (the stations to pick up and return bicycles), system access and user registration, system status information systems, and maintenance programs. Bike-sharing systems are considered today as one of the main components of a sustainable urban transport strategy mode, and they are seen and operated as a public transport mode. These systems are used in many cities around the world, and the leading examples include Paris-*Velib* (1800 station with more than 20000 bicycles), Montral-*BIXI* (411 station with 5120 bicycles) and Hangzhou-*Public Bicycle* (2416 station with 60600 bicycles).

In Turkey, cycling is still commonly considered as a soft policy by local governments, and the potential of bicycle use as an urban transport mode has been systematically under-recognized as an urban transport policy. Bicycle is mostly seen as a leisure time and sport activity. However, there is an increasing interest in some cities to build bike lanes and bike roads. In parallel to this trend, bike-sharing systems have also been recently launched in a number of cities. After the Kaybis Bike-share system in Kayseri, established in 2009, other cities such as Konya, İstanbul, Antalya, İzmir, and Samsun implemented this system in Turkey. However, there has not yet been a comprehensive analysis about this experience. There are no studies that show what has been experienced in the planning, construction and operation of these systems in Turkey, what the mistakes or correct attitudes of policy makers have been for their bike-sharing systems, and how much these systems are advanced compared to the experience of best-practice cases around the world. Therefore, **the aim of this research** is to analyze and provide a better understanding of the bike-share experience in Turkey, particularly in the three cities that became pioneers for this system in Turkey: Konya ‘Smart bike’, Kayseri ‘Kaybis’ and İstanbul ‘İsbike’.

In this research, it is intended to analyse and discuss the meaning and importance of bike-sharing in in urban planning and transport planning. A particular focus is on the use of these systems as an urban transport mode by providing a new

sustainable and non-motorized alternative for urban travel. The significant components of bike-sharing planning are integration into urban planning and transport plans, public transport integration of bike-sharing, and bike station site selection, which is related to the latter issue. In addition, bike-sharing cannot be considered only as a planning activity; there are also design issues and operational aspects from a project management perspective. Within this research, both planning and management aspects of bike-sharing will be investigated, and at the end, some principles will be recommended for bike-sharing in Turkey considering these two aspects.

The research questions of the study supported by some sub-questions, which serve fundamentally to achieve and improve the aim of the research, can be stated as follows:

- What are the strengths, weaknesses and the areas that can be improved for 'Smart bike', 'Kaybis' and 'İsbike' bike-sharing systems -in Konya, Kayseri and İstanbul respectively- from Turkey in the light of the criteria determined through the analysis of literature and best practices from the world?

  -- How was the planning background of these systems shaped in terms of planning the systems, decision-making, bike station site selection, planning aim, and bicycle road infrastructure?

  -- What is the general condition of the main components of these systems in terms of system design including aspects such as station shelter, sufficiency of bicycle numbers, locking mechanisms, noticeability of bike stations, and adopting 4th generation characteristics?

  -- How are the operational issues of bike-sharing shaped in these cities considering system continuity, mobile applications, smartcard integration, registration, maintenance of systems, pricing policy, and helmet wearing?

-- Are there any supportive complementary policies applied for bike-sharing systems in terms of encouraging policies, the use of systems as a sustainable non-motorized transport mode, and effective announcement/advertisement of systems?

-- Are there any intentions for future to develop the systems in terms of system extensions, demands from people, and physical improvements of systems?

- How do policy makers of these systems evaluate the systems that they operate: successful, deficient or developing?
- What can be the indispensable criteria -planning, design and operational principles- as policy inputs for future implementations in Turkey?

The research method comprised in-depth interviews with policy makers of selected three case study cities, participant observation while cycling with the bicycles of bike-sharing systems, collecting written and visual documents about bike-sharing in Konya, Kayseri and İstanbul.

In the following chapter of the study, Chapter 2, unsustainable growth trends in transport are described; consequences of car dependency are illustrated, and two integrated solutions for creating more sustainable urban transport systems are presented: restrictions on automobile use and improvements in public transport, walking and cycling. The literature review in this chapter particularly focuses on the increasing importance given by policymakers to the mode of cycling and the emergence of bike-sharing systems. The history, benefits, effects, costs and challenges, the future, and business models of these systems are presented in detail. At the end of this chapter, three successful bike-sharing examples from three different continents are studied in terms of general layout of systems, initiation process, bicycle and station capacity, existence of bicycle road infrastructure, pricing, public transport integration of systems, and the use of bike-sharing as an urban transport mode. These are Velib (Paris/Europe), BIXI (Montreal/America) and Public Bicycle (Hangzhou/Asia).

In Chapter 3, the methodology of the study is presented together with the context of the study, main aim and research questions, case study selection, and the method of case study analysis. The methodology builds on the analysis of the literature review and the investigation of successful practice cases presented in the previous chapter. Based on the outcomes of these analyses, a list of criteria is formed to serve as the basis of analysis and assessment for the Turkish bike-share case studies.

Chapter 4 presents the case studies after a brief description of cycling in general and bike-sharing in Turkey. The three bike-sharing examples are analyzed comparatively focusing on five areas, or indicators: planning background, system design, operational issues, supportive complementary policies and future plans. The chapter ends with the main findings of the case study analysis.

Finally, in Chapter 5, the research is concluded with a general summary of the research, main findings and recommendations for policy makers of bike-sharing in Turkey. Ideas are also offered for further studies in this field.

CHAPTER 2

2. UNSUSTAINABLE GROWTH OF URBAN TRANSPORT AND THE INCREASING IMPORTANCE OF BIKE-SHARING SYSTEMS AS AN URBAN TRANSPORT ALTERNATIVE

Various researches exist in the literature showing that the excessive use of automobile in urban transport is unsustainable. Automobile dependency, which has clearly seen and deeply felt impacts on environment, social relations and economic stability, is considered as an unsustainable behavioral pattern for daily inner city travels. Within the context of this research, firstly the concept of sustainability is presented in relation with urban transport; then unsustainable growth of the transport sector and the problems associated with car dependency are described. Later on, policies, projects and measures for making urban transport more sustainable will be discussed with a special focus on the increasing importance of bike systems and bike-share projects.

2.1. The Concept of Sustainability

Technological and industrial innovations of the past centuries have made daily life easier and faster; however, at the same time, we started to consume nature, create various kinds of imbalances in economy, and constitute deficiencies in social relations. Consequently, if nothing is done to protect the earth and its natural assets, and to maintain acceptable living conditions for all societies in the world, the current growth trends cannot be sustained since it severely compromises the future of the world.

After the beginning of the 21th Century, the world was exposed to deal with many new challenges. However, the most significant one has stood as growing instability of many natural phenomena such as volcanic activity, drought, fire, flooding, and hurricanes. Climate change is an obvious fact which is proved by small but continuous increases in temperatures across the globe, named global warming. Much of the population in the world is located in flooding-sensitive areas and more than half of megacities existed in the world are located near to sea

level or in river flood plains. For example, in these urban areas, around 500 million people will live and flooding tendency and the risk of rising sea level may strongly influence these locations. Besides the trouble of rising sea level, there is evidence for increasing occurrences of other disasters, such as fires, storms, crop failures, new diseases, and threats to biodiversity. Human activities resulted in some of these disasters directly, however in other cases their causes are not so obvious (Banister, 2005).

The process of global warming has to be controlled which means that all forms of carbon emissions should be decreased. The total global emissions of CO_2 which is the basic global warming gas have increased by about 60 percent between the years of 1971 and 2001 (International Energy Agency, 2001).

In addition to emissions created, since the industrial revolution, people have been over-consuming the natural resources to further industrial and economic development. Consumption of natural resources brings two main human based problems that are the depletion of resources for future development and the wastes of human, including air pollution and other wastes that have deteriorated drinking water. After the industrial revolution, technological and economic improvements have resulted in environmental damages, such as, most importantly, greenhouse effect and air-water pollution (Instiutte for Research and Innovation in Sustainability, 2011).

The emergence of sustainability concept was dated to 1972, in UN Conference on the Human Environment in Stockholm, aiming to have a cleaner environment by decreasing air and water pollution, and chemical contamination. 113 nations agreed the principles of this conference; later on, a global reaction to environmental issues was firstly revealed (Newman & Kenworthy, 1999). In Brundtland Report, the most commonly used definition of sustainable development was mentioned as *"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs".* (United Nations, 1987)

The concept of sustainability consists of four main principles retrieved from the Brundtland Report and those principles shape the significant approaches to global sustainability in general. These are;

- The elimination of poverty, especially in the Third World, is necessary not just on human grounds but as an environmental issue.
- The First World must reduce its consumption of resources and production of wastes.
- Global cooperation on environmental issues is no longer a soft option.
- Change toward sustainability can occur only with community-based approaches that take local cultures seriously (Newman & Kenworthy, 1999).

The perception of sustainable development has tried to be created considering the aim of decreasing consumption of resources in general. The most significant point here is to make decisions against irreversible impacts in global scale through a common policy making pattern of different countries, since it was realized after industrialization period that the world itself and its future are not the consideration of just one or several, but all of the countries or regions in the world.

The sustainability or sustainable development term has appeared from a political process which has aimed to integrate the strongest necessities of our time in global scale. The first one is the need for economic development to overcome poverty. The second one is the need for environmental protection of air, water, soil, and biodiversity, upon which we all ultimately depend. And, thirdly the need for social justice and cultural diversity to enable local communities to express their values in solving these issues stands as the final one (Tumlin, 2012). Therefore, in summary, the concept of sustainability refers to environmental protection in global scale along with any kinds of social or economic development (Figure 1).

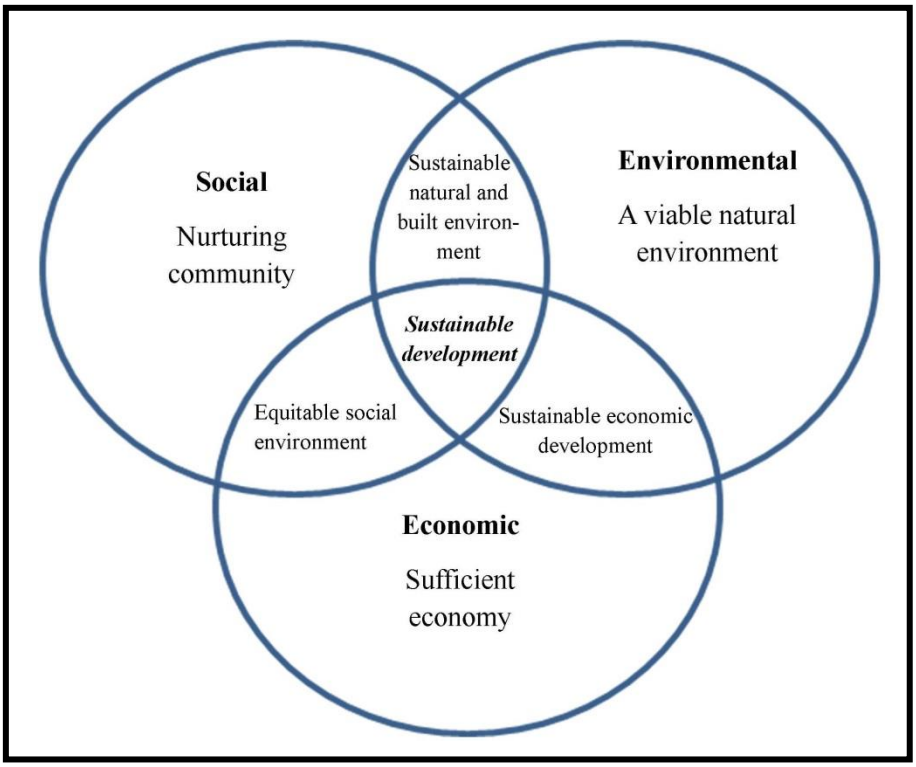

Figure 1. Three Pillars of Sustainability

Source: (http://www.pittstate.edu/office/president/initiatives/sustainability/what-is-sustainability.dot)

The statement of economic development is mainly about the growth in the economy in time and how this kind of an economic development is seen in the wealth of countries. Social development consists of concerns about the distribution of that wealth between individuals in society named social equity and over urban space named spatial equity. The third component of sustainability relates to the protection of environment in general. That kind of a protection includes sustaining the current stock of environmental resources and leaving this stock to other generations which has not been quite exploited. The environment part of sustainable development covers both the global and local environment within the context of the use of resources and production of pollution, and the subjects about biodiversity, sanitation, water quality and waste management (Banister, 2005).

The outlined components of sustainability have to be applied to cities. The goal of sustainability in a city can be stated as achieving the decrease in city's use of

natural resources, reduction of waste production; at the same time, improving the livability of the city, thus, it can more easily fit within the capacities of global, regional and local ecosystems (Newman & Kenworthy, 1999). The major objective of sustainable urban development has to ensure that development has to contain the use of carbon resources within the context of sustainability principles. In addition, all people in society have to reach that development according to their welfare and well-being. When the cities are considered depending on this framework, urban transport plays a key role in providing the efficient operation of the wealth-creating activities; and in bringing towards social well-being and ensuring access to those activities. It should be noted that transport is a major and growing consumer of energy; therefore, it has to make a significant amount of contribution to the environmental objective of decreasing its use of carbon-based energy sources (Banister, 2005).

2.2. Urban Transport and Sustainability

Each people in the world travel to shop, work or business; each kind of raw material has to be transferred from land to manufacture or usage, and all products have to be reached from production place to the market and from staff to the consumer. Transport, that is the term that covers those activities, plays a key role in the fabric of a modern-day urbanized nation. The way the people live or work has varied as a result of advancements in lifestyle and in transport capabilities; therefore, what can be stated for the future is that these developments and changes will continue to occur (O'Flaherty, 1997a). Thus, the important question is in what way this continuous process in transportation will take place and what kind of strategies will be needed in order to have both a more socially, economically and environmentally sustainable and livable future in urban areas.

Global warming, greenhouse effect and rising consumption of non-renewable resources constitutes the main components of environmental problems and the transport sector stands as one of the most significant contributor of it (Low, 2003). A policy change has occurred in various locations in the world by adopting sustainable and clean transport objectives which take part in many national and supranational policy documents. The necessity of adoption of a more sustainable

development which has minimized negative impacts on the environment became a universally-acknowledged objective (Babalık-Sutcliffe, 2009). Policy documents that have an emphasis on sustainable transport include the Brundtland Report published in 1987 (United Nations, 1987), the Earth Summit in Rio de Janeiro in 1992 (Earth Summit, 1992), and the Kyoto Protocol in 1998 (Kyoto Protocol, 1998). The OECD Conference on Sustainable Transport in 1996 (OECD, 1996) and the Habitat II meeting in İstanbul in the same year also made arguments about sustainability focusing on urban development and transport. In addition, the 2001 Habitat document (UNCHS (Habitat), 2001) emphasized the role of urban transport on sustainable human settlements development, and this document highlighted the significance of the transport sector in achieving overall sustainability objectives. Furthermore, the World Bank Urban Transport Strategy (World Bank, 2002) helped to highlight a framework for urban transport planning which contains the effects of transport on urban development, the environment, and poverty reduction, the significance of non-motorized transport, mass rapid transportation, public road passenger transport, as well as the methods of demand management, traffic management and pricing. EU Transport White Papers (European Union, 2001; European Union, 2011) also focused on the necessity to constitute a more balanced transport system and the need to move towards green urban transport modes (Babalık-Sutcliffe, 2009).

In recent years, significant discussions about the physical development of trans-European transportation systems and their operation were made, and previously mentioned legal documents were prepared that focus on present and future transportation policies. As understood from the document of White Papers, today, the primary principle is sustainability in existing European Union transportation policies (European Union, 2001), and to promote economic development, competitiveness and efficiency through green, i.e. environmentally-friendly transport modes and vehicle technologies (European Union, 2011).

In the last 30 years, the most preferred transport modes in either passenger or freight transport have been the modes that created most of the harmful environmental impacts. Since 1970, the most commonly used transport mode in

passenger traffic has become the automobile; and most of traffic increase was observed firstly in private automobile, and secondly in air passenger transport in those years. In addition, road transport, which has also been the most preferred mode in freight transport, has become the most crowded transport mode due to traffic. Those mentioned transportation types are the most polluting ones, and according to a research applied by European Union in 1998, 28% of CO_2 gas emissions which causes greenhouse effect are derived from the traffic in transport sector (European Union, 2001). Transport also represents between 20-25% of aggregate energy consumption which means that it stands as a major global consumer of energy (World Energy Council, 2007). Considering the contribution of transport to the future of sustainable development in cities, it can be easily stated that there is an evident need to have the integration of sustainability and transport sector to examine the ways of decreasing negative effects particularly on nature.

Sustainable urban transport includes cycling, walking, public transport, renewable energy and fuel-efficient vehicle technologies. Ensuring sustainable transportation for the communities has positive impacts on the three components of sustainability, i.e. environment, society and economy (Schafer, 1998). The concept of sustainable transportation can also be described as "transportation services that reflect the full social and environmental costs of their provision; that respect carrying capacity; and that balance the needs for mobility and safety with the needs for access, environmental quality, and neighborhood livability" (Jordan & Thomas, 1997). As another definition, "sustainable urban transportation system limits emissions and waste to within the area's ability to absorb; is powered by renewable energy sources, recycles its components, and minimizes the use of land; provides equitable access for people and their goods and helps achieve a healthy and desirable quality of life in each generation; and is financially affordable, operates at maximum efficiency, and supports a vibrant economy" (Duncan & Hartman, 1996).

The concept of sustainability refers to the explanation of the necessity for a long term perspective in order to achieve the reduction for demand on environmental

resources in general; it also explains the need to make essential changes to achieve the goals that are socially and economically beneficial (Newman & Kenworthy, 2000). Organization for Economic Co-operation and Development (OECD) held a conference in 1996 to state the concerns about governments regarding transport as a sector which creates significant problems for sustainable development. According to that conference, motorized transport has vital and commonly accepted environmental and health impacts which are global warming and depletion of ozone layer, spread of toxic organic and inorganic substances, depletion of oil and other natural resources, and damage to landscape and soil. This statement mentioned that there were over 800 million motorized vehicles in the world, and this number has been continuing to increase at higher rates than human population (OECD, 1996). As a result, in the current sustainability discussions particularly about urban transport, the main problem is about what we desire to sustain; more accurately, what we desire not to sustain anymore.

2.3. Unsustainable Growth of Urban Transport: Automobile Dependence

If sustainability is tried to be applied to cities, the forces that shape them have to be examined; therefore, in this framework, it will be easy to suggest global and local solutions for the current problems (Kostof, 1991). Dominant forces shaping the cities can be considered as:

- Economic priorities
- Cultural priorities
- Transportation priorities (Newman & Kenworthy, 1999)

Firstly, in order to establish any kind of infrastructure –particularly for transportation- that shapes the city, commitment of economic resources is required. Previous experiences reveal that sprawled and car dependent urban form in some cities were not embraced, and a more compact, less car oriented urban forms started to be supported. This was basically because of an economic priority rather than road-based infrastructure one (Newman & Kenworthy, 1999). In the nineteenth century and into the twentieth century, Western city had two distinct

types of urban structure: the first one was traditional high-density cities, and the other one was low density new frontier ones. The reason for this difference was the way these two types of cities used their capital. The high density cities did not use their capital accumulation for urban infrastructure in contrast with low density ones in which higher proportion of wealth is used for suburban infrastructure and housing (Frost, 1991). This shows the impact of economies on the development of urban structure. Secondly, cultural priorities affect the shape of cities. The history, tradition and culture of a city may have influence on urban development; for example, United States tends to be forming edge cities away from the inner cities. In addition, in the new global cities, there has been a necessity for face-to-face interaction; therefore, industries in central inner city areas has been shifted away (Newman & Kenworthy, 1999).

2.3.1. How the Automobile was Inserted to Our Lives and Shaped Urban Structure

The third and accurately the most important element that shapes the urban structure is the transportation choice of public and policy makers for the future of a city. Urban macro form is determined through planning by considering the future potentials, tradition, economic capability and future objectives. At this point, transportation tools step in the process as rail systems, road investments, cycling opportunities, and walking alternatives. That kinds of tools mainly determine the future development of urban development, and depending on these tools; according to the classification of Newman and Kenworthy (1999), in their book of "Sustainability and Cities: Overcoming Automobile Dependence", cities can be grouped into three main groups: the walking city, the transit city, and finally the automobile city.

The initial cities were settled in the Middle East between 10000 or 7000 years ago, and the urban structures of those cities were developed in time according to walking pattern of society. Although central parts of American and Australian cities had an urban structure of Walking City, this feature was lost in time. In recent years, just some historical urban areas have kept this kind of a structure like

Society Hill in Philadelphia, the North End in Boston and the Rocks in Sydney. According to Figure 2, the traditional Walking City includes high density (100-200 people per hectare); mixed land use, narrow streets which have organic form appropriate with existing landscape, and half an hour reaching distance on foot between destinations (Newman & Kenworthy, 1999).

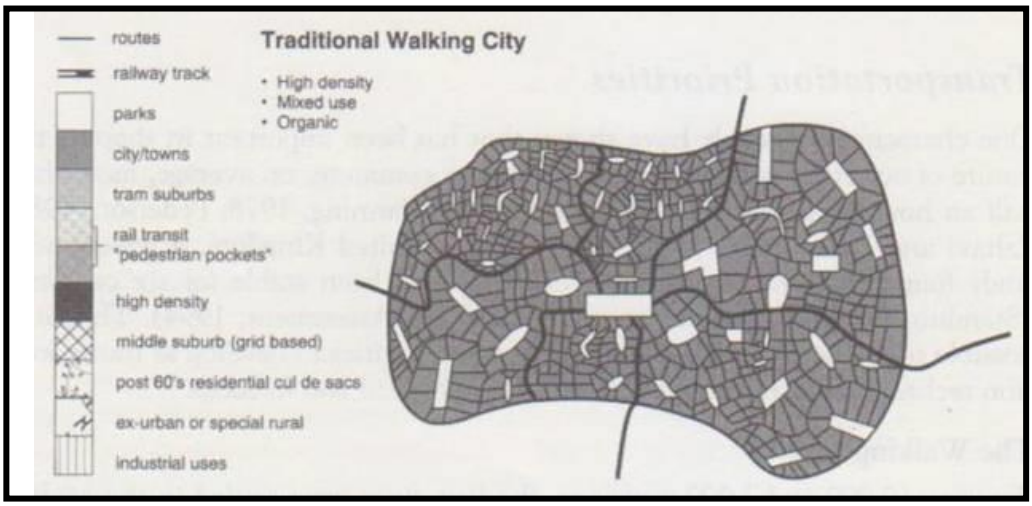

Figure 2. Traditional Walking City

Source: (Newman & Kenworthy, 1999)

After the 1960s, population and industry made the old Walking Cities begin to collapse in Europe and the New World. As a result of this, a new urban form developed and the cities which had this kind of form owned the capacity to accommodate many more people at lower densities while maintaining the half-hour average accessibility distance. This condition was fulfilled by new transit technologies; for example, the train and tram (initially horse-drawn, then steam, then electric) changed the macro form of the cities which were oriented towards outward and enabled faster travel for passengers, and finally, the Transit City was created as seen on Figure 3 (Newman & Kenworthy, 1999).

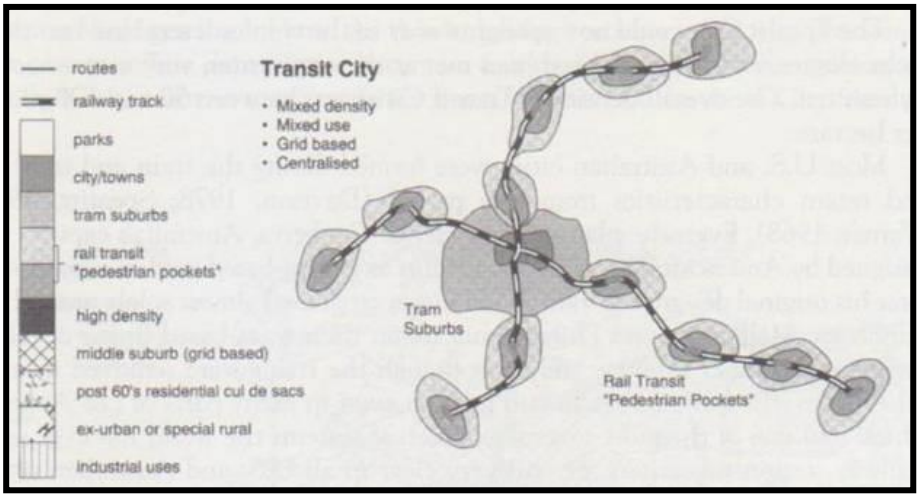

Figure 3. Transit City

Source: (Newman & Kenworthy, 1999)

Trains and trams constitute different kinds of impacts on the development of cities. For the Transit City, the trains usually created sub-centers at railway stations. These sub-centers were small cities with walking scale pattern. Nevertheless, trams created linear urban development on main corridors or streets. These two cases formed mixed use and medium density urban areas along tram lines and rail station nodes. The overall density of this kind of urban form was between 50 and 100 people per hectare. Today, a significant and powerful movement in planning named transit-oriented development (TOD) tries to reemphasize the importance of an urban development which is based on transit passenger travel. When the current European cities are considered, it is seen that the pattern of the Transit City that has transit oriented form and tram systems are retained in most examples although in recent decades, they have started to sprawl around their main corridors becoming increasingly dependent on automobile transportation (Newman & Kenworthy, 1999).

The automobile, supported by bus, has become the transportation mode which formed the urban physical structure after the beginning of the years of Second World War. By this technology, it was possible for the city to develop in any direction. Initially, urban development occurred between train lines, and then the cities started to develop fifty kilometers away from the central core for the

average half-hour journey.The Automobile City appeared (Figure 4). In Auto Cities, as a reaction to the industrial city, urban planners started to separate residential and business centers by zoning and they used low density housing pattern in those residential areas. Therefore, journey distances were increased, reinforced further by decentralization and urban sprawl. In addition, the density of the Auto City decreased to approximately ten or twenty people per hectare. The recently experienced Auto City concept means the availability of automobile, and this made developers provide not more than basic power and water services which means that people could make the transportation connections themselves. After this kind of a process, the phenomenon of automobile dependence as a transportation issue, which appeared not as a choice but a necessity in Auto City, has become a significant characteristic of urban life (Newman & Kenworthy, 1999).

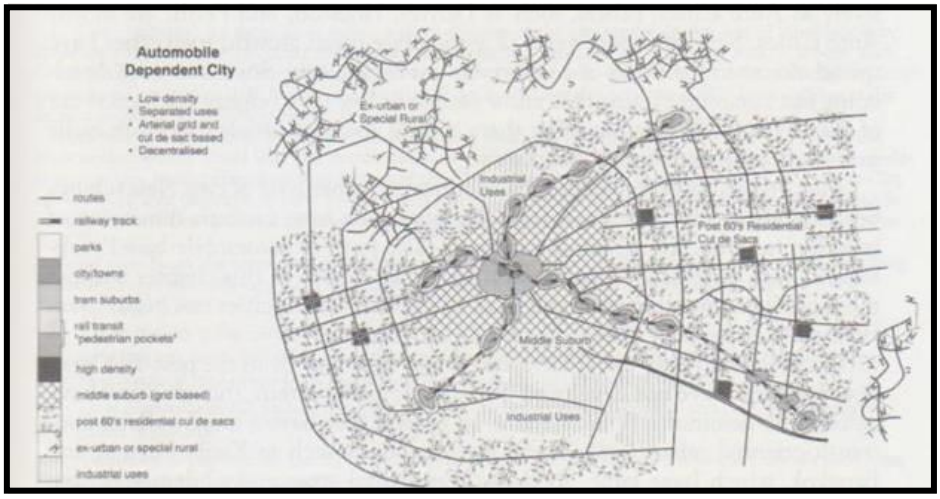

Figure 4. Automobile Dependent City

Source: (Newman & Kenworthy, 1999)

According to a study carried out by Newman and Kenworthy (1989), three cities - New York, San Francisco and Melbourne- were taken as examples in order to examine the change in gasoline use and urban density starting from core suburbs towards outer suburbs as shown in Table 1. Gasoline use per person increases; on the contrary, urban density decreases in three cities when the distance increases from core suburbs towards outer suburbs; in other words, from walking oriented

urban structure to automobile oriented one (Newman & Kenworthy, 1989). This means that behavior of private car use is more common in the places that are far away from city center in which the density decreases. Therefore, it can be concluded that automobile use has become an inevitable necessity or, more accurately an obligation, in the sprawled parts of cities and this causes negative infrastructural and environmental costs to the cities.

Table 1. Variations in Car Use with Urban Density across Cities, 1980

	Core Suburbs (Walking-oriented)		**Inner and Middle Suburbs (Transit-oriented)**		**Outer Suburbs (Automobile-oriented)**	
CITIES	*Gasoline use (per person)*	*Urban density (persons per hectare)*	*Gasoline use (per person)*	*Urban density (persons per hectare)*	*Gasoline use (per person)*	*Urban density (persons per hectare)*
New York	11.9	251	20.1	107	59.6	13
San Francisco	17.5	128	33.3	57	58.4	8
Melbourne	13.2	32	20.3	20	26.9	10

Source: (Newman & Kenworthy, 1989)

In a car oriented city, people living in suburbs have no other choice that the automobile to determine their life style and travel behavior. New suburbs far away many kilometers from the city center, experience a kind of isolation from traditional urban functions and, depend on the car for every urban need and activity. Hence urban and transport problems in car oriented or dependent cities are growing rapidly (Newman & Kenworthy, 1999).

When the effects of car dependence are considered in urban areas in terms of sustainability concerns for the future of environment, society and economy, it is obvious that an automobile based urban pattern cannot be sustained. The following section highlights why car based urban systems are considered unsustainable.

2.3.2. Why Car Dependency is Unsustainable?

In the late 1960s, both public and policy makers tended to reconstruct central urban areas in order to create more space for traffic such as roads and parking spaces. In the early 1970s, many Western countries realized the negative urban and health impacts associated with the excessive use of automobile, and prepared regulations to reduce emissions of pollutants per vehicle kilometer for cars and other kinds of road vehicles together with considering noise emissions of them (Wee, 2007).

The use of automobiles has significantly increased during the last few decades. Between the years of 1970 and 1990, the number of passenger kilometers by private car per capita experienced an abrupt rise by 90 percent in Western Europe and 13 percent in the United States (Jakobsson, 2004). Road traffic that depends on motorized vehicles is a fundamental contributor to particularly environmental problems at a global scale. Steady growth of motorized traffic threats the quality of life in urban areas, and private car use is an important source of these problems. In this instance, reducing negative effects per vehicle through new technologies cannot make a significant impact to completely control these problems; instead, changes in volumes of car traffic are necessary (OECD, 1996).

According to Newman and Kenworthy (2000), the problems of car dependence can be classified into three headings of sustainability (Table 2).

Table 2. The Problems of Car Dependence

ENVIRONMENTAL	ECONOMIC	SOCIAL
• Oil vulnerability	• External costs from accidents and pollutions	• Loss of street life
• Photochemical smog	• Congestion costs, despite endless road building	• Loss of community

Table 2 (continued)

• Toxic emissions such as lead and benzene	• High infrastructure costs in new sprawling suburbs	• Loss of public safety
• High greenhouse gas contributions	• Loss of productive rural land	• Isolation in remote suburbs
• Urban sprawl	• Loss of urban land	• Access problems for car for car- less and those with disabilities
• Greater storm-water problems from extra hard surfaces		
• Traffic problems such as noise and severance		

Source: (Newman & Kenworthy, 2000)

It can be seen in the table that problems of car dependence cover a wide range of issues, varying from economic efficiency, environmental responsibility, social equity, and human livability. The effects of automobile dependence on the *efficiency of economy*, firstly, start with infrastructure costs. A significant amount of costs for new urban infrastructure emerges, because older infrastructure in the city is underutilized. In fact it is obvious that, as long as the urban development is low density and sprawled rather than transit oriented, monetary sources will still be wasted. Then, transportation costs come for the issue of economic efficiency. It

is important to mention that the total costs of an automobile-based urban transportation system exceed transit system costs by 30% to 40%. Moreover, this system could become completely automobile-based with a little focus on public transport; therefore, the land use structure has to be on the basis of more concentrated and non-motorized movements including public transport. In addition, time costs of an automobile based urban transport system also exist as a constraint. Urban traffic mostly creates congestion, and cities have been oriented their way out towards it. Therefore, people lose most of their time for travelling from one destination in a city to another, and it has to be reconsidered that the solution for the problem of time loss necessitates land use changes in order to reduce the need to travel. The last problem of economic efficiency on the basis of automobile dependence is land waste which refers to the use of urban land for car parking and new road construction. The loss of available productive land for excessive parking and road space is not only the concern of economic constraints, but social as well as environmental ones. Secondly, the constraint of *social equity* on automobile dependent cities stands initially together with inequalities in being car-less. In any city, a significant part of population cannot drive, because of being too young, too poor, too old, or just disabled and being thus disadvantaged. Then, the issue of inequalities in location comes. The people living in middle, outer and fringe suburbs created in the era of the car are access disadvantaged because of lack of transit, which is often the case in car-dependent cities. This kind of a disadvantage has two key characteristics: primarily, the policy makers focus on transportation rather than land use policy approach which reduce the need for car travel; and secondary, they give priority to private cars over public transport and non-motorized modes. Furthermore, there are constraints of automobile dependence on *human livability*. Initially, the issue of loss of community constitutes one of the significant automobile-related constraints. The interactions between neighborhoods and communities are decreased, because together with the domination of automobile on urban transport, pedestrian or transit system travels -which cause accidental or casual interaction between people-lessened. Therefore, it is evident that walking, cycling and public transport

play crucial role in considering the quality, and more interaction of human oriented aspects of access and transportation. Moreover, loss of urban vitality stands as another part of constraints. The vitality and culture of the city is decreased when urban spaces are dominated by automobiles instead of people. The main problem here is structuring our cities according to car use and an emphasis on private rather than public space (Newman & Kenworthy, 1999).

One of the most important constraints on automobile dependent cities is about *environmental responsibility*. Newman and Kenworthy (1999) mentioned environmental effects of automobile dominance in cities as follows:

- Oil vulnerability: The main resource of modern cities and civilization is oil which constitutes almost the most concentrated of our energy forms, most easily extracted, processed and transported of all our fossil fuels, and the people have become highly dependent on it because of urban transport needs. Thus, there will be increasing vulnerability to oil shocks in future.
- Greenhouse gases: Attempts for reducing CO_2 will orient policy makers to turn to transportation for changes, because it is the most rapidly growing user of fossil fuels. After the increase in greenhouse gases for many years, the waste products of industries, that have vital effects on climate change, now have to begin to decrease. Therefore, it will be impossible to achieve this goal if we would not change the focus of planning to rebuild Auto cities.
- Smog: The cleaning quality of air is fundamental for the health of cities, however automobile-based urban structures bring a kind of environment that regularly exceed smog limits. Smog pollution can be dealt with a combination of incremental approaches like technological developments for cars and their engines, and improvements in traffic systems. On the other hand, if the efforts are not focused towards reducing annual growth in car travel, other approaches cannot be effective by themselves.
- Sprawl impacts: The cities experiencing urban sprawl towards fringe have high amount of asphalt or road infrastructure for the movements of

automobiles (about eight parking spaces per car in the US, and more roads per capita), therefore more stormwater pollution exists.

- Traffic impacts: The noise and visual pollution, loss of community perception, road accidents (globally 250 000 deaths per year), and parking problems are created with excessive traffic impacts depending on automobile dependence. Reduction of these kinds of impacts can be possible with only the changes in urban systems, such as provision of less car dependent housing and employment regulations, traffic calming tools, building up new public transport networks, and giving priority to non-motorized modes in urban transport such as walking and cycling (Newman & Kenworthy, 1999).

Primarily, local air pollution stands as one of the most significant environmental effects of traffic. The emissions coming from road vehicles create significant levels of concentrations of pollutants which cause negative health effects, smell disturbances, dirt on anything located near to the roads. Climate change is a very important issue that is constituted basically as a result of combustion of fossil fuels causing CO_2 emissions. Another problem is the effects of acidification on nature, agriculture and landscape. Then, most importantly, air pollution comes as a final result affecting the ozone formation (Wee, 2007).

Urban transport is also highly related with injuries and deaths as a result of accidents and this probably have the most dramatic unfavorable influences on both objective and experienced quality of life of survivors, their families and friends. Besides, it can be extensively considered that serious accidents have irreversible impacts on victims due to drunk or careless driver who fatally injures someone else (Gifford, 2007). Motor vehicle accidents constitute 44% of total accidental deaths in the United States; in addition, approximately about 45,000 people have been died every year in the last 30 years for that reason (Best, 2005). In Table 3, statistical data can be seen including population, number of people with driver license, total motor vehicle accidents, deaths and injuries between 2002-2011 for Turkey. When the number of people with driving license is

considered almost in parallel with the number of motor vehicles in traffic, it can be obviously seen from the table that the number of total motor vehicle accidents -constituted much of them from car involvements- raised almost threefold in number between the years of 2002 and 2011. In those accidents, important numbers of them involved death or personal injury which increased also in parallel with the number of driver in traffic and total accidents. In addition, almost each year, an approximate average number of 4300 people were killed, and more people also injured. In this case, it is evident that motorized traffic has a direct effect on not only human health, but its existence, and if the increase in the use of motorized vehicles -especially private cars- continues, the condition will be very dramatic as expected.

Table 3. Number of driver license, persons killed, persons injured, motor vehicles and population between 2002-2011 in Turkey

YEARS	Population (Thousand)	Number of People with Driving License	Total Motor Vehicle Accidents	Accidents involving death and personal injury	Number of people killed	Number of people injured
2002	69 626	14,994,960	439 777	65 748	4 093	116 412
2003	70 231	15,488,493	455 637	67 031	3 946	118 214
2004	71 794	16,151,623	537 352	77 008	4 427	136 437
2005	72 065	16,958,895	620 789	87 273	4 505	154 086
2006	72 974	17,586,179	728 755	96 128	4 633	169 080
2007	70 586	18,422,958	825 561	106 994	5 007	189 057
2008	71 517	19,377,790	950 120	104 212	4 236	184 468
2009	72 561	20,460,739	1 053 346	111 121	4 324	201 380
2010	73 723	21,548,381	1 106 201	116 804	4 045	211 496
2011	74 724	22,798,282	1 228 928	131 845	3 835	238 074

Source: (Turkish Statistical Institute, 2012)

Thus, the seriousness of the circumstance has to be stated that on the one hand, a car based urban transport system damages particularly the environment, climate, and nature; and on the other hand, it affects human health and quality of life in general. It is evident that car use has unfavorable results on three phases of

sustainability: on economy, society, and especially environmental quality; therefore, the answer of the question about what we undoubtedly should not sustain anymore for urban transport appears more clearly. In short, a car-based urban travel pattern cannot be sustained, and some kinds of sustainable solutions have to be considered in policy making.

2.4. Sustainable Solutions for Car Dependency

In order to preserve a lifestyle that includes various activities at different places in urban areas, travel has to be convenient, fast, and affordable. Many kinds of investments in road infrastructure, improvements in automobile technology, and increasing affordability to purchase automobiles resulted in a situation where most modes of travel cannot compete with private car for urban transport. Actually, instrumental motives constitute primary motives for buying and using private cars, and in addition to these instrumental reasons, the reasons people prefer to use their car even for short distances -despite the suitability of cycling and walking- are convenience and the advantage on time pressure (Mackett, 2003). Besides, private car use is considered as fast, comfortable, prestigious, flexible, facility for free choice of route, and possible to carry heavy cargo (Jakobsson, 2004). All these contents constitute the causes about why people prefer car use instead of public transport or non-motorized modes such as walking and cycling. Since the consideration of using the car as an only unique and appropriate urban transport mode seem quite reasonable to drivers; in fact, a kind of a dependency is formed unconsciously. Therefore, it should be realized that some kinds of precautions have to be taken and new sustainable approaches must be adopted including much more use of public transport and non-motorized modes against the negative aspects of car dependent urban transport systems. In current decades, this is evident in the concepts of New Urbanism, Smart growth, and Transit Oriented Development (TOD). Besides, most importantly, sustainable solutions to automobile dependence can be derived under two headings: primarily, improving the alternatives to the automobile, and then implementing restrictions in the use of automobile, thus presenting incentives for using alternative modes and disincentives for using the automobile.

A discussion came into agenda about the approaches to urbanism which has been evolving in North America for over a century, named New Urbanism. This approach has been considered as an urban reform movement which was highly popular in the 1990s (Talen, 2005). Yan and Gerrit (2003) mentioned that a group of architects found the Congress for the New Urbanism in 1993 and dedicated this meeting to creating buildings, neighborhoods, and regions that provide a high quality of life for all residents, while protecting the natural environment (Yan & Gerrit, 2003). New Urbanism can be considered as the most significant planning movement in this century which mainly focuses on creating a better future for us all. It aims to reform the design of the built environment, and to increase quality of life by establishing better places to live (http://www.newurbanism.org/newurbanism.html). Thus, a brief explanation about the principles of New Urbanism can be stated as including high density, mixed use neighborhoods; strategically placed open spaces; convenient public transit, bicycle paths and pedestrian-friendly streets; and well-designed architecture to establish social connection (Yan & Gerrit, 2003).

According to the Charter of New Urbanism (1996), the main principles of New Urbanism movement about transport and mobility in urban areas can be summarized as follows:

- Most of the activities have to be located within walking distance which allows independence for the people who cannot drive, particularly the elderly and the young.
- Transportation alternatives should constitute a framework that allow the support of a physical organization including maximization of access together with transit, pedestrian, and bicycle systems. Therefore, mobility through region increases and automobile dependence is reduced.
- Neighborhoods have to be compact and mixed use, and pedestrian friendly. In addition, some corridors between neighborhoods and districts form connections through boulevards, rail lines, rivers and parkways.

- Appropriately planned and coordinated transit corridors can make metropolitan structure organized and urban centers revitalized. However, highway corridors should not displace investment from existing centers.
- Convenient building densities and land uses have to be within walking distance of transit stops which constitutes public transit to become an effective alternative to automobile.
- The automobile must be applied in the development of contemporary metropolis; however it should not lose the respect to the pedestrian and the form of public space.
- Streets and squares should create environments which seem safe, comfortable, and interesting to the pedestrian. If they are well-designed, they encourage people to walk, and enable neighbors to communicate and protect their communities (Congress for the New Urbanism, 1996).

In addition to the contribution of New Urbanism movement for the sustainability of urban transport, another concept stands as Smart Growth which aims to organize the urban growth in a sustainable manner.

Smart Growth concept exists under the umbrella term of sustainability, and together with local, regional, state and federal plans, it aims to achieve compact, non-sprawl, transit corridor or new town development patterns. It also necessitates sufficient public facilities in the areas that urban development occurs (Freilich & Popowitz, 2010). The policies of Smart Growth aim to achieve the goal of reducing per capita impervious land which is covered by any kind of urban land use such as buildings, roads or parking facilities, minimizing vehicle ownership together with vehicle travel, and increasing the use of alternative urban transport modes compared with sprawled, automobile-dependent, and more dispersed urban macroform. In short, Smart Growth can be considered as an alternative to dispersed, automobile dependent development in outer parts of urban areas that are usually referred to as urban sprawl (Litman, 2012).

According to the report prepared by International Economic Development Council in Washington (2006), the principles of Smart Growth can be listed as:

- Mix land uses
- Use land efficiently
- Create a range of safe, convenient, and affordable housing opportunities and choices
- Create walkable neighborhoods
- Foster distinctive, attractive communities with a strong sense of place
- Preserve natural lands, farmland, and critical environmental areas
- Strengthen and direct development toward existing communities
- Provide a variety of transportation choices
- Make development decisions predictable fair, and cost-effective
- Encourage community and stakeholder collaboration in development decisions (International Economic Development Council, 2006)

When it is thought from the perspective of urban transport, Smart Growth provides walkable communities, different transportation alternatives, contributes access to many different origins and destinations, includes a quality pedestrian environment, and useful public transport services. Within the context of a Smart Growth transportation system, six items are included:

- Multiple routes between points
- Short building blocks and frequent chances to cross streets on foot
- Direct and safe travel routes provided by sidewalks and bicycle facilities
- Different kinds of street types providing access and mobility
- Access management which means that, for instance, there should be a link between highways and towns; however, they should not bypass these towns
- Dense and frequent public transport service (Ang-Olson, Ecola, & Santore, 2003)

As easily seen in all these principles, the common conclusion can be drawn that automobile use should not be supported, and its alternatives have to be improved in order to achieve the future sustainability of our cities. In this case, urban public

transport constitutes a significant choice for urban travel supported by the concept of Transit Oriented Development (TOD).

The problems in urban transport contains traffic congestion, accidents, inequitable access to transport and services, changing prices, unreliable public transport, noise and air pollution created by emissions from automobiles and their negative impacts on human health, decreasing use of walking and cycling, and dominance of car use in urban traffic for even short distances. The Transit Oriented Development concept contains moderate and high density housing near to the important retail, services, and public uses that focus on mixed-use urban development on strategic points along the rail system. The main emphasis of TOD is directed to a pedestrian oriented environment and strengthening the use of public transport, and this kind of integration between land use and transit results in an urban development pattern which increases the use of public transport systems, and provides reduction in urban sprawl, traffic congestion and air pollution. In addition, pedestrian friendly mixed use development structure connected to transit enables urban growth minimizing environmental and social costs (Calthorpe Associates, 1992).

Calthorpe (1993) presented the urban design principles associated with Transit Oriented Development in his book as:

- A compact and transit supportive development urban growth on regional level,
- Location of housing, jobs, commercial activities, parks and civic uses within walking distance of transit stops,
- Formation of street networks that are pedestrian friendly and directly connected to local destinations,
- Provision of a mix of housing types, densities, and costs,
- Protection of environmental quality and high quality open spaces,
- Making public spaces the focus of building orientation and neighborhood activity

- Encouragement of infill and redevelopment along transit corridors in the existing neighborhoods (Calthrope, 1993)

As expected, a variety of solutions to the problem of automobile dependence can be mentioned as restrictions for using cars, and improving public transport services and biking and walking conditions. This requires a careful management of the urban transport system. In the 1980s, concepts of congestion management and travel demand management were tried to be discussed referring to problems in cities, inter-city corridors, and activity centers that produce urban traffic (O'Flaherty, 1997b). These management measures can help to accomplish one or more of the following targets:

- Reduce the need to make a trip
- Reduce the length of a trip
- Promote non-motorized transport
- Promote public transport
- Promote car pooling
- Shift peak hour travel
- Shift travel from congested locations
- Reduce traffic delays (OECD, 1994)

There is a necessity to improve the alternatives to the automobile and at the same time better manage the extensive usage of automobiles in urban areas. Today contemporary transport policies for a more sustainable urban transport system can be categorized under two headings: restrictions on automobile use and improving the alternatives to automobile.

2.4.1. Restrictions on Automobile Use

At the beginning of the 20th Century, automobile was only available for the accessibility of a small minority group of people, but today, even in countries like Turkey, it has become widespread for the middle class income group of societies. The reason of this rapid advancement is that when automobile is compared to public transport, which has relatively lower speed, longer journey durations, and

sometimes problems of reliability and punctuality, it seems superior and more convenient. Automobile enables people to reach from one place to another without waiting, with comfortable sitting, privacy and door to door transportation (Elker, 1979). However, automobile is a commonly used urban transport vehicle in the city today, and despite its advantages, it should not be ignored that automobile is an urban transport mode which has the most negative effects on public transit among all urban transport modes (Elker, 2012). Besides the negative effects on public transit, it has also environmental, economical, and social drawbacks; therefore, first and foremost, the use of automobile should be restricted and decreased as much as possible. The possible policies to achieve this target can be listed as follows.

- **Vehicle ownership taxes:** These taxes on car purchase can be considered as the most obvious direct charge on private car. Increasing the proportion of fixed car use costs may have effect on decreasing car use or ownership (May, 1997). The aim of this kind of taxes is to make people feel that they cannot afford to buy a car; however, high income people will always continue to buy a new car, and high income people are not be affected from this increase. The real impact could be on middle class of society, therefore the efficiency of this policy about decreasing car use and ownership stands as a debatable issue.
- **Fuel taxes:** These taxes can contribute to the efforts for decreasing car use, particularly in longer term, people start to choose more fuel efficient vehicles in order to deal with these taxes. Therefore, this provides the condition for fuel savings and also, efficiency for environmental sustainability strategies. On the other hand, it would not have too much impact on congestion or traffic safety. As in vehicle ownership taxes, fuel taxes affects mainly the accessibility of low income people who could not afford the increase in these taxes (May, 1997).
- **Parking measures:** Time, fee, travel time and cost are all important for parking; therefore, it is possible to affect the demand for car use positively or negatively by facilitating or bringing additional burden to the parking

action at arrival points. Freezing or decreasing the supply of parking space particularly in city centers is an effective precaution that makes car use for travelling city centers less attractive. In addition, another policy for decreasing automobile travel to city center is charging more in CBD for parking compared to peripheral locations (Elker, 2012; Kılınçaslan, 2012).

- **Congestion charging:** That kind of charging could decrease car use in the charged area, and contributes the decrease in environmental impacts and accidents. Several types of congestion charging methods exist, and the most significant one stands as charging to cross screenlines or cordons, using paper licenses, toll gates, or totally automated electronic charging. Other types were applied as charging in a defined area according to how much time is taken, travel distance, and time spent in congestion (as in Cambridge). With this type of charging, urban traffic diverts to boundary routes and other modes of transport –particularly buses- are used much more. As a result, congestion charging can achieve significant efficiency, environmental and safety advantages together with increasing accessibility. However, there is also a risk of being congested for alternative modes, and this problem can be solved together with careful design (May, 1997).
- **Traffic calming measures:** This method mainly aims to reduce the speeds of motor vehicles in built up areas including the promotion of pedestrian, public and bicycle transport. The main objectives of traffic calming can be listed as:
  - Decreasing the higher speeds of vehicles in urban traffic
  - Making regulations on road conditions encouraging people to drive calmly and more carefully
  - Displacement extra car and commercial vehicle traffic from the roads and streets which are calmed
  - Advancements on amenity and improvements for the environment
  - Decreasing accidents in traffic and severity (O'Flaherty, 1997c).

Newman and Kenworthy (1999) also added these objectives as:

- Decreasing local air and noise pollution and vehicle fuel consumption
- Advancement of urban street environment for non-car users
- Reducing the dominance of private cars on roads by providing more living spaces instead of roads (Newman & Kenworthy, 1999)

Methods of traffic calming consist of many kinds of techniques as exemplified below:

- street planting on the road and greening the environment
- extensions on sidewalks and supply of cycle ways on the roads
- narrowing driving lanes
- establishment of light rail occupying almost half of the existing road space
- provision of angle parking allowing the separation of widened pedestrian facility and cycle ways from traffic
- using Woonerf style service and access roads
- pedestrianization of streets and squares
- decreasing the width of roads at the pedestrian crossing points by using changes in street surface
- speed bumps or plateaus in order to limit the speed of vehicles especially near pedestrian crossing points (Newman & Kenworthy, 1999).

- **Car-pooling:** This concept is about putting single car drivers into fewer vehicles, therefore it is expected that travel distance of vehicles, traffic congestion, and air pollution can be reduced. Car-pooling can be applied in an informal manner which is organized by a group of people sharing the driving and decrease the cost of driving alone. the efficiency of car-pooling increases when distance of trips are long, and the participants who are compatible, have jobs in the same area, and have full-time jobs with same travel time table each day (O'Flaherty, 1997b).
- **Charging for road use**: More radical mechanisms are considered in many countries in order to deal with the use of private car on congested roads.

> Road pricing is one of the more commonly used measures which consists of employing the "user pays" principle on a congested road to create thoughts on drivers' mind about whether or not to use the controlled roads (O'Flaherty, 1997b)

All these measures constitute precautions for decreasing automobile use because of sustainability concerns that were previously stated. Besides, when the excessive use of car is transformed to car dependency, the restrictions to decrease the use of it cannot be efficient and adequate enough; therefore, some other solution is needed which stands as improving the alternatives to the car. These alternatives modes can be stated as public transport, walking, and finally cycling.

2.4.2. Improving Public Transport, Walking, and Cycling

Particularly, after the oil crisis in the early 1970s, the interest on public transport for daily urban access has significantly increased, and people started to prefer public transport more instead of their car. Many new generation metro systems, Light Rail Systems (LRT), buses, and trams have been built in the world in order to meet the demand for mobility and to do this in a less energy-intensive way. In addition, due to especially sustainability concerns, walking appeared as another alternative for particularly short distances, and for that purpose, pedestrianization projects in city centers were implemented and new areas that only pedestrian access and use are enabled were established to support walking. In addition to public transport and walking, cycling started to receive attention since experience in some Northern European cities showed that it could be used as an effective urban transport mode. Until a few decades ago, it has been mostly considered as a soft policy by the authorities, meaning that cycling was seen as a leisure or sport activity, and investments to improve cycling infrastructure to make it easier for people to move by using their bicycles for the aim of creating an alternative urban transport mode have not been considered as effective transport investment options. However, today there is a better understanding of the potentials of cycling as an urban transport mode. In the following sections, alternatives to the

automobile are presented, and hence information is given on public transport, walking and finally cycling.

2.4.2.1. Public Transport

The most efficient passenger transport mode for long distances and at the corridors that travel demand is high in urban transport is public transport. In cases of short travel distances pedestrian travel and transport through cycling can also be efficient alternatives (Sutcliffe-Babalık, 2012). It can be seen that public transport systems provide significant advantages for passenger travel when compared to car use. At most five people can be carried by car; on the other hand, the passenger capacity of a bus changes between the ranges of 40 or 120 which means that 8 or 24 times more people can be carried by public transport. Automobile and public transport is also differentiated in terms of the necessity of road use. For example, a 12 lane road is needed for 40,000 people to cross over a bridge; on the other hand, only 4 lanes for bus, and two lanes for a light rail system is needed (Illich, 1992). In addition, another advantage of public transport systems compared to the car is the efficiency for energy consumption, that is, per passenger transported per kilometer automobile consumes five times more energy compared to bus and metro, and automobile creates 125 times more air pollution compared to bus. For these reasons, improving public transport plays a key role within the framework of sustainable development strategies. Consequently, sustainable urban development objective necessitates a high quality and sufficient capacity public transport system (Sutcliffe-Babalık, 2012).

2.4.2.2. Walking

Another sustainable mode for urban accessibility is walking. Pedestrian oriented regulations -especially in city centers- can make people use their car less for transportation and, also it contributes to decreasing unsustainable impacts of automobile on the streets or open public spaces.

According to Tumlin (2012), pedestrian planning principles include several critical issues including that most of the needs of daily life should be available within walking distance; buildings should be in relation with sidewalks rather than

parking lots; road traffic has to be calmed; lighting should be arranged for the benefit of pedestrians; people should feel safe. Even if all these principles are applied in the design of a walkable environment; at first glance, walking may not seem as an alternative transport mode compared to car or public transport; however, if urban planning and design of an area includes efficient regulation principles that focuses on facilitating pedestrian movements particularly in short distances, it can seriously affect the appearance of car in the areas in which the car existence is not desired -particularly in city centers- due to wishes for the efficient pedestrian use of urban space and for a less polluted, more equal urban social environment.

2.4.2.3. Cycling

Finally, and the most importantly for this study, cycling stands as a transport alternative which can contribute significantly to sustainability of our urban transport future. Using bicycle as a transport mode has been common travel choice for many years in the globe: there are a number of cities where people ride their bicycle from their home to school, or to work, or to a leisure activity, or to the opposite direction, and now this can be considered as a permanent culture, in other words, 'cycling culture'.

Learning from the experience of such cities with a cycling culture, many other cities in the world started to invest in cycling infrastructure by developing bikeways, bike lanes, and building bike parks. In order to further encourage the usage of this mode, which is one of the most sustainable modes of travel since it requires no energy and emits no pollution, many cities in the world also started to launch bike-share systems.

2.5. Planning and Implementation of Bicycle as a Sustainable Transport Mode

Cycling is commonly accepted as a clean and sustainable urban transport mode. The potential of cycling is in its being an alternative to automobile use for short distance travel in cities (European Conference of Ministers of Transport, 2004). Bicycle can be a leisure time or sport activity, or it can also serve to an aim of

movement from one point to another. According to Grava (2003), cycling can be used in several ways and the most common ones are listed as:

- Children's toy
- Recreational device
- Competitive sport
- Urban transport
- Service vehicles

Cycling, which means using a bike in order to move from one point to another, is considered in this study for its use as an effective urban transport mode. When the production of bicycles started, it was accepted as a tool for sport and leisure time activity in the open air. Today, rather than just being a recreational tool, cycling is considered as a contemporary urban transport mode for daily access to education, health, or shopping. Although bicycle has been used for centuries, the spread of it in urban areas is dated to the mid of 20th Century. In the post war period with limited economic conditions, the number of users of bicycle increased in Northern and Central European cities. Today, Denmark, Netherlands, and Germany are the countries in which cycling habit seems highest; and besides, in China, India, Indonesia, Bangladesh, Japan, USA, and Canada cycling has become widespread in recent decades. In addition, in some cities of Turkey, there have also been regulations which encourage the usage of cycling as an urban transport mode in recent years (Kılınçaslan, 2012).

In the following section, firstly, cycling is introduced as a transport alternative together with its infrastructural implementations in urban areas through planning. Then, after an effective infrastructure and conscious is produced, the systems of bike-sharing can be an important urban transport policy to increase bike use in cities, and this important point of the rise of bike-sharing is introduced within the study. Finally, examples from the experiences of foreign cities in different countries about effective and successful use of bike-sharing are stated. As a result, lessons learned from these different cases are highlighted with a view to formulate

an assessment framework together with some evaluation criteria, which can then be applied to analyze the experience in Turkish cities.

2.5.1. The Rise of Cycling, Its Benefits, and Planning-Infrastructural Measures

In the 1950s and the 1960s, in most western European countries, growing motorized transport levels, sprawled urban development, and policies of administrations heavily focused on car use in urban areas; as a result, cycling experienced a sudden decline (Pucher & Buehler, 2012b). In that period, many European cities oriented their government policies towards expanding roadway and provision of car parking, and they left the needs of cyclists remained ignored (Hass-Klau, 1993). The rise in the usage of car created environmental pollution, traffic congestion, injuries and fatalities. Therefore, governments chose to restrict car use and apply some deterrent measures against car while providing public transportation, walking, and cycling (Pucher & Buehler, 2012b).

Many countries in different parts of the world have officially adopted the significance of cycling as an urban transport mode in relation with increasing safety (European Conference of Ministers of Transport, 2004). During the recent years, governments have been considering some kinds of urban policies in order to realize the potential of cycling for the aim of developing the sustainability of transport networks. In many cities of Europe, North America, and Australasia, the programs and facilities about cycling have been extremely developed and expanded. In recent two decades, in countries such as Australia and United States that can be named as car oriented ones, the usage of cycling spread significantly with some cities experiencing a really cycling boom. Northern European countries -particularly Netherlands and Denmark- have a historical cycling culture and they also have significantly advanced their existing cycling infrastructure and high levels of usage of cycling. In addition, in some countries such as France and Spain, cycling usage did not used to be popular as an urban transport mode, however they have also increased their cycling in their major cities. (Pucher & Buehler, 2012c).

For example, in Berlin, between 1975 and 2008, the number of daily bike trips increased by 300% (City of Berlin, 2010). According to national data, a significant increase in cycling has been experienced since the policy shift from motorized transport to cycling in 1970s. 1.3 km to 1.6 km in Denmark, from 0.6 to 1.0 in Germany, and from 1.7 to 2.5 in Netherlands (European Commission, 2005-2007; US. Department of Transportation, 2010). Consequently, it can be said that cycling has gained much importance in recent decades, and it has a significant modal share in total number of trips in different countries from different parts of the worlds as seen in Table 4.

Table 4. Cycling per person and per day (kilometers) and modal share (number of trips)

Country	Cycling per person and day in kilometers (2000)	Modal share as a percentage of number of trips
Netherlands	2.3	27
Denmark	2.6	18
Sweden	0.7	12.6
Germany	0.8	10
Belgium	0.9	10
Finland	0.7	7.4
Ireland	0.5	5.6
Austria	0.4	5
Italy	0.4	4
France	0.2	3
UK	0.2	2
Luxembourg	0.1	1.5
Greece	0.2	1
Portugal	0.1	1

Table 4 (continued)

Spain	0.1	0.7
Norway		6
Switzerland		9
USA		0.7
Japan		14

Source: (European Commission, 2002; European Commission, 2000)

Bicycle use as an urban transport mode is highly related with travel distances in the city. Grava (2003), states that the most appropriate distance which bike users find easy to travel is 8 k m; therefore, small and medium size cities where travel distances are less than 8 km, and urban fabric dense, bicycle is a convenient urban transport mode. Yet, many kinds of factors exist for daily bicycle travel within the city such as personal choices or individual health condition. According to Kılınçaslan (2012), these factors can be differentiated. He mentions that besides the size of the city; climate conditions, topographical features, distribution of urban land use, and focus points can be encouraging or disincentive for bicycle use. Places with temperate climate, flat or smooth hills make bike use more convenient and a preferred mode.

Bicycle use in urban areas for the aim of individual transportation seems inevitable for some countries due to having bike culture for their daily urban travel pattern. In other countries, usage of bike is encouraged as a way to combat the negative consequences of car-based transport systems.

Greenhouse gas emissions are produced because of one of the main sources of urban transportation and it contributes significantly to climate change. On the other hand, cycling stands as a zero-emission mode of transport which constitutes a potential for lower emissions in the passenger transport sector (Garrad, Rissel, & Bauman, 2012). Bike use does not constitute any environmental or noise pollution, therefore cycling has become internationally popular as an environmentally friendly urban transport mode. Usage of cycling in urban areas instead of using cars could serve the decreasing consumption of energy and

congestion in urban areas, and the rise of cycling could be an encouraging alternative for decreasing greenhouse gases and other emissions (European Conference of Ministers of Transport, 2004). In addition, when bike use is compared to other modes of transport such as bus, air, and train in terms of damaging the environment, it can be realized that cycling seems the most appropriate mode as seen in Table 5. In terms of space consumption, energy consumption, releasing harmful gases, and risk of accidents, cycling seems less harmful to the environment, and the safest one compared to car, buses, air travel, and railway transportation.

Table 5. Comparison of Environmental Impact of Transport Modes Base=100 Private Car

	Car	Bus	Bicycle	Air	Train
Space consumption	100	10	8	1	6
Primary energy consumption	100	30	0	405	34
CO_2	100	29	0	420	30
Nitrogen oxides	100	9	0	290	4
Hydrocarbons	100	8	0	140	2
CO	100	2	0	93	1
Total atmospheric pollution	100	9	0	250	3
Risk of accidents	100	9	2	12	3

Source: (European Conference of Ministers of Transport, 2004)

Bicycles can also provide an opportunity to have the most direct door-to-door service when it is compared to motorized urban transport modes, and it is also a compact machine which does not occupy urban space except for its own size. Cycling also consumes low energy, and unlike motorized modes, it does not produce any air or noise pollution (Grava, 2003). In addition, if bike use becomes a daily transport mode, it gives the opportunity to have regular exercise, bringing significant health benefits (European Conference of Ministers of Transport, 2004). Urban environments supporting bicycle use and walking, and discouraging car dependence can also achieve social interactions, community attachment, amenity,

and livability (Todd & Doherty, 2009). Besides, cycling contributes to social inclusion. Each people in a society cannot have a chance to own or have access to a motor vehicle, and cycling gives chance for an affordable and convenient type of personal movement in urban environment (Garrad, Rissel, & Bauman, 2012).

While the benefits of cycling for daily urban travels are clear, realization of these benefits is possible if the necessary bicycle planning and its infrastructural measures are carried out in order to make the urban environment convenient for cyclists. Otherwise, bicycle using may make daily urban transportation life difficult and unsafe for cyclists instead of playing a role as a facilitator for daily movements.

In order to use bicycle for urban transportation, cyclists need sufficient route infrastructure. European and American urban policies heavily focused on dealing with this challenge. In some European countries like Germany, Sweden, Denmark, and Netherlands, the users of bicycles are needed to be separated from fast and heavy traffic which depends on the significant principle of road safety. This kind of a policy should bring a systematic traffic calming together on streets with different densities, and a spread network of bicycle lanes (Furth, 2012).

Bicycle lanes define the entire infrastructure necessary for bike use. In the cities that bicycle is accepted as one of the main urban transport mode, its plans are properly prepared, and bicycle lanes constitute an exact network in the city. In addition, the design of physical components in urban space encourages bike use. Bicycle lane network can be designed not only for urban scale, but also for regional scale (Kılınçaslan, 2012).

When a bicycle network is designed for an urban area, many choices exist for how the system can be structured. However, there are some kinds of features that are considered as prerequisites for the construction of a bike network:

- The smoothness of pavement surface has to be as much as possible, and it should not become slippery in rainy conditions, and loose materials should not be used.

- The cycling network should provide safe and secure environment; the design of the system should eliminate crashes between bicycles and bicycles and other vehicles, and criminal actions and vandalism should be minimized.
- Movement of cyclists has to be continuous with few stops on bike lane in order to preserve the fluidity of motion and energy use necessary for the movement.
- Cyclists can observe their environment together with taking the advantage of visual quality and amenities for their comfort and rest (Grava, 2003).

In urban areas, three different types of bike lanes exist in general. These are mixed use roads: the right of way is given to cyclists, motorized vehicles, and pedestrians together; roads with bicycle lane: roads which contain assigned lanes to cyclists at roads and streets; and finally, separate cycling paths: the right of way is completely assigned to cyclists, the intersections with motorized vehicles and pedestrians are minimized (Kılınçaslan, 2012). In order to make cyclists comfortable and safe, these different types of bike lanes also have distinctive traffic volumes and maximum vehicle speeds as seen in Table 6.

Table 6. Standards Applied in the Cities that Cycling is Intensively Exist

Mixed use roads	-Average daily traffic < 2000 vehicle -Vehicle speed < 50 km/h
Designated lanes on-street	-Average daily traffic = 2000-8000 vehicle -Vehicle speed = 50-58 km/h
Roads with protected lanes	-Average daily traffic = 8000-14000 vehicle -Vehicle speed = 58-75 km/h
Separate cycling paths	-Average daily traffic > 14000 vehicle -Vehicle speed > 75 km/h

Source: (Grava, 2003)

- Mixed use roads: Bicycle has a right of way and is considered as a vehicle existing in urban traffic. Average number of vehicles on these roads can be

2000 at most, and other vehicles can have the maximum speed of 50 km/h. On these roads, there is no need to make special arrangements for bicycles.

- Roads with bicycle lane: Bicycle lanes on the roads are classified into two groups. In the first one, bike lane is totally segregated from road traffic and has its own pedestrian sidewalk regulation (Figure 5). In the second one, two main types can be seen as striped bike lanes, and barrier bike lanes (Figure 6). As the first group, if there is enough width on the sidewalk, bike lane can be located in this space. The important point here is leaving buffer spaces or lanes between pedestrian-bicycle, motorized vehicle-bicycle. 2.4 meters width is enough for cyclists and in the streets having low traffic volume this width can be decreased to 1 meter (Kılınçaslan, 2012). In the second group, striped bike lane is constituted by drawing a line on the floor, and a lane is formed which is segregated from traffic and assigned only to the use of bicycle together with signs showing bicycle symbols on this lane as seen in Figure 7 (Grava, 2003).

Figure 5. Segregated Bike Lane from Road Traffic near to sidewalk in Paris

Source: (http://grid.platformpublicaffairs.com/safelakefront/?q=node/13)

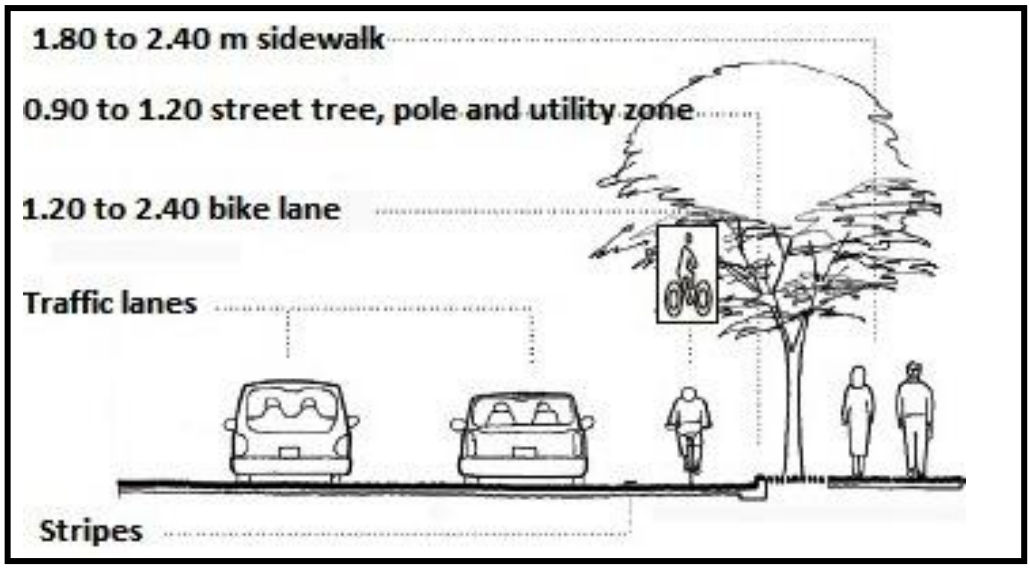

Figure 6. One Direction Bicycle Lane in Urban Traffic

Source: (Grava, 2003)

Figure 7. Striped Bike Lane in Memphis

Source: (http://streetsblog.net/2013/05/23/memphis-to-add-15-miles-of-protected-bike-lanes/)

On the other hand, barrier bike lane is constituted by using a physical barrier in order to avoid motorized vehicles enter the lane (Figure 8). When special lanes are assigned for bicycles, regulations on junctions have to be made. For example, since bike lanes are on the right side of the road, cyclists who prefer left turn may have problems with opposite direction of traffic and vehicles preferring right turn.

- Separate cycling paths: These kind of cycling routes are designed mostly in recreational areas and for the aim of using bike as a leisure time activity. Bike lane is structured totally independent from existing road infrastructure; in addition, this type can be used in new development areas, but not in high density urban areas (Kılınçaslan, 2012).

Figure 8. Barrier Bike Lane in New York

Source:(http://www.raisethehammer.org/article/1901/repaint_king_street_with_protected_bike_lanes)

Bicycle parking is another infrastructural measure of cycling. There should be enough parking points for bike users in the city particularly in railway or bus stations, city centers, shopping areas, or workplaces. It is especially important to

have parking spaces for bicycles at public transport destinations to encourage people to use both public transport and bike (Figure 9). Besides, common parking lots can also be used for bicycles similar to those for automobiles so that more secure and protected bicycle parks can be provided (Figure 10).

Figure 9. Example of Bicycle Parking in New York

Source:(http://commons.wikimedia.org/wiki/File:Union_Sq_bike_parking_jeh.JPG)

Figure 10. Multistorey Common Bicycle Parking Lot in Amsterdam

Source: (http://commons.wikimedia.org/wiki/File:Bicycle_parking_lot.jpg)

When the planning side of a bicycle lane is considered, according to Grava (2003), all these physical infrastructure regulations in a city have to follow a preparation program that includes, firstly, arrangement of intensive education programs for public, motorized vehicle drivers, and cyclists. These programs mainly aim to convince people including residents of the area, workers, and administrators about the benefits of bike use. Secondly, bike users should be ensured to obey traffic rules in order to provide safety for themselves and pedestrians. To achieve this, it is important to prepare legal regulations to make cyclists subjected to traffic fines if they violate traffic rules. Thirdly, it is important to make physical rehabilitations on the points that high density of motorized vehicle and bicycle traffic exist. Some of these are putting a phase on traffic lights for cyclists, rehabilitation of sight and lighting, and providing secure transition in tunnels, bridges, and underpasses. Another component of preparation programs is locating signing boards, painting road signs, and arrangement of rest areas. It is necessary to make physical regulations on roads, to create bicycle parking and storage opportunities. Finally, because of lack of convenient and adequate facilities and infrastructure, which is caused by lack of necessary demand for cycling, bicycle use cannot become widespread. Therefore, the demand for bike use has to be formed at first.

Integration of bicycle with public transport is another significant issue to increase the use of cycling in a broader network. The catchment area of rail stations and bus stops increases when bike use is combined with public transport (Figure 10). Giving cyclists the possibility to carry their bicycles together with public transport services enables them to make daily urban travel longer than it would be possible with a bike alone. This kind of integration with public transport can also constitute alternatives when cyclists deal with topography and unwanted gaps on the route, bad climate conditions, and possible mechanical failures of bikes (Pucher & Buehler, 2012a).

Figure 11. Bicycle Carrying Opportunity for Metro Transit in Minneapolis

Source: (http://minnesota.cbslocal.com/2011/08/05/cycling-in-the-cities-youve-come-a-long-way-baby/)

In addition to all these infrastructural improvement and investments, there is a recent program that is adopted by many cities in the world with a view to extend bicycle use in urban areas: bike-sharing systems. In the literature, this program is referred to with different names such as 'bike sharing', 'city bike', 'public use bicycle systems', 'bicycle transit', 'smart bikes' and 'public bike'. Within this study, the system will be referred to as 'bike-sharing'.

2.6. An Innovative Program to Improve Cycling: Bike-Sharing Systems

Strategies for more sustainable transportation that include new vehicle technologies, clean fuels, transportation demand management, improvement of public transport, walking and cycling, were implemented worldwide by many policy makers due to concerns about climate change, unstable fuel prices, and energy security (Shaheen & Lipman, Reducing Greenhouse Gas Emissions and Fuel Consumption: Sustainable Approaches for Surface Transportation, 2007). Bike-sharing systems, which are simple bike loan programs for daily urban travel on different locations of the city, can also contribute to the effort of policy makers for the solution of these concerns.

The essence of bike-sharing is simple. Within the system, people use bicycles on an as-needed basis for the aim of short term bicycle access. Bike-sharing ensures a sustainable and environmentally friendly mode of public transportation, and this flexible short term bicycle usage program intends daily mobility for its users. People access to public use bicycles at the bike stations with a self-service reservation, pickup, and drop-off. These programs contain multiple bike station locations in order to let cyclists pickup and return bicycles to different stations located at different parts of the city. The main costs of the system are bicycle purchase, maintenance costs, storage and parking facilities (Shaheen, Cohen, & Chung, 2009). According to Bührmann (2007), the main characteristics of bike-sharing programs can be classified as below:

- They are innovative programs of rental or free bikes in urban areas,
- The system can be used for daily urban transport as one-way-use is possible which becomes an important part of public transport network,
- Bike-sharing is different from traditional leisure oriented bicycle rental services, because this system gives chance to have fast and easy access,
- These systems vary according to their organizational structure, the business models, and the technology applied which is moving towards 'smart bikes' including rental processes via smart card or mobile phones.

This program has become an alternative public transport mode among other mobility alternatives. When operation of bike-sharing systems is compared with other modes of transport such as walking, private car, public transport, or taxi for inner city travels, bike-sharing seems one of the most convenient mode if trip length and cost are considered as seen in Figure 12.

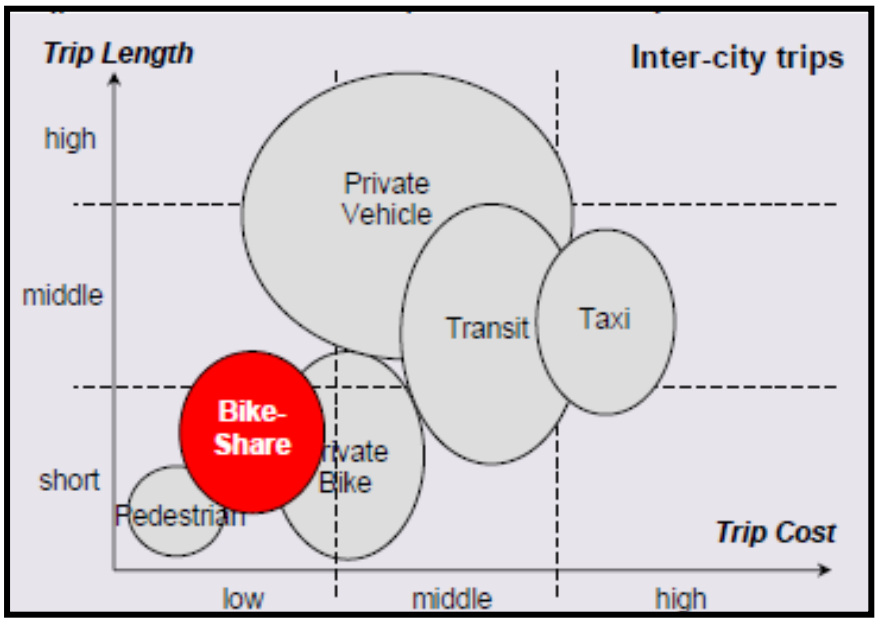

Figure 12. Bike-sharing Systems together with Other Modes of Transport Comparing Trip Length and Trip Cost

Source: (Curran, 2008)

Integration of bike-sharing systems with other public transport modes and provision of free or affordable bicycles within this system to the people make the automobile use for short trips decrease; therefore, it helps to reduce traffic congestion and noise or air pollution (Lin & Yang, 2011). By the year of 2011, there are an estimated number of 135 bike-sharing programs in around 160 cities in the world including more than 236,000 bicycles on four different continents; besides over 35 more bike-sharing systems were being planned in 16 different nations in 2011 (Shaheen, Guzman, & Zhang, 2012).

The system operation type of bike-sharing is classified in two categories as manual and automated systems. In manual bike-sharing systems, bike taking and returning are supervised by an appointed employee of staff, and this system does not include any information technology in order to keep track of the use of bikes and monetary transactions. On the other hand, in automated bike-sharing systems, self-service bike taking and returning is applied. Bicycles can be locked to particular electronically controlled racks or include electronically controlled lock of their own (Transport Canada, 2009). Manual and automated bike-sharing mechanisms are differentiated from each other in terms of different city sizes,

loan duration, and daily users per bike, capital cost and operation cost per bike as seen in Table 7.

Table 7. Comparison of Manual and Automated Bike-sharing Systems

Factor	Manual	Automated
City size	Small to medium	Medium to large
Loan duration	Medium (>1 hour)	Very short (<30 min)
Daily users per bike	Low (<5)	High (5-20)
Capital cost per bike	Low	High
Operating cost per bike	Medium to high	High to medium

Source: (Transport Canada, 2009)

An automated bike-sharing system consists of different components including mechanical elements and infrastructural systems, as described below (Midgley, 2011):

- Bicycles: Shared bicycles should not be difficult to use, and they need to give users the opportunity to choose from different sizes. The main features of bicycles are being mechanically reliable, distinctive in appearance, and robust to vandalism or theft.
- Docking stations: According to the grouping of The Transport Canada Bike Sharing Guide, three main types of docking stations exist. The first one is fixed-permanent. Bicycles are locked to appointed racks, which act as stations, when they are not in use (Figure 10 & Figure 11). The second one is fixed-portable. In this system, easy establishment and removal of stations enable the distribution of station according to changing demand and the use of stations at temporary locations for special events (Figure 12). The third one is flexible systems. This system does not necessitate bicycles to be locked to a designated rack or station, bicycle have a general purpose locking device and they can be locked to any stationary object when not in service. In this system, there is no need to have a network of stations.

- System access and user registration: At first, cyclists need to unlock the bike from docking stations, and this can be done by using two different ways. Firstly, bicycles are checked out from the rack by using smart cards or magnetic stripe card. The second technology is constituted with an automated lock on the bicycle itself and users establish connection for the entry code via mobile or pay phone.
- System status information systems: Bike-sharing systems provide current information on web sites for the availability of bikes on stations; besides, most of the systems shows bicycle lanes marked on the maps.
- Maintenance programs: Maintenance and logistics of the systems are significant issues in largest bike-sharing programs with the average bike operation reaches 180,000 km per year.
- Bicycle redistribution mechanisms: In the system of bike-sharing, many numbers of stations should be located conveniently in the city, and some stations may become empty or very loaded in terms of the number of bicycles according to differentiating demand. To balance the system, bicycles should be carried from intense to emptier ones with a vehicle.

Figure 13. One of the Velib's Fixed Station Being Refilled in Paris

Source: (http://www.tc.gc.ca/eng/programs/environment-utsp-casestudy-cs74e-bikesharing-813.htm)

Figure 14. Docking Station of 'Bicing' in Barcelona

Source: (https://commons.wikimedia.org/wiki/File:Estacio_bicing_bcn.jpg)

Figure 15. A Bixi Station Module Being Installed for an Event in Toronto

Source:(http://www.flickr.com/photos/yvonnebambrick/3001397180/sizes/o/in/photostream/)

After introducing the basic characteristics of bike-sharing including its definition and two main types of the system, of the following section presents the historical development of this system.

2.6.1. History of Bike-sharing: Three Generations

Bike-sharing have been spread in cities around the world, such as Paris, Barcelona, Salt Lake City, and Montreal (Table 7), after it was firstly introduced in Amsterdam in the 1960s under the name White Bicycle Plan.

Table 8. Worldwide Bike-sharing Programs together with the Number of Bicycles and Stations

Country	Programs	Bicycles	Stations
Argentina	1	560	15
Australia	2	2600	200
Austria	3	1500	82
Belgium	1	2500	180
Brazil	2	452	43
Canada	1	6100	490
Chile	1	150	15
China	19	123,172	4422
Czech Republic	1	30	16
Denmark	3	2650	187
France	29	36,830	3141
Germany	5	13,330	811
Ireland	1	550	44
Italy	19	3763	362
Japan	1	150	15
London	1	6000	400
Luxembourg	2	400	64
Mexico	1	1200	90
Monaco	1	10	2

Table 8 (continued)

Norway	1	1660	154
Poland	1	155	13
Romania	1	300	3
Slovenia	1	300	31
Spain	25	14,048	1142
South Korea	2	2031	185
Sweden	2	1500	110
Switzerland	1	600	45
Taiwan	2	5000	61
United States	4	3122	313
United Kingdom	2	6091	420
TOTAL	**136**	**236,754**	**13,056**

Source: (Shaheen, Guzman, & Zhang, 2012)

The history of bike-sharing can be classified into three main groups from the 1960s until present which are free bike systems (White Bikes), coin-deposit systems, and Information-Technology (IT) based systems as discussed below.

- White Bikes (or Free Bikes): First Generation

The first generation of bike-sharing systems is dated back to July 1965 in Amsterdam called White Bikes. Within this system, bicycles were painted white and made available for public use. A person finds a bicycle, rides it to the destination, and leaves it for the following user. However, bicycles in the system were thrown into canals or retained for private use in time (DeMaio, 2009). In this free bike program, the main component of the system was the bicycle; they were painted one color, left randomly to any area of the city for free use, and they remained unlocked. However, these bikes were generally damaged or stolen for personal use (Shaheen, Guzman, & Zhang, 2012).

- Coin-Deposit Systems: Second Generation

Some problems were faced in free bike systems, therefore the City Bike Foundation of Copenhagen, Denmark, has started a new bike-sharing service

which developed the coin-deposit systems as the second generation of bike-sharing. The characteristics of this second generation are:

- Distinguishable bicycles by using color or particular design,
- Designated docking stations where bikes are borrowed, returned, and locked,
- Leaving small deposits in order to unlock the bicycle (Shaheen, Guzman, & Zhang, 2012).

The first large scale second generation bike-sharing program was started in 1995 in Copenhagen with the name of Bycyklen, or City Bikes. This system developed bike-sharing features of the previous generation considerably which was established for intense utilitarian use in the city together with solid rubber tires and wheels with advertising plates (DeMaio, 2009). The program of Bcycklen which led to the second generation is still famous due to operation with more than 2000 bikes and 110 city bike racks. After coin-deposit model of Copenhagen, many European bike-sharing programs started such as "Bycykler" in Sandnes, Norway (1996); "City Bikes" in Helsinki, Finland (2000); "Bycykel" in Arhus, Denmark (2005); and first coin-deposit system in North America which is "Yellow Bike Project" in Minneapolis and St. Paul. According to the experience of this generation, these new systems were more expensive to operate but much more reliable than previous systems. These coin-deposit systems did not restrict the usage time for bicycle, so that bikes were usually used for a long time or they were not returned at all, which meant bicycle thefts (Shaheen, Guzman, & Zhang, 2012).

- IT-Based Systems: Third Generation

Initially, first generation of bike-sharing -free bikes- constituted significant urban mobility option together with its drawbacks, which were theft and failures in bicycle returns. Another generation bike-sharing programs developed the system by realizing the use of coin-deposit locks. Then, third generation bike-sharing programs involving advanced technologies for bicycle reservations, information tracking, pickup, and drop-off became widely popular. An important number of systems operates today as third generation. The main features of that generation are:

- Distinguishable bicycles by using special design, color, or advertisement,
- Docking stations
- The technology of kiosk or user interface to check bikes in or out,
- Advanced technology by using such as mobile phone, magnetic strip card, or smartcards (Shaheen, Guzman, & Zhang, 2012).

The future will be shaped towards a fourth generation that contains innovations and significant developments such as solar powered and movable docking stations, electric bikes which seems to be the most important one in terms of attractiveness, and mobile phone real time availability applications (Midgley, 2011).

The awareness for the effectiveness of bike-sharing programs has seriously increased over years, and particularly in the last decade, the number of implementation of these systems have spread all over the world noticeably (Figure 16). This increase is being experienced in many European countries, such as France, Germany, Italy, and Spain, and in recent years in China as seen in Figure 17.

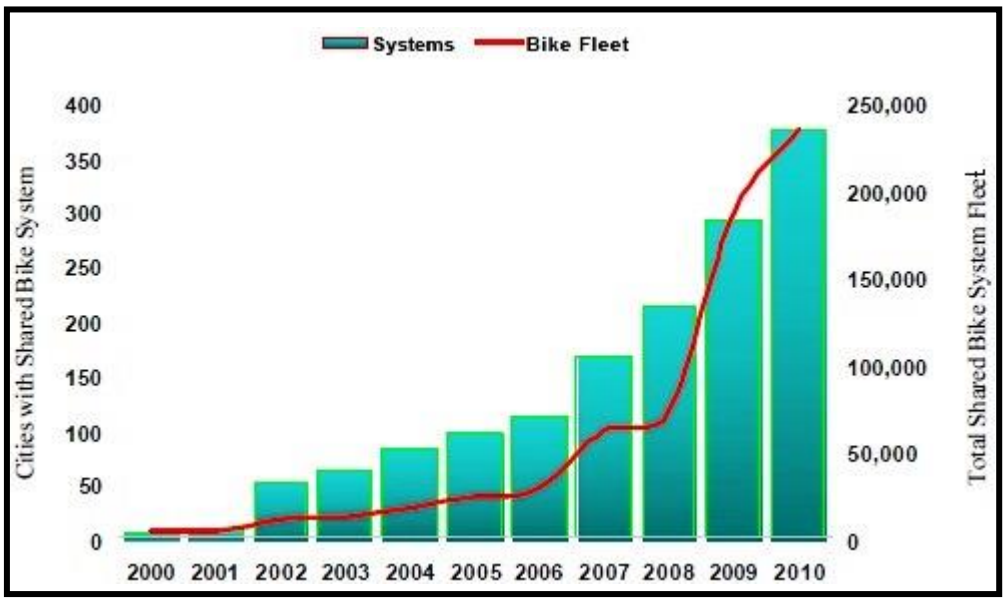

Figure 16. Growth in Bike-sharing Programs and Total Fleet between 2000-2010

Source: (Midgley, 2011)

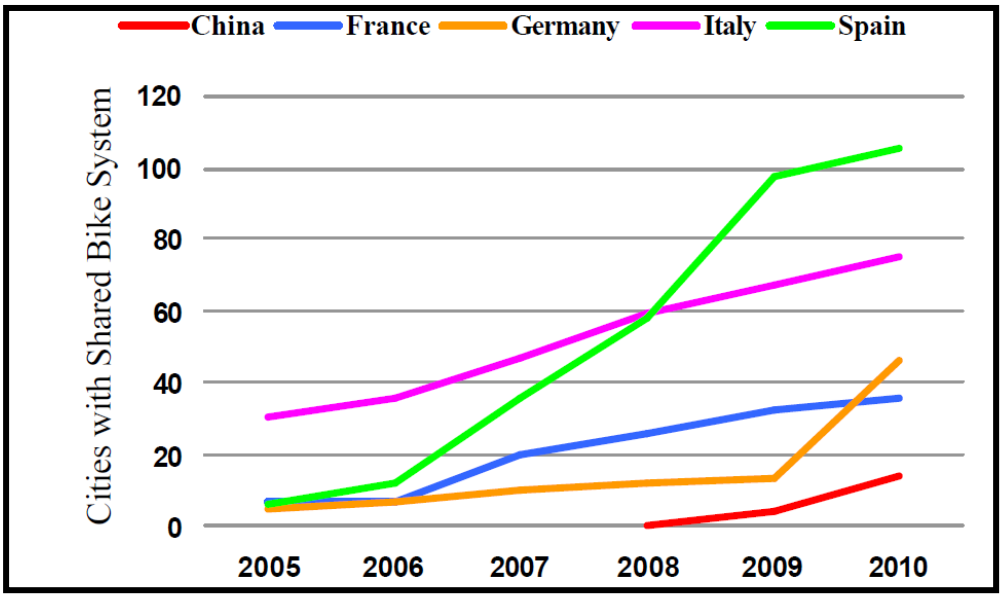

Figure 17. Growth in Bike-sharing Programs in Selected Different European Countries and China between 2005-2010

Source: (Midgley, 2011)

In recent decades, different bike-sharing experiences have been applied in different cities of Europe, America, Asia, and Australia. These systems mainly depend on the features of 3rd bike-sharing generation including Information-Technology based systems and networks (Table 9). The following Table summarizes different programs from different parts of the world including their start date and main characteristics.

Table 9. Different Bike-sharing Examples from Different Continents with Specific Characteristics

Continent	City or Country (year of start)	Features of the Program
EUROPE	Rennes, France (1998)	-IT based "Smart-Bike" program, free bikes up to three hours, replaced by program of "LE Velo STAR" in 2009 operating with 900 bicycles and 81 stations.

Table 9 (continued)

EUROPE	Lyon, France (2005)	-3rd generation program named "Velo'v" operating with more than 4000 bicycles in Lyon and Villeurbanne.
	La Rochelle, France (1974)	-The program including 120 bicycles and 12 stations, replaced with a fully automated system in 2009 called "Yelo" currently operating with 350 bicycles and 50 stations, enabling full integration with public transportation network with smartcards.
	London, England (2010)	-Named "Barclays Cycle Hire" system with 6000 bicycles at 400 stations.
	Paris, France (2007)	-"Velib" program, most widely known 3rd generation system with 20,600 bikes and 1451 stations at every 300 meters,
	Kayseri, Turkey (2009)	-"Kaybis" bike-sharing program including almost 25 stations with 300 bicycles, first initiative in Turkey.
	Konya, Turkey (2011)	-Konya "Public Bike-sharing System" including 400 bicycles with 40 stations.
AMERICA	Washington D.C., USA (2008)	-Launched with 120 Bicycles and 10 stations named "Smartbike", first IT based system in North America.
	Arlington County-Virginia-Washington D.C. (2010)	-After the end of "Smartbike", "Capital Bikeshare" program started with 1100 bikes and 114 stations, as May 2012 being the largest bike-sharing program in USA.

Table 9 (continued)

AMERICA	Montreal, Canada (2009)	-"BIXI (BIcycle-TaXI)" program containing 5000 bicycles and 400 stations.
	Minneapolis, USA (2010)	-"Nice Ride" program with BIXI as the service provider containing 700 bicycles and 73 stations.
	Toronto, USA (2011)	-Currently operating with 1000 bicycles and 80 stations, expansion of program into the Ottawa-Gatineau area operating with 100 bicycles and 10 stations.
	Mexico City, Mexico (2010)	-"EcoBici" program operating with 1200 bicycles and 90 stations, built of 300 km bike lane network to encourage cycling before "EcoBici" program.
	Brazil (2008)	-Beginnig of two bike-sharing programs: "UseBike" in Sao Paulo, and "Samba" in Rio de Janerio.
ASIA	Singapore (1999)	-The first bike-sharing program in Asia named "TownBike", and ended in 2007.
	Taito, Japan (2002)	-Second program in Asia, first pilot bike-sharing project in Japan employing 130 bicycles at 12 stations in which magnetic striped cards are used preventing theft.
	Chongwan, South Korea (2008)	-"Nubija" bike-sharing program, operating with 3500 bicycles at 160 stations, not charging users a fee for the first hour as in many other program.

Table 9 (continued)

ASIA	Kaohsiung City, Taiwan (2009)	-First bike-sharing program in Taiwan named "C-bike" offering 4500 bicycles and 50 stations
	Hangzhou, China (2008)	-The largest and most famous bike-sharing system in Asia, named "Public Bicycle", first IT-based system in China, an important factor to establish the system of high density population, operating with 60,600 bicycles at 2400 bike stations, surpassed "Velib"-Paris bike-sharing system as the largest in the world.
AUSTRALIA	Melbourne, Australia (2010)	-"Melbourne Bike Share" operating with 600 bicycles at 50 stations, obligatory usage of helmet that decreased the success of Melbourne's system.

Source: Based on the information in (Shaheen, Guzman, & Zhang, 2012) together with author's contributions for Konya and Kayseri cases

The historical evolution of bike-sharing systems is formed with three different generations including different characteristics until today. Consequently, the main question here is about what the fourth generation will be like together with what kind of new innovations to improve the system. However, prior to 4th future bike sharing generation, it is important to introduce the benefits or positive social and environmental impacts of the system, and main costs and challenges.

2.6.2. Benefits and Effects of the System

Bike-sharing systems have significant effects on increasing the number of people using bicycle, increasing public transport use, decreasing greenhouse gases, and improving public health. Existence of these systems can increase bike mode share between 1.0 – 1.5 % in cities that bicycle use is low (DeMaio, 2009). Besides, according to Shaheen, Guzman, and Zhang (2012), although there are limited

researches for the social and environmental benefits of bike-sharing, it can be mentioned that bike-sharing has impacts on:

- Reduced automobile use
- Behavioral shifts toward increased bicycle use for daily mobility
- Growing perception of bicycle as a convenient urban transport mode (Shaheen, Guzman, & Zhang, 2012)

According to Bührmann (2007), bike-sharing systems present a range of potential benefits as classified below:

- Promotion of urban cycling and increasing its modal share can be an effective measure for cycling as a normal daily transport mode. Bike-sharing systems can also play a role in introducing "bicycle culture" in cities.
- Being fast, convenient and flexible urban transport mode increases mobility choices.
- It encourages intermodality through integration of bike-sharing programs with public transport system.
- Bike-sharing systems are space efficient, and contribute sensitive use of inner urban space. For instance, the area covered by one parking lot – serving 6 users/day on average- can be substituted by five bike-sharing racks - serving 15 users/day on average-.
- Bike-sharing systems affect human health positively.
- The systems make sustainable non-polluting mobility preferences increase for inner urban transport.
- Because of mass users of bicycle on roads, traffic safety for cyclists increases.
- Bike-sharing programs may become a part of local cityscape which provides a sense of local identity.

Besides, according to a research carried out by Tang, Pan and Shen (2012), the reasons why cities are interested in such bicycle system are stated as:

> To facilitate green transportation, to encourage the use of bicycles, to provide an alternative travel mode to alleviate traffic congestion, and to fill

the service gap of public transit or promote convenient transfer for the transit system.

Bike-sharing system stands as an alternative urban transport mode, and different cities from different parts of the world especially from Europe- adopted these bicycle sharing schemes in order to achieve some targets which serve mainly sustainable urban transport considerations, increasing awareness of cycling, and environmental well-being. Table 10 mentions objectives of bike-sharing programs of some countries from Europe, Canada, and USA.

Table 10. Objectives of Bike-sharing Programs in several Cities

Bike-sharing System	Objectives
Barcelona (Spain)	• Improve interchange between different modes of transport, and promote sustainable travel. • Create a new individual public transport system for citizens' habitual travel needs. • Implement a sustainable, health inducing service fully integrated with the city's public transport system. • Promote the bike as a common means of transport. • Improve quality of life, reduce air and noise pollution.
Goteborg (Sweden)	• Raise the status of cycling. • Promote using bicycles for short distance trips.
Lyon (France)	• Help create a more sustainable transportation system in the region by launching a public bicycle system that provides a new mobility option for short trips. • Help achieve transport and land use planning objectives including pollution emission reductions, reduced traffic congestion, road and parking cost savings, consumer cost savings, energy conservation, reduced crash risks, improved public health, and support for smart growth land use development.

Table 10 (continued)

Montreal (Canada)	• Encourage the use of public bicycles instead of cars for short, inner-city trips.
Paris (France)	• Act on air quality and public health. • Improve mobility for all. • Render the city a more beautiful and agreeable place to live in. • Encourage economic vitality. • Reinforce regional solidarity.
Washington, D.C.	• Provide as many transportation options as possible and reduce the level of congestion, especially downtown.

Source: (Curran, 2008)

The primary effect of bike-sharing systems seems provision of emission free urban transportation. For example, according to Velib bike-sharing system in Paris, it is estimated that 78,000 bike-sharing trips -approximately 20 min per trip, meaning that 312,000 kilometers daily travel are done, and this distance can be covered by a car with producing 57,720 kilograms of carbon dioxide (CO_2) emissions per day. The same condition is valid for the users of BIXI service provider as of August 2009, an estimated 3,612,799 km distance is covered through the system of bike-sharing, which translates into 909,053 kilograms of CO_2 emissions savings. As a result, it can be estimated that the activity of bike-sharing owns the potential to contribute to decreasing greenhouse gas emissions (Shaheen, Guzman, & Zhang, 2012).

Another most noticeable benefit of bike-sharing is increasing the use of bicycle; for example, in Lyon within the initial year of operation of Velo'v program, bike use increased by 44%. This program also reports that bicycle use replaced 7% of travels made by private cars in Lyon (Bührmann, 2007). Bike-sharing systems enable new preferences for short trips, enhance mobility around the city, and promote access to existing public transport services of the city. A survey applied in Paris to bike-sharing program users showed that 89% of Velib users are allowed to move around Paris more easily, and 54% of users travelled more in

Paris together with this program (New York City Department of City Planning, 2009). Within a bike-sharing system, users do not need to own, store, or maintain the bicycle; therefore, it attracts new people for cycling and makes bicycle-riding a part of their lives in new ways. For example, in the first year, 96% of Velo'v users had not ridden in Lyon before (Holtzman, 2008).

Bike-sharing systems also help to improve the health of people; because it gives chance to make regular daily exercise if it is adapted to life as an urban transport mode. It enables to take part in cycling activity, and simultaneously, users would have made necessary physical activity that they need for the maintenance and improvement of human health.

The potential social, environmental, and health benefits of bike-sharing and public awareness of it increased as a result of the growth and evolution of these systems worldwide. Together with this increasing awareness, cycling has started to be considered as an urban transport mode on public perception. For example, according to a survey applied in 2008, 89% of the users of bike-sharing program of Paris think that Velib made it easier to travel in the city. Besides, according to SmartBike, 79% of the users of bike-sharing system in Washington D.C. reported that this system was faster or more convenient than other options. Consequently, cities with successful bike-sharing schemes have improved the image of cycling as an urban transport mode for daily travel (Shaheen, Guzman, & Zhang, 2012).

2.6.3. Costs and Challenges

Main costs of bike-sharing system can be grouped into two categories as capital costs and operating costs. Capital costs consist of firstly bicycle purchase, and docking station and equipment construction. Then, license or purchase of the back-end system used to operate the equipment, member access cards (if necessary), getting maintenance and distribution vehicles, and installation come after. For example, when capital costs per bicycle are compared among some selected programs, it is seen that it can range between $3000 and $4500 per bicycle in Montreal, New York, Washington D.C., Lyon, and Paris. On the other hand, operating costs contain staff, distribution, maintenance, office space, insurance, storage facilities, website hosting and maintenance, electricity charges

for docking stations, membership cards and warehouse/storage fees. When similar programs are compared in terms of operation costs, it is seen that it can range between $1200 and $1700 per bicycle (New York City Department of City Planning, 2009).

Bike-sharing systems also have several challenges in establishment or operation of programs. Bicycle theft and vandalism is one of the most important challenges in the system, despite the use of custom components and personal user identification technologies. In the Paris system, within the first two years of operation, some 7800 bicycles were stolen and 11,600 bicycles were vandalized beyond repair. Existing technologies such as global positioning systems (GPS) or radio frequency identification tracking developments can have significant impact on decreasing bicycle theft; however this investment increases implementation costs. In addition, another important consideration for bike-sharing is about insurance and liability. For instance, most bike-sharing programs do not make helmet use obligatory for the users that can conflict with insurance and liability laws (Shaheen, Guzman, & Zhang, 2012). Then, topography and climate seem to be physical challenges for cyclists. In hilly conditions, cycling might be convenient for the cyclists of Tour de France; however it can be deterrent for daily users. Slopes between 4% and 8% constitute important challenge for cycling, and slopes above 8% seem almost impossible to cycle. Besides, hot and humid climates for most time in year, and ice and snow in winter make cycling difficult, even impossible to ride. Afterwards, inexperienced cyclists create another concern for the system. According to complaints of some of the motorists, the users of bike-sharing programs tend to be inexperienced riders who do not obey the traffic rules. This problem can be overcome by training programs to the cyclists of bike-sharing (Midgley, 2011).

After introducing benefits and costs-challenges of the system, it is important to mention the future of bike-sharing together with new technologies and other improvements which may be called as the fourth future generation.

2.6.4. The Future of Bike-sharing

Historically, bike-sharing systems have experienced three main generations. It is expected that a standard bike-sharing scheme should have the prerequisite components such as docking stations, information technology based software, or automated locking. In addition to these improvements within the system, different sorts of innovative additions to the operation or physical infrastructure of the system will be realized in future that can be called as fourth generation of bike-sharing.

Previous experiences in bike-sharing have resulted in emergence of fourth bike-sharing generation model which can also be called as demand-responsive or multimodal systems. These systems already include the main characteristics of third generation; in addition, they are likely to comprise flexible and clean docking stations, bike redistribution innovations, public transport or car sharing integration of systems through smartcards, and technological improvements in the system such as using solar power, GPS tracking, touchscreen kiosks, or electric bicycles. Therefore, basic components of fourth generation can be summarized as bicycle, docking station, kiosk/user interface, bicycle redistribution system, and integration with public transport with smartcard (Shaheen, Guzman, & Zhang, 2012).

Firstly, distribution of bicycles should help bike-sharing systems to be more efficient and environmentally friendly, because the system in which the authority moves bikes from areas of high supply/low demand to areas of low supply/high demand seems expensive, polluting, and time consuming (DeMaio, 2009). In other words, assigning larger vehicles for bike transfer increases implementation costs and seem not an emission-free solution. More efficient redistribution methods will be applied such as automated technologies enabling demand responsive bike relocation, and user based redistribution (cyclists perform the relocation of bikes) by the method of demand based pricing in which cyclists gain price reduction or extra credit if they locate bikes at empty docking stations (Shaheen, Guzman, & Zhang, 2012).

Secondly, ease of installation of a bike station which is costly, takes time, and necessitates the installation of special infrastructure to underground, and powering stations with solar panels come as improvements of new generation. This new easy installation feature includes a technical platform containing the base of station and wires necessary for locking and pay station. In addition, the powering of stations by construction of infrastructure of electricity is expensive, takes time and prevents easy relocation of station because of cost. Therefore, locating solar panels to the stations satisfy the need for energy as seen on Figure 18 (DeMaio, 2009).

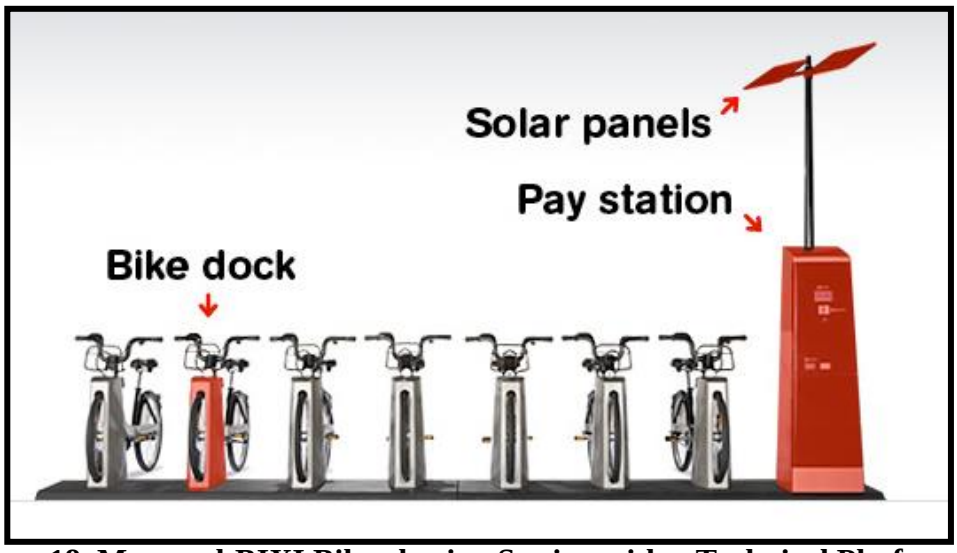

Figure 18. Montreal-BIXI Bike-sharing Station with a Technical Platform

Source: (http://www.thetransportpolitic.com/2009/04/23/bixi-close-to-launching-first-ambitious-north-american-bike-share-in-montreal/)

Thirdly, another future improvement of bike-sharing is arranging flexible stations instead of fixed ones in which cyclists can use mobile phone technology to see where the bicycle is, and they can pick up and drop off the bicycle to street furniture. Within this system, a code is sent to users' mobile phone to unlock the bicycle, and then major intersections are used for leaving it. After locking the bicycle, users inform the program about where it is locked. Therefore, as a result of this method, bicycles within bike-sharing system can be available throughout entire city; besides, the infrastructure for operation of the system can be minimized (Shaheen, Guzman, & Zhang, 2012).

Another area of advancement for fourth generation is the integration of bike-sharing system with other transportation modes through smartcards by which different transportation modes can be used one after another. However, such coordination between various modes of transport including bike-sharing on a single card might be difficult to operate and costly, it requires multiple agency relationship (Shaheen, Guzman, & Zhang, 2012).

Finally, tracking of bikes comes as another improvement. Bicycle tracking through global positioning system (GPS) enables improved data collection about favorite bicycle travelling route and calculation of vehicle distance travelled, and determining the places of stolen bicycles (DeMaio, 2009). Gathering data about favorite bike route within the system allows policy makers to define or change the most appropriate location of a bike station; thus, the efficiency and success of bike-sharing systems increase.

2.6.5. Business Models and Vendors

The efficiency of bike-sharing systems within the context of urban transport is highly related with provision and management methods, because efficient business models of the system can make the construction and operation costs and usage fee minimized, and user friendliness of it increased.

Provision of bike-sharing systems can be realized by local governments, transportation agencies, advertising companies, for-profit groups, and non-profit groups (DeMaio, 2009). The following table shows main providers of bike-sharing including example programs from all over the world (Table 11).

Table 11. Bike-sharing System Providers and Business Models

PROVIDER	STANDARD OPERATING MODEL	PROGRAM EXAMPLE
Advertising company	Provide bike-sharing services in exchange for rights to advertise on city street furniture and billboards	-Smartbike (US) -Cyclocity (France)

Table 11 (continued)

Public transportation agencies	**Provide bike-sharing services under the guidance of a public authority to enhance the public transportation system**	**-Hangzhou Public Bicycle (China)** **-Call a Bike (Germany)**
Local governments/ public authority	Directly design and operate a bike-sharing program for the well-being of cities or local government purchases bike-sharing services that are provided by others	-City Bikes (Denmark) -Nubija (South Korea) -Youbike (Taiwan) -Shanghai Public Bicycle (China)
For-profit	Provide profitable bike-sharing services minimal government involvement	-Nextbike (Germany)
Non-profit	**Provide bike-sharing services under the support of public agencies or councils**	**-BIXI (Canada)** **-Hourbike (UK)** **-Wuhan Public Bicycle (China)**

Source: (Shaheen, Guzman, & Zhang, 2012)

The basic sources of funding in contemporary bike-sharing schemes are the partnerships between advertising companies (private sector) and municipalities. This kind of collaboration can be constituted in the way that advertising companies supply bike-sharing services in exchange for advertising rights of city street furniture and billboards (Shaheen, Guzman, & Zhang, 2012). In this method of Public-Private partnership, a municipality generally organizes a competitive call for tenders for gaining the rights of advertising space in public realm, and the participators of tendering stage make offers to provide a bike-sharing scheme in

interested area (Transport Canada, 2009). As a result, different responsibilities and costs are undertaken by municipality and advertising company to establish a well operating system as classified in Table 12. In the bike-sharing program examples of Konya, Kayseri and Istanbul from Turkey, that kind of local government-advertising company business model was also used.

Table 12. The Responsibilities and Costs Undertaken by Municipality and Advertisement Company in Public-Private Partnership Business Model for Bike-sharing

PARTNER	RESPONSIBILITIES
Municipality	Roles: • provides space for advertising • determines the locations of bike stations • provides space for stations Costs: • construction costs for installation of stations (valid for only fixed-permanent systems) • may cover a portion of supply costs for system equipment such as bicycles, stations, and service vehicles • may cover a portion of operating costs
Advertiser	Roles: • provides bicycles, stations, and service vehicles • provides Information Technology (IT) infrastructure for system control and for financial issues • operates the system: maintenance, repairs, bicycle redistribution • provides customer service through web site or call center • hires and trains all required staff

Table 12 (continued)

Advertiser	Costs: • equipment: bicycles, stations, service vehicles, IT infrastructure (may be shared with municipality) • operations: staff, maintenance supplies, replacement parts, replacement bicycles (may be shared with municipality)

Source: (Transport Canada, 2009)

After introducing the definition, basic characteristics, history, benefits, costs and challenges of bike-sharing in general, understanding of the system is developed through good-practice examples from the world in the next section.

2.7. Bike-sharing Systems from Different Parts of the World: Paris (France), Montreal (Canada), and Hangzhou (China)

In this section, the main characteristics of best practices of bike-sharing systems from different parts of the world will be stated. Turkish cities are newly experiencing bike-sharing system as an urban transport mode. Before analyzing Turkish cases, it is important to determine what the best practices in the world have experienced, what the main characteristics of them are, and which components have seemed indispensable to consider the system as efficient or successful. In this regard, a general overview of *Velib* in Paris, *BIXI* in Montreal, and *Public Bicycle* in Hangzhou examples will be studied to infer outcomes for Turkish cases.

2.7.1. Velib (Paris/FRANCE)

When the Mayor of Paris took office in 2001, a project named *Espaces Civilises* (Civilized Spaces) was made which consisted of overall greening and livability strategy. The Velib program was also based on this project. The objectives of this project for Paris were mainly:

- decreasing traffic congestion,
- prioritizing public transport, pedestrians and cycling,
- creation of a bicycle network,

- promoting policies and programs to increase the presence of bicycles on the streets of Paris (Bennhold, 2007)

The Velo'v smart bike system in Lyon became a model to the large public bicycle system in Paris together with its success in France. Velib system, short for "Velo Liberte" or "Bike Freedom" (JCDecaux, 2008), was launched in 2007 under the leadership of the city's mayor. It is one of the most extensive system for maximum number of stations and bicycles, size of service area, number of registered users, and volume of daily uses in the world. The operation of Velib has been carried out by French advertising company JCDecaux with a 10-year contract in exchange for the right of use of 1600 advertising billboards in Paris (Transport Canada, 2009). Bike-sharing service of Velib in Paris consists of a network of 1800 stations and more than 20000 bicycles (Figure 19). The system remains open 24 hours a day and whole year. Besides, 160 employees, who are responsible for the maintenance of bicycles to be safe and roadworthy, are working within the system (Mairie de Paris, 2010). The cyclists can get a bike online or at any of the bike stations by using credit or debit card. Then, the hired bicycle can be left at any other station (Bennhold, 2007). In Figure 20, the distribution of Velib bike-sharing stations in the city is shown by red circles. It is important to realize that bike stations are intensively located in particularly the center of Paris.

Figure 19. An Example of Bike Stations in Velib Bike-sharing System

Source:(https://www.google.com/maps/@48.866093,2.341978,3a,56.8y,212.52h,73.61t/data=!3m4!1e1!3m2!1sZ2GhEu9MCVNGTCjfvO7r5w!2e0)

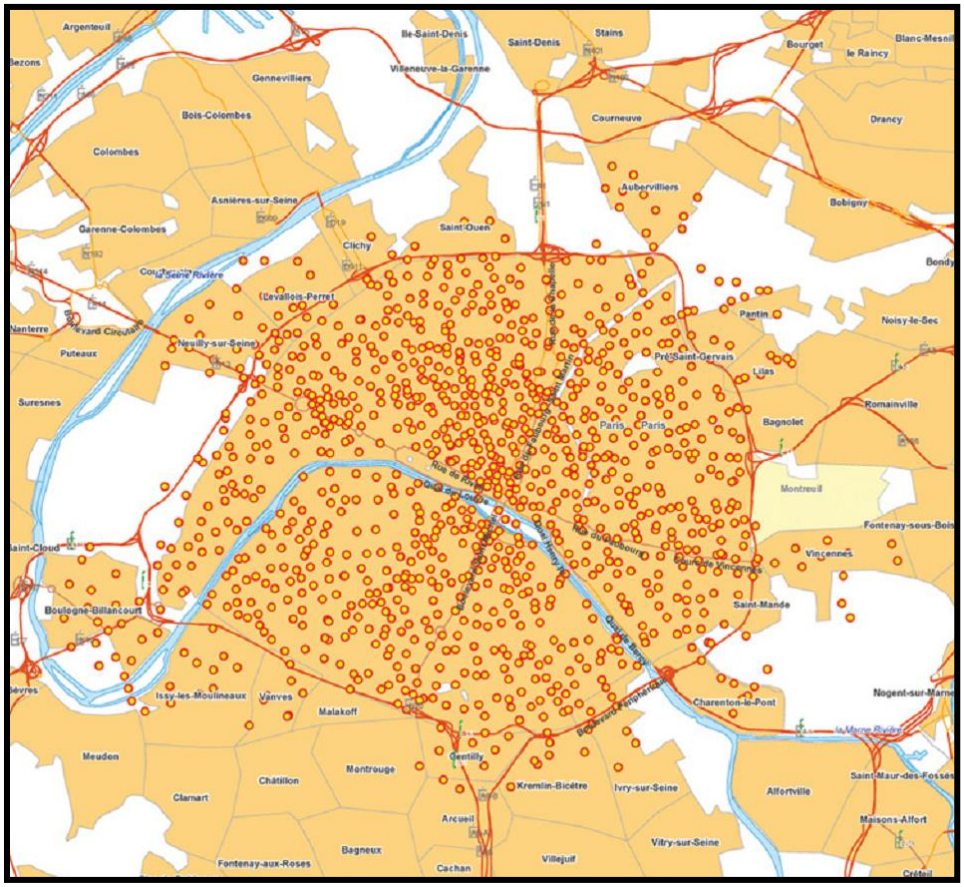

Figure 20. The Map of Distribution of Bike Stations for Velib bike-sharing System

Source: (Nair, Miller-Hooks, Hampshire, & Bušić, 2013)

Velib is different from any other bike-sharing program due to the fact that Velib bike stations cover the entire city of Paris. This condition makes this system a comprehensive part of Paris urban transport network. Velib started to operate in 2007 and emerged in two main stages which are 10000 bicycles in July 2007 and 10600 more in December 2007 -as the Velib bicycles seen in Figure 21-. Together with the second extension stage of the system, the Velib bike-sharing program has covered the entire city of Paris (Mairie de Paris, 2010). The main establishment aim of the programs was summarized by Bennhold (2007) as 'The program, Vélib (for "vélo," bicycle, and "liberté," freedom), is the latest in a string of European efforts to reduce the number of cars in city centers and give people incentives to choose more eco-friendly modes of transport'. As a justification of these aims, by the construction of Velib bike-sharing system in Paris, a 70% increase in bicycle

use and 5% decrease in car use and congestion were realized in the city (Bremner & Marie, 2008).

Figure 21. Bicycles of Velib Bike-sharing System

Source: (Nadal, 2007)

In Paris, Velib bike stations were established every few blocks in the entire city. The approximate density of stations is 28 bike-stations/square mile (1 square mile is equals to 259 hectare) which increases around commercial or public transport nodes (New York City Department of City Planning, 2009). In other words, a bike station exists in every 300 meters in central Paris (Nadal, 2007). In Figure 22, station density is seen in central part and more peripheral part of Paris.

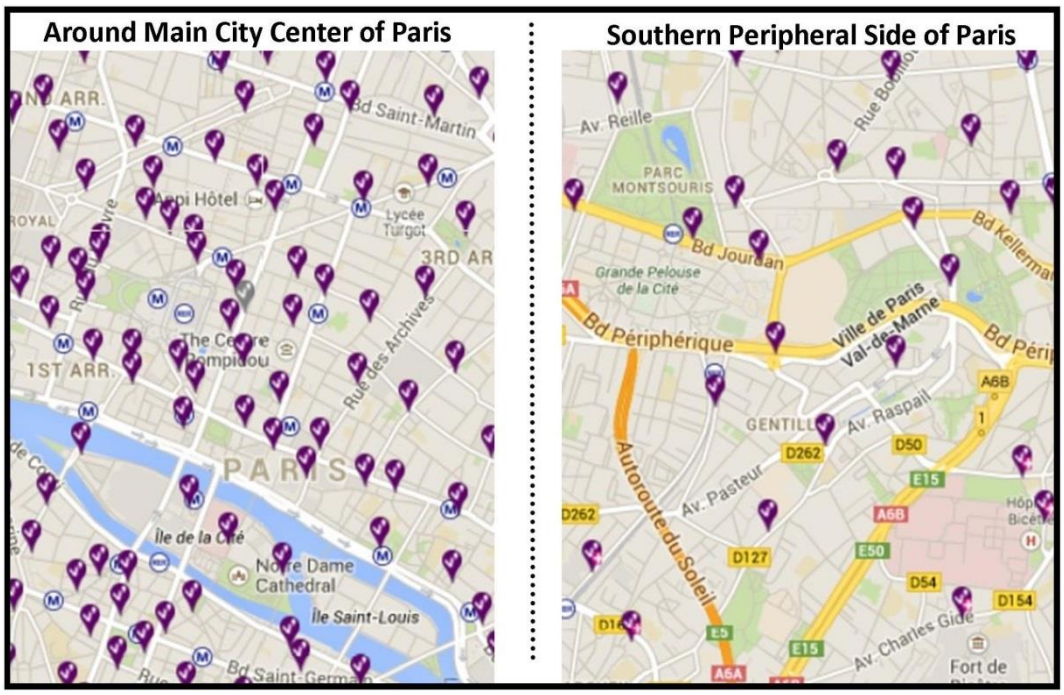

Figure 22. Station Density of Velib System in Two Different Parts of Paris
Source: (Mairie de Paris, 2010)

In addition, pricing policy for Velib seems to be quite affordable (Table 13). This system is used depending on a fee-based pricing policy which enables the usage of the bicycles for free for the first 30 minutes (Shaheen, Guzman, & Zhang, 2012).

Table 13. Pricing Policy of Velib Bike-sharing System in Paris

TIME PERIOD	INCREMENT	TOTAL
First 30 minutes	Free	EUR 0
Second 30 minutes	EUR 1	EUR 1
Third 30 minutes (1 - 1.5 hours)	EUR 2	EUR 3
Every half hour increment afterwards	EUR 4	EUR 7+

Source: (Nadal, 2007)

According to the reports released for Velib', 20 million trips were made by the bicycles of this system. To enable 78000 trips a day on average, which is a rather intensive usage of the system, an efficient bicycle redistribution and maintenance mechanism is necessary (Shaheen, Guzman, & Zhang, 2012). Therefore, the service provider of Velib -JCDecaux- has a fleet team that uses 130 motorized

bicycles, 20 CNG (Compressed natural Gas) service vans and electric cars, and a floating maintenance barge (Mairie de Paris, 2010).

Integration of bike stations with public transport has seemed crucial for the efficiency of bike-sharing system and mode integration. Paris metro system is composed of 300 stations –mainly concentrated in central part of the city- and 16 underground lines, which is one of the most frequently used system in the world. In Paris, Velib program enables passengers an opportunity to have intermodal trips between train and bike stations by construction of stations of these two systems near to each other. In addition, most of the stations of Velib were positioned within the pedestrian catchment area starting from a station of public transport network in which the distance is approximately 400 meters (Nair, Miller-Hooks, Hampshire, & Bušić, 2013).

Velib system is one of the most significant components of *Espaces Civilises* (Civilized Spaces) project of Paris that launched the greening and livability strategy for the city; and within the framework of this project starting from 2001, amount and quality of bicycle and pedestrian infrastructure has increased. €24 million financial investment was used for the development of widening sidewalks from 4 to 8 meters, the number of planted trees, and building bikeways (Nadal, 2007). Figure 20 shows the general layout of bicycle infrastructure in Paris. There is a 371 km bicycle road network in Paris by 2009 (New York City Department of City Planning, 2009). Policy makers in Paris revealed a Four-Year Cycling Plan in order to encourage and support Velib bike-sharing. By 2010, the total length of bicycle lanes in the city was 439 km, and it was planned to be increased to 700 km by 2014 (Freemark, 2010). In Figure 23 below, the continuous purple line shows existing bicycle lanes in 2010, and the dashed ones represent planned bicycle infrastructure in Paris.

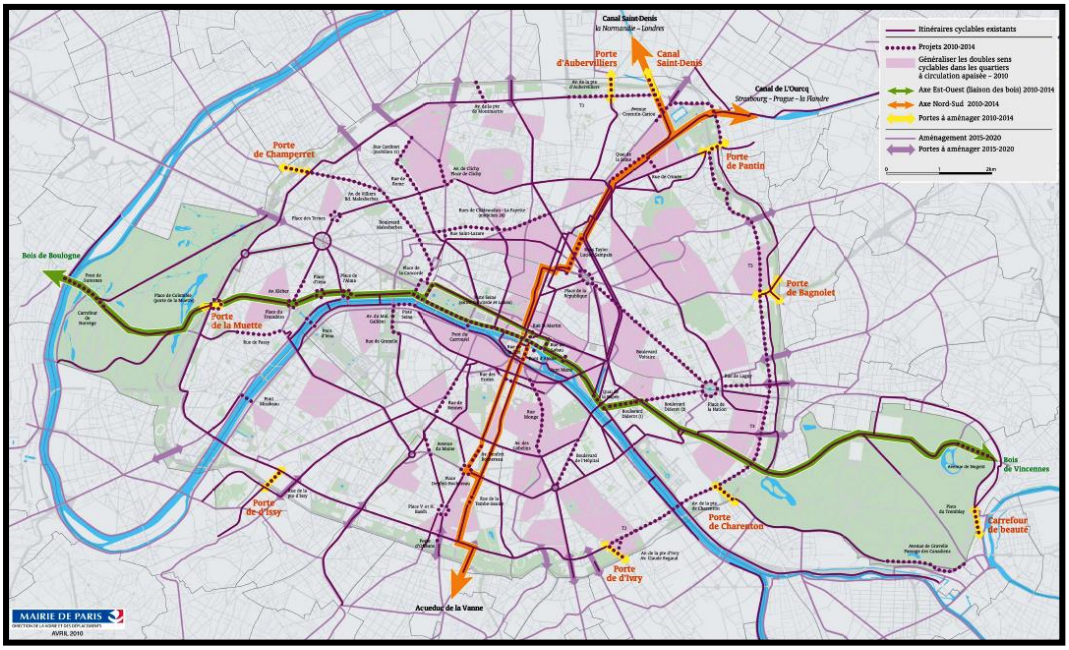

Figure 23. The Map of Bicycle Road Infrastructure in Paris

Source: (Freemark, 2010)

2.7.2. BIXI (Montreal/CANADA)

In Montreal, there was a need to deal with the harmful effects of automobile and negative impacts on environment; therefore, policy makers investigated for viable and concrete solutions in 2007. As a result, bike-sharing was considered as an important mode of urban transport which was focused in the City of Montreal Transport Plan (*Plan de Transport)*. Stationnement de Montreal Company has got the authority for managing the system which is also responsible to regulate parking operations in the city (PBSC Urban Solutions, 2010). This public park operator of Paris took the maintenance of system rather than giving it to an advertiser firm, because Stationnement de Montreal was thought to own the needed capital and human resources for operating and managing a bike-sharing system (Transport Canada, 2009). As a result, BIXI (BIcycle taXI-the word is the combination of *bicycle* and *taxi*) bike-sharing system was constructed in 2009 as the first fundamental initiative for public bicycle-sharing in Montreal, Canada (Imani, Eluru, El-Geneidy, Rabbat, & Haq, 2014).

Initially, Stationnement de Montreal projected to introduce 2400 bicycles and then, additional 2600 more were inserted to the system by the summer of 2009

(New York City Department of City Planning, 2009). As a result of this second phase, there were 400 bike stations and 5000 bicycles within the system. Then, the total number of bicycles and stations were raised to 411 stations and 5120 bicycles in total together with the additions that came from the cities of Westmount and Longueuil (PBSC Urban Solutions, 2010). At the beginning, first phase contained the main core center of Montreal, and the second phase extended the system towards north, west and south as seen in Figure 24. The ultimate distribution of stations in the city of Montreal is shown in Figure 25.

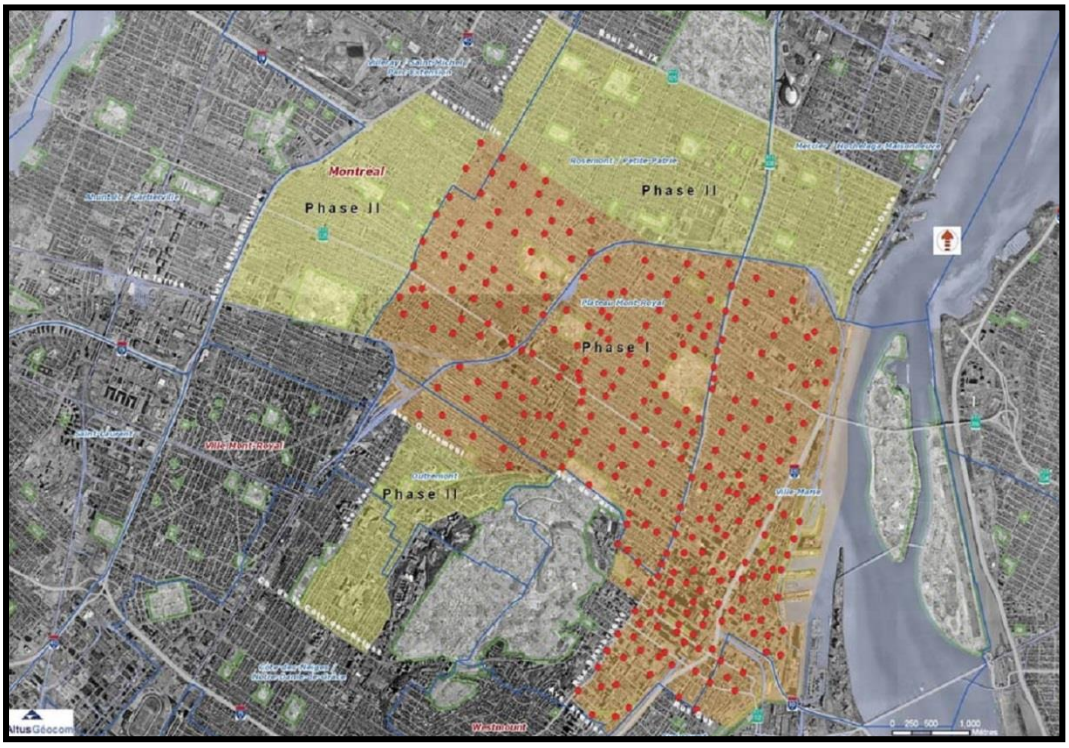

Figure 24. Two-phase development of BIXI System in Montreal Mentioning the Distribution of Bike Stations at Initial Phase

Source: (New York City Department of City Planning, 2009)

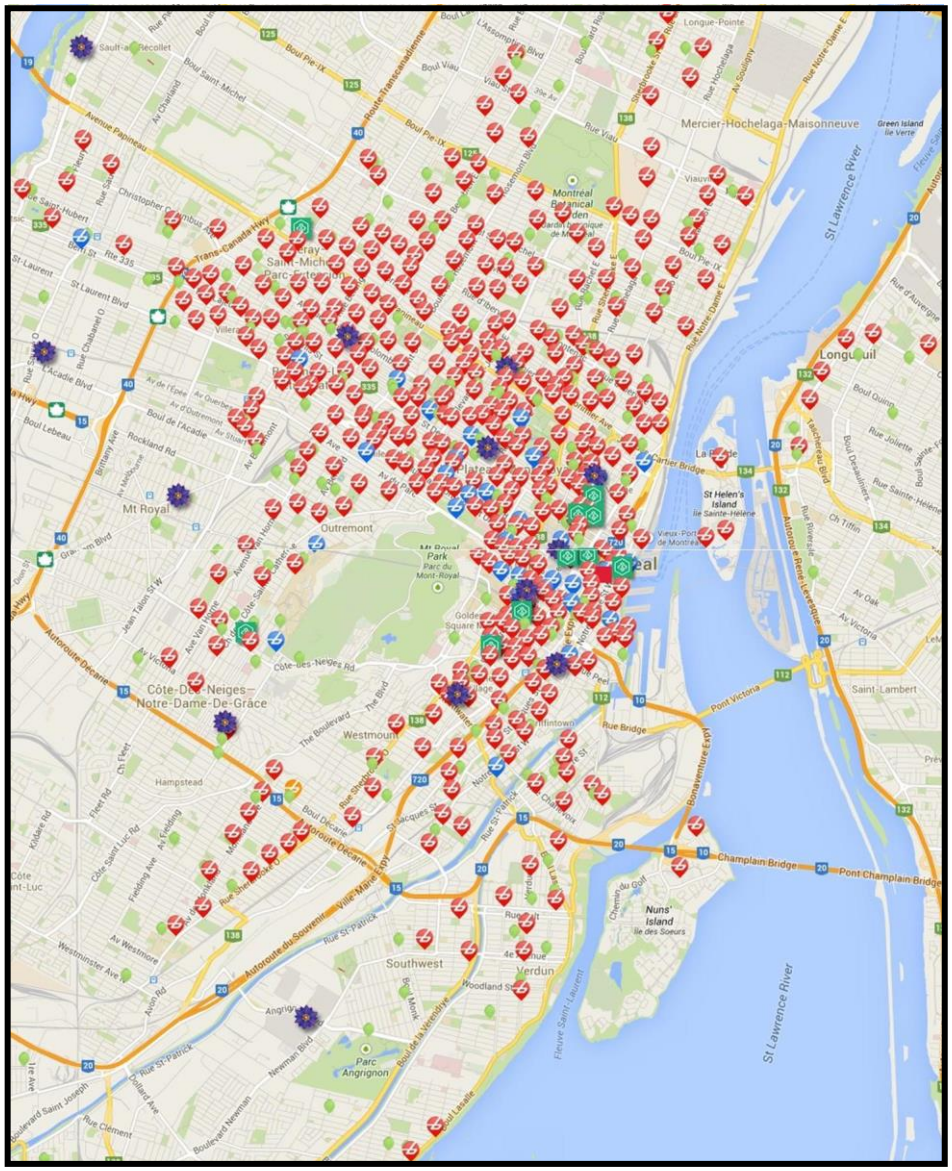

Figure 25. The Ultimate Distribution of Stations in the City of Montreal by 2014

Source: (BIXI Montreal, 2013)

BIXI, which was projected to become the largest system in North America and one of the largest in the world, was planned to be integrated into the existing public transport network of Montreal and to support the travel demands of commuters in the city. Station site selection of BIXI program was done depending on the criteria of positioning every 250-300 meters around 15 square km radius from central Montreal (New York City Department of City Planning, 2009).

Bike stations in BIXI program are flexible which means that almost each station has the characteristic of being portable, and fixed stations on street pavement are in few numbers. These stations do not need electric network construction since they are solar powered and wireless network is used which enables rapid and inexpensive construction opportunity for stations. Such a flexibility of stations make bike-sharing components, including bicycles and stations, easily removable between November and April -during winter period- (Transport Canada, 2009). In Figure 26, an example of BIXI station is shown together with the integration with on-street bicycle lane.

Figure 26. BIXI Station in Montreal together with Its Integration with on-street Bicycle Lane

Source: (http://actsofminortreason.blogspot.com.tr/2010_07_01_archive.html)

BIXI bike-sharing system has different pricing regulations to BIXI members and casual users. Table 14 shows pricing policy for casual users which enables free ride in the first 30 minutes, then the price increases for each 30 minutes. For members, an opportunity is given as riding bicycles free for 45 minutes.

Table 14. Pricing Policy of BIXI Bike-sharing System Applied to Casual Users in Montreal

TIME PERIOD	INCREMENT	TOTAL
First 30 minutes	Free	$ 0
Second 30 minutes	$ 1,75	$ 1,75
Third 30 minutes (1 - 1.5 hours)	$ 3,50	$ 5,25
Every half hour increment afterwards	$ 7	$ 12,25 +

Source: (BIXI Montreal, 2013)

An extensive dual bike lane network exists in Montreal providing access in residential and commercial areas (New York City Department of City Planning, 2009). In general, bike-sharing systems are highly related with bicycle lane network in the city since this infrastructure enables the efficient, rapid and safe travels made by the public bicycles of this system. In Montreal, bicycle tracks and roads constitute an efficient network that serve the flow of bicycle trips made in the city of Montreal closely associated with BIXI bike stations (Figure 27).

Figure 27. The Map of Bicycle Road Infrastructure in the City of Montreal

Source:(https://www.google.com/maps/@45.4706522,73.5721793,13z/data=!5m1!1e3)

In short, the main characteristics of BIXI system in Montreal can be summarized as follows;

- It is easy to install and remove stations since they are flexible,
- Kiosks at stations are solar powered featuring an environmentally-friendly characteristic,
- No excavation is needed to be done under favor of portable and self-sufficient energy supplied station platforms,
- The real time availability of bicycles at any station in Montreal can be learned from any bike station (PBSC Urban Solutions, 2010).

2.7.3. Public Bicycle (Hangzhou/CHINA)

In China, Hangzhou Public Bicycle system, which was initiated by the Hangzhou Public Transport Corporation in 2008, is the most popular one in Asia with its largest number of stations and bicycles (Hangzhou Public Bicycle, 2008). In 1970s, China was considered as a country of 'Kingdom of Bicycles' in which bicycle was a considerable vehicle for urban mobility among public. The reason that bicycle use was widespread this much is low income for people, short travel distances in cities, and adopting compact urban form; however, a steady decrease in bicycle use in China was observed in recent two decades for the reasons of increased tendency on motorized transport, economic development, declining cycling infrastructure and environment, and increased travel distances. In other words, the prevailing urban development policy in China brought limitations on bike use. Consequently, the Chinese Ministry of Housing and Urban-Rural Development took an attitude towards with a view to combat traffic congestion and associated environmental externalities, and bike-sharing was a tool to address such problems as a governmental initiative. Therefore, Public Bike bike-sharing system was applied to Hangzhou on May 2008 by city government, and by the beginning of 2011 there were 60600 bicycles and 2416 stations within the system (Shaheen, Zhang, Martin, & Guzman, 2011). Figure 28 shows a general layout for the distribution of bike stations in Hangzhou.

Figure 28. General Layout for the Distribution of Bike Stations in Hangzhou
Source: (Jiang, 2011)

Public Bicycle system is the world's largest bike-sharing system. In Hangzhou, the percentage of general bicycle trips among other modes is 43%, and bike-sharing system has a significant share for that. The target of policy makers is to increase the number of bicycles to 175000 by 2020 to benefit the potential to reduce greenhouse gas emissions in Hangzhou (ICLEI Local Governments for Sustainability, 2011).

Provision of an efficient and free bike-sharing program was the principle aim of Public Bicycle system in Hangzhou to meet the demands of local people and tourists. In addition, this system has also played a supportive role to feed public transport network throughout the city (Hangzhou Urban Design Institute, 2008).

The main characteristics of Hangzhou Public Bicycle system can be summarized as follows:

- The initiation of program was supported by local government, and a state owned corporation operates the system,

- One of the most important objectives of Public Bicycle is enabling the integration of bike-sharing with public transport,
- Public transport integration of system through smartcard is realized which means that there is an opportunity to get a discount for public transport after the use of bike-sharing,
- The initial hour is free for the users,
- Fixed docking stations are used in the system (Figure 29),
- Inexpensive and one-speed bicycles are used in Public Bicycle in order to minimize theft and vandalism (Shaheen, Zhang, Martin, & Guzman, 2011).

Figure 29. Fixed Bicycle Station in Public Bicycle System of Hangzhou with Its Station Shelter

Source: (http://www.flickr.com/photos/jpasden/5969633717/in/photostream/)

Cyclists of Public Bicycle in Hangzhou ride these bicycles for their initial or last 1 km trip with an average duration of 23 minutes; therefore, 96% of trips do not exceed one hour in which bicycle rental is free for initial first hour according to the pricing policy of the system (Table 15). As a result, the system does not get

too much revenue, and it is compensated by advertisements on bicycles. Thus, bicycles are quite affordable to users in Hangzhou (ICLEI Local Governments for Sustainability, 2011).

Table 15. Pricing Policy of Public Bicycle System in Hangzhou

TIME PERIOD	INCREMENT	TOTAL
First hour	Free	$ 0
Additional 1 hour (1 – 2 hours)	$ 0,15	$ 0,15
Additional 1 hour (2 – 3 hours)	$ 0,30	$ 0,45
Every 1 hour increment afterwards	$ 0,45	$ 0,90 +

Source: (Hangzhou Public Bicycle, 2008)

Public Bicycle system is being intensively used; therefore, policy makers respond to such a demand by operating 35 stations 24 hours a day, and most of the other stations serve between 6.00 a.m. and 21.30 p.m. which creates time for the responsible staff to maintain and redistribute the system (Hangzhou Public Bicycle, 2008).

2.8. Summary

In this chapter, first the concepts of sustainable transport and the need to develop alternatives to the automobile were described, highlighting the unsustainable growth trends that automobile-oriented urban areas create. The role that public transport, walking and cycling can play in creating more sustainable urban transport systems were discussed, and the increasing importance of bicycle use as an urban transport mode was presented. In addition to policies and projects of developing and improving bike network and parking infrastructure, bike-sharing systems were described as a recent approach in promoting bike usage for urban transport. The definition, history with three commonly accepted generations, main costs and challenges, the future anticipations, and business models of bike-sharing were explained. Then, a general overview of the successful and efficiently used system examples from Paris, Montreal and Hangzhou were examined.

The analysis of the bike-sharing concept and the best-practice cases from three different continents (BIXI -Montreal/Canada- from America, Velib -Paris/France- from Europe and Public Bicycle -Hangzhou/China- from Asia) provide a

framework for the research to be carried out in this thesis. The literature review and analysis of cases from different parts of the world reveal several crucial approaches, policies and criteria constituting indispensable issues to analyze bike-sharing. These can be classified as the planning background of systems, general design elements of bicycles and bike stations, operational issues, supportive policies performed by policy makers to encourage the system, and future intentions to increase the efficiency of cycling through bike-sharing. In this research, these elements constitute the framework for the analysis of selected Turkish bike-sharing cases from Konya, Kayseri and İstanbul. The main aim in this comparison is determining planning, design and operational principles of bike-sharing in Turkey. The following section, which presents the research methodology, describes in further detail how this framework will be used for analyzing Turkish cases and Turkey's experience with bike-share systems.

CHAPTER 3

3. METHODOLOGY

3.1. Context

In this research of bike-sharing systems of 'Smart bike', 'Kaybis' and 'İsbike' -in Konya, Kayseri and İstanbul-, are to be investigated and evaluated determining the general circumstances of these systems depending on the inferences made from literature review of bike-sharing and best-practice cases from different parts of the world. The context of the study was shaped according to the general framework that bike sharing has become a significant agenda and has significantly increased in terms of new system construction in various parts the world. Globally, as a result of unsustainable car oriented urban transport policies, people face diverse problems like traffic congestion and air pollution as well as climate change and health problems. To deal with these issues, public transport, walking, and cycling have to be improved and made viable and attractive alternatives to the car. In recent decades, cycling has become widespread in many cities in the world -particularly in Europe- as a non-motorized transport alternative: new infrastructural investments were made to facilitate and enable safe and efficient use of bicycle. This trend has been further supported by bike sharing systems, which aimed at making bike usage a common urban transport mode with a view to reduce car dependency and hence alleviate transport and traffic problems associated with the extensive use of the car.

3.2. Aim and Research Questions

In recent decades, bike-sharing is effectively used as a transport policy tool in many countries, and this system has also received attention from local governments in Turkey in recent years. In 2009, the first bike-sharing started operation in Kayseri, and then Konya followed with another system. In 2013, one of the newest systems was initiated in İstanbul. These three bike-sharing systems have been in operation since and there are a number of other cities that have just launched a bike-share system or planning one as ofmid-2014. However, there has

not yet been a comprehensive analysis about this experience. There are no studies that show what has been experienced in the planning, construction and operation of these systems in Turkey, what the mistakes or correct attitudes of policy makers have been for their bike-sharing systems, how much these systems are advanced compared to the criteria inferred from the literature review and selected best-practice cases around the world, and on what aspects these three cases and other intending cities need to pay attention. Therefore, **the aim of this research** is to analyse and provide a better understanding of the bike-share experience in Turkey, particularly in the three cities that became pioneers for this system in Turkey.

According to the investigation made in previous chapters, **the research questions of the study** supported by some sub-questions, which serve fundamentally to achieve and improve the aim of research, can be stated as follows:

1. *What are the strengths, weaknesses and the areas that can be improved for 'Smart bike', 'Kaybis' and 'İsbike' bike-sharing systems -in Konya, Kayseri and İstanbul respectively- from Turkey in the light of the criteria determined through the analysis of literature and best practices from the world?*

-- How was the planning background of these systems shaped in terms of planning the systems, decision-making, bike station site selection, planning aim, and bicycle road infrastructure?

-- What is the general condition of the main components of these systems in terms of system design including aspects such as station shelter, sufficiency of bicycle numbers, locking mechanisms, noticeability of bike stations, and adopting 4th generation characteristics?

-- How are the operational issues of bike-sharing shaped in these cities considering system continuity, mobile applications, smartcard integration, registration, maintenance of systems, pricing policy, and helmet wearing?

-- Are there any supportive complementary policies applied for bike-sharing systems in terms of encouraging policies, the use of systems as a sustainable non-motorized transport mode, and effective announcement/advertisement of systems?

-- Are there any intentions for future to develop the systems in terms of system extensions, demands from people, and physical improvements of systems?

2. *How do policy makers of these systems evaluate the systems that they operate: successful, deficient or developing?*

3. *What can be the indispensable criteria -planning, design and operational principles- as policy inputs for future implementations in Turkey?*

3.3. Case Study Selection

In the analysis of bike-sharing in Turkey, three examples from three different cities were selected and visited for the research. These cities are not randomly determined; on the contrary, several criteria were considered for each city.

The bike-sharing system in Kayseri -'Kaybis'- was selected because this system is the first initiative of this kind in Turkey which started its operation in July 2009. Therefore, the analysis of the Kayseri case reveals how bike-sharing system firstly entered Turkey. Besides, it was found out from the preliminary researches that the locations of bike stations within this system were positioned to serve mainly public transport which means that bike-sharing is seen as an urban transport alternative by policy makers in Kayseri. The main theme of the thesis research was also oriented towards considering cycling and bike-sharing as an urban transport mode. As a result, 'Kaybis' system in Kayseri was selected to be included as a case study in the research.

The 'Smart bike' system in Konya, which has been the second bike-sharing initiative in Turkey in operation since October 2011, was determined as the second case study. Konya is a city that is renowned to have the most widespread bicycle culture together in Turkey with its extensive bicycle road infrastructure

and bicycle use as a daily urban transport mode. Therefore, it was inferred that policy makers of the 'Smart bike' system had planned to integrate bike-sharing system with this bicycle culture that already existed in the city. Thus, this city was also selected as another case study.

After Kayseri and Konya, other bike-sharing initiatives started in İzmir and Samsun at the beginning of 2013; however, 'İsbike' system in İstanbul that also started at the same year appeared to have more rigorous plans to extend the system at the time of case study selection. Although these plans to extend the system were not materialized, and the systems remained as a line that operated only at the coastal corridor between Kadıköy and Kartal districts, and hence more as a recreational tool than urban transport mode, it was nevertheless decided to keep Istanbul as one the case studies. İstanbul case was significant, because it would be important to observe the entrance of bike-sharing to a metropolitan city of over 10 million populations. It was considered that analyzing the challenges as well as future development plans for the Istanbul case would be a valuable contribution for the study. As a result, the systems in Kayseri, Konya and İstanbul were selected as comparative research case study areas from where main findings of the analysis are produced. These three Turkish cases are compared in terms of their planning background, system design, operational issues, supportive complementary policies, and future plans. In the end, it is aimed to conclude some basic planning, design and operational principles of bike-sharing in Turkey.

3.4. Method of Analysis

For field research, my visits to these three cities were carried out between 26-27 August 2013 for Konya, 29-30 August 2013 for Kayseri, and 6-7 September 2013 for İstanbul. In order to investigate bike-sharing cases in Konya, Kayseri and İstanbul, I applied four main data collection methods which are in-depth interviews, participant observation, collecting written documents, and collecting visual documents:

- **In-depth interviews** were carried out with policy makers of bike-sharing systems in each city. In Konya, a total of three interviews were made:

with an engineer working in Konya Metropolitan Municipality Directorate of Road Making; the manager of Konya Metropolitan Municipality Department of Urban Development; and the director of the private company, which has the responsibility of operating the bike-sharing system. In Kayseri, one interview was made with the Electrical and Electronics Engineer of 'Kayseri Ulaşım A.Ş.', the firm that is the responsible authority for bike-sharing system, and also in İstanbul, one interview was made with the responsible authority of Bicycle Unit of İSPARK. Before going to these three cities, I prepared interview questions and all the interviewees were asked the same questions. In the research, the interview questions were formed through the outcomes of the literature review made for bike-sharing and the analysis of successful cases from different parts of the world. **In-depth interview questions and their explanatory sub topics** are presented below.

---

1. *What are your general opinions about urban transport?*

-Automobile use.
-Use of public transport.
-Use of bicycle.

2. *What were your aims for the construction of system? How did the idea emerge? Did the project intend to contribute to the image of the city? Did you also consider any of the following objectives in launching this system:*

-to help decrease car dependency?
-decreasing air pollution and environmental awareness?
-increasing bicycle use as an urban transport mode/alternative?
-considering the positive impacts on human health?
-increasing public transport use together with the integration of bike-sharing to public transport?

-decreasing the costs for road construction and other automobile related infrastructure?

-providing urban transport for all people with an equal social status?

3. *Generally in Europe, there are plans to integrate bike-sharing systems with public transport through smartcards (a common card system that enables transfer between different modes). Is there any kind of an integration of your bike-sharing system?*

-If not, is there any plan for this?

-If the passenger wants to use bike-sharing right after the use of public transport, are there any transfer discounts? If not, have you ever considered such a possibility?

-It can be said that in the cities that bike-sharing is integrated with other public transport modes and free or discounted bike-sharing system exist, traffic congestion, noise and air pollution are reduced by means of decreasing car use. Are there any impact analysis or observations regarding this issue for this city?

4. *Positioning bicycles at proper and accessible places in the city, and existence of enough number of bicycles at stations seem to be significant for the success of the system. Which criteria were taken into account for site selection of bicycles? (closeness to central places, commercial areas, education-university areas, working places…?)*

-Are there enough bicycles at stations? Are there any stations that run out of bicycles; or stations where no bicycles are used? (These questions are to support the question whether the locations of the stations are correct or not)

-Is the total number of bicycles enough within the system?

-Have you got any demand coming from public for a new station place or any station relocation from one place to another?

-Has there been a station removed since the beginning of the system?

-Has there been a station relocated since the beginning of the system ?

5. *Is there a maintenance program for the system?*

6. *Is there a public information program showing the existing situation of the system?*

-If yes; can it show the remaining bicycles at any station?

-If yes; how is the information conveyed to public? (Through mobile phone application or computer based software or both?)

7. *Is there a mechanism for the redistribution of bicycles? (Redistribution from overloaded stations to emptier ones)*

8. *Are there any campaigns, festivals or organizations for the advertisement of the system; or is there a plan for such activities?*

9. *Are there problems of bicycle thefts or deteriorations for bike-sharing systems which are significant problems of these systems?*

-Did it happen at the beginning of the system? If yes; is there any decrease in this problem? Were there any specific efforts presented to eliminate the problem?

10. *What kind of a business model was applied in this city for the construction of bike-sharing system? What kinds of partnerships were established? Who were the actors?*

11. *When the systems in Europe are investigated, it is seen that both wearing and not wearing a helmet while cycling bring some problems. What about helmet wearing requirements or regulations in your bike-sharing system?*

12. *If bicycle use has increased as a result of the initiation of bike-sharing, is there any increase in the number of accidents in which cyclists take part in?*

13. *Sometimes, there may be some problems between cyclists and pedestrians. Is there any increase in the number of accidents between pedestrians and cyclists?*

-Did you receive any complaints from pedestrians about cyclists of bike-sharing?

-Have pedestrians got used to cyclists? Are there any conditions such as walking on bicycle road or lane?

14. *In some cities in the world, we can see that bike-sharing systems are constructed without developing bicycle road network sufficiently in the city. On the other hand, in Mexico City, before the construction of bike-sharing system in the city, 300 km bicycle road network was made. Will any investments be made on bicycle road making? Do you think that bicycle roads contribute to the success of bike-sharing?*

15. *Are there any thoughts or projects for further developing the system, station additions, increasing the number of bicycles? (Or GPS tracking for bicycles as is the case in some cities in the world)*

16. *A questionnaire study was carried out in the cities of Beijing, Shangai, and Hangzhou analyzing the trip purposes in using the bike-sharing system in each city. Possible trip purposes are presented below. In this city, do you have any information about the trip purposes bike-share users? Is there any research for it?*

-To work
-To school
-To return home
-For shopping
-For entertainment
-Touristic trip
-Others..

As a result of in-depth interviews which were applied to policy makers in Konya, Kayseri and İstanbul, a comparative study was made for these three bike-sharing cases from Turkey in order to make the analysis of the results gathered from interviews. Interview questions were reviewed to make them easily comprehendible for this comparison analysis. Therefore, five main themes were determined together with their sub questions or research issues. The list below illustrates the components of the analysis, which are then used as analysis tables when presenting the findings of the field research.

Planning background

- *Is the system based on a transport plan; or an urban plan or urban design project (integration with any sort of plan)?*
- *Initiation of the project (Who launched the decision of bike-sharing?)*
- *Bike station site selection*
- *Planning and construction aim of the system*
- *Bicycle road infrastructure in relation with bike-sharing that directly effects the efficiency of the system*

System Design

- *Existence of station shelters*
- *Sufficiency of total number of bicycles within the system*
- *Locking mechanism*
- *Noticeability or visibility of stations*
- *Inclusion of any characteristics from fourth generation of bike-sharing for future*

Operational issues

- *System continuity in all seasons and bad weather conditions*
- *Mobile application for bike-sharing systems*
- *Public transport integration of systems through smartcards (intermodality)*
- *Ease of use of the system for locals and visitors in terms of user registration process*

- *Maintenance of systems and bicycle redistribution mechanisms*
- *Pricing*
- *Helmet wearing obligation*

Supportive complementary policies

- *Encouraging policies to increase the use of systems*
- *Is the system constructed for supporting non-motorized transport as an upper scale vision? Are policy makers aware of the significance of it?*
- *Advertising efforts for bike-sharing*

Future

- *Is there a plan for system expansion to serve urban transport more?*
- *Demand coming from citizens/users for station addition or new system construction*
- *Are there any planned physical improvements on the components of systems?*

- **Participant observation** is another method of gathering information for research areas. I individually participated by cycling throughout bike-sharing service area of those cities during 2 days for each city by using bicycles of bike-sharing systems. In Konya, I had registered the system from the web site of service provider by using credit card before I went for site analysis, and then, I started using bike-sharing in Konya beginning from the bike station which was closest to my arrival point of railroad terminal. In two-day analysis in Konya, I never get on any other motorized vehicle for my inner city urban travel; the only modes for urban transport for me were walking and cycling with bike-sharing in this city. In Kayseri, my bike-sharing experience started from the bike station in the city center after a difficult system registration procedure. I almost never walked in the city; almost all my movements in the city were realized by bicycles of 'Kaybis' bike-sharing. In İstanbul, in two-day field analysis period, I could only use bicycles of bike-sharing in the first day after travelling to

Kadıköy coastal line on which bike-sharing stations start and continue along the coastal corridor.

- **Collecting written documents** is another research method that I have used. I scanned all the available documents about bike-sharing in general and specific to the ones in Konya, Kayseri and İstanbul. These included web sites, articles, books, academic thesis, projects and news.
- **Collecting visual documents** is another part of data collection process. In this stage, searching internet and taking photos in Konya, Kayseri and İstanbul constituted the main part of gathering data. In addition, some conceptual schemes were produced in order to make the analysis of bike-sharing in Turkish cases more easily comprehendible.

CHAPTER 4

4. ASSESSMENT OF BIKE-SHARING SYSTEMS IN KONYA, KAYSERI AND İSTANBUL

This chapter presents a comparative study of the bike-sharing systems in Konya, Kayseri and İstanbul. First, the state of cycling and bike infrastructure in Turkish cities are described; and then, bike-sharing concept in particular to Turkey is explained providing information on cities that are operating bike-share systems as well as those that are planning. The main focus of the chapter is the comparative analysis of the three case studies from Turkey, Konya, Kayseri and Istanbul.

4.1. Cycling in Turkish Cities

Cycling in the city in order to reach to work, to home, or to any place that is desired to be travelled to is considered as a crucial element in urban transport planning since it has many benefits such as decreasing automobile dependence for individuals, being a green mode of urban transport, serving as a supplementary solution for environmental, ecological or social sustainability concerns and providing health benefits to its users. Thus, policy makers in many cities in the world have constructed bicycle lanes or separated bicycle roads and launched bike-sharing programs as vital urban transport strategies to support cycling. In Turkey, the condition seems different within the context of the use of bicycle in the city as a transport mode. Bicycle has mostly been considered as a soft policy in Turkey, an instrument just to support recreational needs of people.- The idea of using bicycle as an urban transport mode was systematically under-recognized by policy makers until the last decade.

In Turkey, cycling could not gain enough significance as an urban transport mode; however, despite the lack of supportive policies, some cities adopt bicycle use more than the average of Turkey: İzmit, Adapazarı -industrial cities-, Adana, Gaziantep -advantageous cities with their climate conditions and flat topography-, and other urban and rural settlements in Aegean Region (Yüksel Proje-Ulaşım Art, 2001). The city of Konya in Turkey has become the pioneer to make bicycle use a kind of a travel preference in cities. The traditional cycling structure of

citizens in Konya has created an inevitable demand for construction of bicycle roads and regulations to enable cycling as a safe mode of urban transport.

In Konya, convenient topography and climate conditions has enabled bicycle use efficient between urban center and peripheral vineyards and orchards, and between residential and working areas. The meeting of people in Konya and bicycle is dated to 1920s due to the convenience of a flat topography and lack of other urban transport modes apart from horses and horse-drawn vehicles. Bicycles played an important role of connecting urban center and periphery of the city in those years. Today, as a result of the common use of bicycle among various ages of people in Konya, a bicycle culture is present; so that, this city has come to the forefront in Turkey with its considerable cycling experience as an urban transport mode (Yüksel Proje-Ulaşım Art, 2001).

By the end of 2012, 196 km bicycle road was constructed in Konya (Konya Metropolitan Municipality, 2013). As seen in Figure 29, shared bicycle lanes and separated bicycle roads exist at different parts of Konya. However, no bicycle lane or road exist at the core city center, and people have been trying to deal with intensive traffic, often at the expense of their safety while cycling. Policy makers in the municipality have not taken any concrete steps to designate some parts of motorized vehicle roads to cyclists (Figure 30).

Figure 30. Shared and Segregated Bicycle Roads from Konya

Source: (Konya Metropolitan Municipality)

Figure 31. Cycling in the Core Center of Konya without Separated Bicycle Road as well as Cycling Safety

Source: (Personal Archive)

In Kayseri, there is also a cycling culture in the city due to the flat topography and grid urban layout enabling efficient link between central and more peripheral locations in the city. According to Demirdirek (Analysis of 'Kaybis' Bike-sharing System in Kayseri, 2013), 85 km bicycle lane was created together with the positioning of bike-sharing system in the mid of 2009. All these bicycle lanes are shared types which are juxtaposed with vehicle traffic (Figure 31).

Figure 32. Examples of Shared Bicycle Lanes in Kayseri

Source: (Personal Archive)

Bicycle lane network of Kayseri was created according to the locations of the stations of 'Kaybis' bike-sharing system; therefore, this network was designed around the main core city center to enable the transfer of people to a tram station. A considerable part of bicycle lanes in Kayseri was created by using the term of '*bicycle boulevard'* that is used for the streets that contain one of the vehicle lanes shared with bicycles. In other words, one lane on the road, which is designed depending on the width capacity needed for the vehicle traffic, is used both by motorized vehicles and bicycles. Due to the lack of any type of separation from motorized and often high-speed traffic, cycling safety is a major problem on such streets (Figure 33).

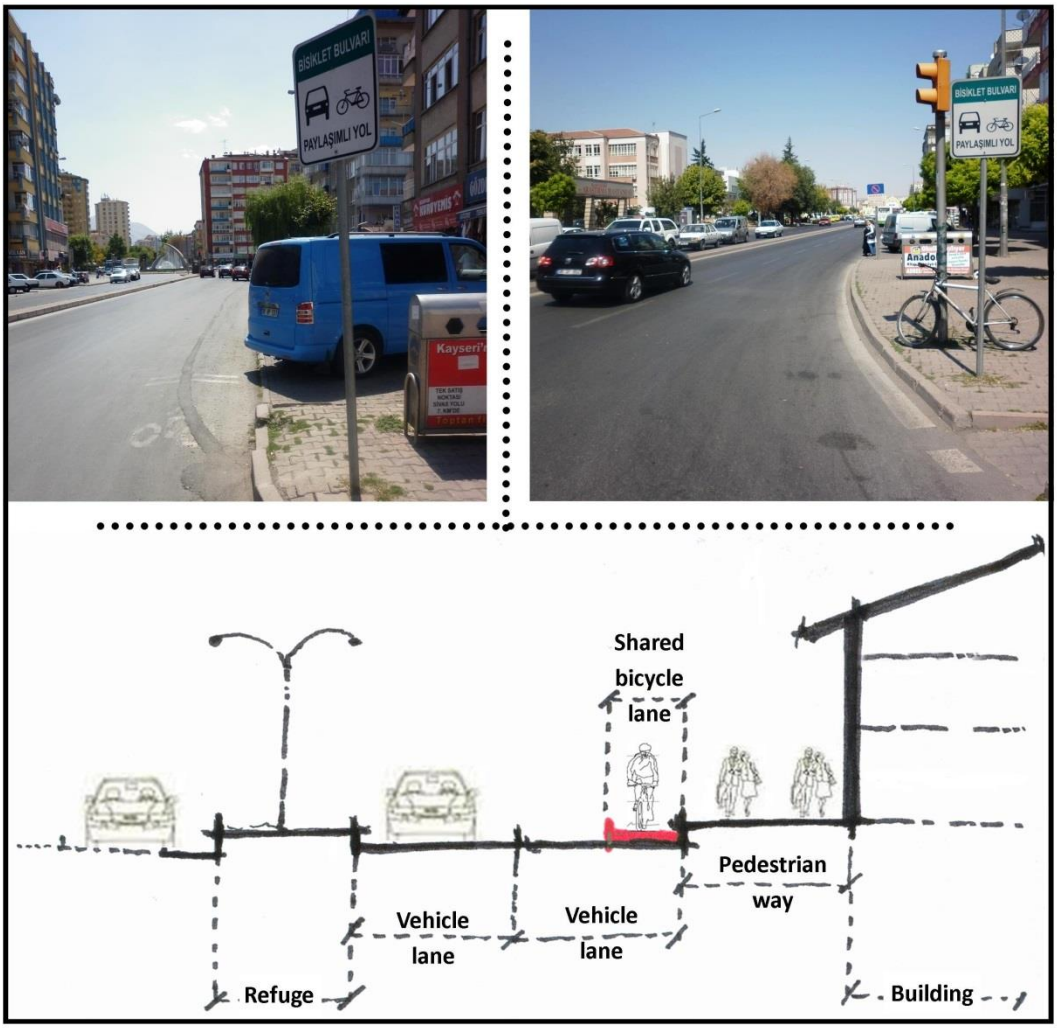

Figure 33. Views from 'Bicycle Boulevard' in Kayseri Including A Section

Source: (Personal Archive)

In İstanbul, coastal corridors in both Anatolian and European sides of the city constitute a potential for recreational cycling. Some efforts have also been put to penetrate bicycle road infrastructure to inner parts of the city on plans. However, bicycle use as an urban transport mode has not efficiently been realized yet. As a result, 'İsbike' bike-sharing system in İstanbul has only been limited to coastal lines in terms of station positioning. Figure 34 shows the examples of bicycle lanes in Kadıköy coastal corridor and Kadıköy Moda Street.

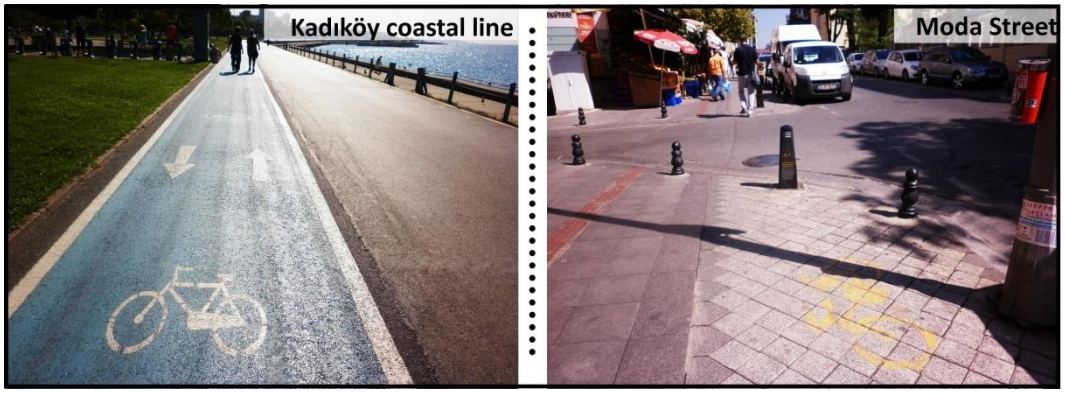

Figure 34. Examples of bicycle lanes in Kadıköy coastal corridor and Kadıköy Moda Street

Source: (Personal Archive)

In addition to the above cities, which form the focus of the analysis in this study, there are few other cities that implement bike roads and lanes; however, such bike networks are still very limited in coverage and such cities are limited in number. Mobility needs are increasingly been met by motorized transport in Turkish cities, and automobile usage is on the increase. Many local authorities consider road programs that propose more road building, road widening, fly-overs or underpasses in inner cities as a solution to reduce traffic congestion, but in a number of cities there is now an awareness that alternatives to the automobile must be improved, and among these alternatives cycling may help encourage more sustainable travel patterns and hence create a more sustainable urban transport system. As described in the earlier chapters of this study, bike-sharing systems may have the potential to change travel patterns of people and to create a bicycle culture for urban transport. The cities that launched bike-share systems are worth analyzing in this context since they may become models for other cities in Turkey that search for strategies to reduce car dependency and encourage sustainable mobility.

4.2. Bike-sharing in Turkey: Konya, Kayseri and İstanbul Case Studies

In Turkey, bike-sharing systems have been recognized by policy makers in local governments in recent years in order to respond to different sorts of demands of

local people or tourists. After the first initiative in Kayseri, a kind of a bike-sharing boom has been experienced since 2009 in Turkey. Free construction of system by means of agreement with private advertisement firms and intense interest of public enable the rise of bike-sharing in Turkish cities. The table below shows all bike-sharing programs in Turkey under operation together with their station and bicycle numbers (as of July 2014) (Table 16).

Table 16. Bike-Sharing Systems in Turkey as of July 2014

CITY	Program Name	Start Date	Number of Station	Number of Bicycle
Konya	*Smart Bike*	October 2011	40	500
Kayseri	*Kaybis*	July 2009	25	300
İstanbul (Kadıköy-Kartal)	*İsbike*	May 2013	10	100
İstanbul (Florya-Yeşilköy)	*İsbike*	At the beginning of 2014	5	100
İzmir (city center)	*Bisim*	January 2014	29	311
İzmir (Karşıyaka)	*Karbis*	January 2013	7	65
Samsun	*Sambis*	June 2013	6	106
Muğla	*"Akıllı Bisiklet"*	Openning in near future	4	40
Antalya	*Antbis*	At the beginning of 2014	6	40
Eskişehir	*Esbis*	March 2014	10	120
Kocaeli	*"Akıllı Bisiklet"*	2014	15	120

Table 16 (continued)

Giresun	***"Akıllı Bisiklet"***	Under project	-	100
Yalova	*"Akıllı Bisiklet"*	Mid 2013	10	120

The first bike-sharing initiative was realized in Kayseri in July 2009 named 'Kaybis' to support mainly the tram line by transferring people from inner parts of the urban area to the tram stations. Therefore, in site selection of bike stations, to enable the integration between these two modes was considered as a crucial issue. Later on, the second bike-sharing system construction was experienced in October 2011 in Konya, in which a considerable bicycle culture exists in Turkey. Konya 'Smart Bike' system was initiated to make short or middle distance travels in the city easier and healthier as well as to support recreational cycling demands of local people and tourists. In addition, policy makers of ISPARK in İstanbul considered Kadıköy-Kartal recreational coastal corridor as a potential for cycling by public bicycles taken from bike stations on different parts of the corridor; therefore, 'İsbike' system was realized on May 2013. Table 17 shows the basic characteristics of these three cases including initiation date, operator and service provider, the area covered by bike stations in the city, city population, and total number of stations and bicycles.

Table 17. Main Characteristics of Bike-sharing Systems in Konya, Kayseri and İstanbul

Program name	**Smart Bike**	**Kaybis**	**İsbike**
City	Konya	Kayseri	İstanbul
Service Provider	Next Bike	Clear Channel	-
Operator	Wall AG	Kayseri Ulaşım A.Ş.	İSPARK A.Ş.
Start date	October 2011	July 2009	May 2013

Table 17 (continued)

Program coverage	Almost entire urban macroform	Around city center focusing on service area of tram line	Coastal Corridor between Kadıköy and Kartal
City population	2 079 225	1 295 355	14 160 467
Number of stations	40	25	10
Number of bicycles	500	300	100

These three cases from different cities in Turkey will be analyzed in detail by means of the questions directed to policy makers in Konya, Kayseri and İstanbul. Under the following heading, issues about 'Smart bike', 'Kaybis' and 'İsbike' are presented including the planning, design, operation, policy implementations and future plans.

4.3. Comparative Analysis of Three Bike-sharing Cases

In this bike-sharing research, the field analysis was designed considering the issues revealed from the literature review and successful examples from other parts of the world. Following the information from the literature review and lessons learnt from best-practice cases, the analysis was conducted to focus on the planning background, system design, operational issues, supportive complementary policies, and future plans of these bike-share systems. The analysis is presented below under these sub-headings.

4.3.1. Planning Background

Any kind of changes made in urban space should depend on a plan, so that the future of activities can be predictable, problems or deficiencies can be determined easily; and as a result, maximum benefit can be gained from the activity or changes in urban space through planning. For example, if a Light Rail System construction is not planned in integration with the network of the public transport

system as a whole within the context of an urban plan or a general transportation plan, the use and efficiency of system may decrease in time; moreover, instead of contributing to the general public interest by facilitating urban accessibility, it might have damaging impact on urban transport. Therefore, any transport project must be considered in integration with the whole transport network; but it must also be considered in coordination with urban development plans and urban design projects. Transport is an outcome of urban land-use and urban development patterns, but it can also affect and determine urban development and has a major effect of urban space and public space. Any transport project, therefore, must be planned and designed in coordination with urban plans, projects as well as wider transport plans and projects, and must be introduced in a policy package of coherent and complementary urban and transport plans, projects and programs.

A similar condition is valid for bike-sharing systems. It is ideal that bike-sharing is considered as a part of urban development and urban plans so that it can contribute to the attainment of the objectives of such wider plans. The case of Paris Velib is a good example: it was described in Chapter 2 that the system was launched as one of the components of a comprehensive urban improvement plan, called Cilivised Spaces, and hence contributed significantly to the realization of this plan's objectives.

In addition to its level of integration to urban and transport plans, the analysis also investigated the initiation of the project, bike station site selection considerations, and construction processes of bike-sharing systems. These analyses are presented below.

- ***Is the system based on a transport plan; or any sort of plan?***

Depending on any kind of plan for a bike-sharing system means that the system would be a part of a general vision or a kind of sustainable transport policy or any kind of planning document.

KONYA

When the basis of Konya 'Smart Bike' bike-sharing system is investigated in terms of planning background, it can be seen that no phrases about bike-sharing

system exist in any planning documents of the city. In 2001, Konya Metropolitan Area Urban and Periphery Transport Master Plan was made, and it included a section that mentions a Bicycle Plan for Konya in order to constitute a basis for bicycle policies in urban transport, regulate and improve bicycle use in the city. In the 2000s, bike-sharing concept has started to become popular as an urban transport mode in the globe; therefore, in the years that Konya Metropolitan Area Urban and Periphery Transport Master Plan was applied, there was not any future projection in the minds of policy makers of local government about constructing a bike-sharing system in Konya. Besides, in Master Plan and Development Plan of Konya, no indicators can be seen about planning decisions of 'Smart Bike' system such as locations of bike-sharing stations. Additionally, in upper scale spatial and strategic plans of Konya-Karaman 1/100000 scale Environment Plan (*Çevre Düzeni Planı),* Konya Metropolitan Municipality Strategic Plan (2007-2011) and Konya Special Provincial Administration Strategic Plan (2010-2014) nothing can be seen about bike-sharing as an upper scale strategy as a transport policy as well as bicycle use as an urban transport mode.

KAYSERİ

'Kaybis' bike-sharing system of Kayseri has also not been an outcome of any spatial plan or urban transport policy of a planning document. In Kayseri Master Plan or Development plan, Yozgat-Sivas-Kayseri Environment Plan, Kayseri Special Provincial Administration Strategic Plan (2010-2014) and Kayseri Metropolitan Municipality Strategic Plan (2007-2011) introduction of a bike-sharing system did not feature before the construction of the system in 2009. Similarly, no statements exist in Kayseri Metropolitan Municipality Transport Master Plan either; however, there is a phrase in the plan as 'supporting public transport modes in Kayseri' which means that integration of different public transport modes with each other including a tram line passing through the city in east-west direction. In this respect, the tram was in the plans and while bike-sharing did not emerge from a planning document, it can be claimed that it was planned in a way to support the tram system because bike station positioning was done for almost completely the achievement of increasing catchment area of tram

line through integration of bike stations with tram stations. Demirdirek and Gündoğdu (2011) stated that this bicycle system was planned to feed the main public transport line of the city and this was compatible with the objectives mentioned in Kayseri Transport Master Plan.

İSTANBUL

In İstanbul, 'İsbike' bike-sharing system was not constructed as a result of any planning or policy document such as a Transport Master Plan, Strategic Plan, Environment Plan, Master Plan or Development Plan. This system is just an outcome of a tendering between İstanbul Metropolitan Municipality and a private firm about city furniture and advertisement which means that private firm constructs bike-sharing system to the city for free as a requirement of tendering condition.

Analysis of plans and policy documents within the context of bike-sharing cases from Turkey shows that 'Smart Bike', 'Kaybis' and 'Isbike' systems were not directly integrated with a general vision, strategy or policy for urban development or urban transport. They stand just as single projects or investments of local governments.

- ***Initiation of the project (Who launched the decision of bike-sharing?)***

Taking the decision of bike-sharing for the sustainability of urban transport is directly integrated with previous issue of being integrated with a plan. If any plan or urban strategy document does not lead the proposition of bike-sharing, so it needs to be initiated by personal efforts of policy makers or private sector suggestion to local governments. Konya, Kayseri and İstanbul cases show such characteristics in terms of initiation of the bike-sharing.

KONYA

In 'Smart Bike' system of Konya, personal efforts of responsible authorities in Konya Metropolitan Municipality resulted in the initiation of the project. Koyuncu (2013), who is the manager in Konya Metropolitan Municipality Department of Urban Development, explains that;

> The system in Konya is constructed within the content of tender of urban furniture; in other words, responsible people in municipality saw foreign successful examples of bike-sharing systems and as a result, they demand the system for the city in tender.

Similarly, responsible person of bicycle roads in Konya, Ceylan (2013), who is working in Konya Metropolitan Municipality Directorate of Road Making, expressed that;

> Metropolitan Mayor of Konya attaches much importance to bike use and making bike use widespread in the city, and all these bicycle lanes and infrastructure are products of the vision of the Mayor. I think he has wanted this 'Smart Bike' system to be constructed in Konya.

KAYSERİ

'Kaybis' system of Kayseri had similar tendering stage for urban furniture. In Kayseri, the initiation process of bike-sharing has been experienced without the content of any upper scale strategy as in Konya. The Metropolitan Municipality made a deal with Clear Channel advertisement firm in order to design and regulate urban furniture and advertisement issues in Kayseri urban center. Within this process, this private firm suggested this system for Kayseri urban center, and municipality put a provision to the agreement with the firm for the construction of 25 bike stations and 300 bikes in the Kayseri urban area. Therefore, in 2009, bike-sharing system in Kayseri 'Kaybis' was established. According to Demirdirek (2013) who is the Electrical and Electronics Engineer of 'Kayseri Ulaşım A.Ş.' firm the initiation process was as follows;

> The initial suggestion came from Clear Channel, which is a global firm carrying out advertisement issues, for our municipality. It also established the bike-sharing system and had performed advertisement issues in the urban area of Barcelona. Kayseri has also been working under an agreement with Clear Channel in advertisement issues. This firm made a suggestion to the municipality through a presentation of bike-sharing, and this system was established to Kayseri for free in exchange for advertising rights given to this private firm.

İSTANBUL

In the process of bike-sharing system in İstanbul -İsbike-, personal efforts of policy makers were effective in the establishment of the system. Similar to the other cases from Turkey, bike-sharing system in İstanbul does not depend on a

transport master plan or urban development plan. The initiation idea of the system emerged thanks to previous General Directorate of İSPARK as Kaya (2013), who is the responsible person of Bicycle Unit of İSPARK, stated that;

> The idea of bike-sharing in İstanbul emerged under the previous General Directorate of İSPARK who saw this system in foreign countries like Netherlands. Then, he intended to construct this system at the İstanbul historical center around Sultanahmet for tourists together with the help of responsible people from Kayseri, but the system failed and they could not deal with it. Later on, they again came last year, and discussed whether we shall construct the system again or not. Then, authorities chose a place (Kadıköy-Kartal recreational coastal corridor) that was well-known, easy to establish, involving bicycle culture and bicycle road for construction. The system started its operation after this process.

Three bike-sharing cases from Turkey show that these systems do not depend on any sort of upper scale sustainable urban transport strategy. While there is an understanding in the world that bike-sharing systems can reduce car dependency and car traffic, support non-motorized transport and be used as a healthy urban transport mode, 'Smart Bike', 'Kaybis' and 'Isbike' systems were not launched with such general visions shared explicitly by decision-makers. Of course actors and decision-makers may be aware of such potentials of the system; however, their introduction was not accompanied with such wider urban strategies explicitly announced. . The systems were not launched as an outcome of comprehensive urban or transport studies; personal efforts were effective in their establishment.

- ***Bike station site selection***

What we can understand from planning of a bike-sharing system on urban space is bike station site selection. As in planning of other modes of urban transport such as buses, Light Rail or Heavy Rail systems, location of bicycle sharing stations seems crucial for people to reach a bike in an easiest manner. Therefore, the question of why the locations of stations have that much significance in planning gains importance.

A station is a transfer point that enables people to move from one place to another within the city. In order to maximize the service efficiency of a station, it should be easily accessible, located at crowded attraction points, and take place in

optimum distance with other stations of the same mode. Bike-sharing is one of the modes that should be carefully planned in terms of station distribution to achieve maximum benefit from definite number of station. The decision of where the bikes will be in the city is differ from each other in the Turkish bike-sharing cases of Konya, Kayseri and İstanbul. Within the content of location of bike-sharing station, integration with other public transport destinations, the effects of university integration and movements which are enabled thanks to this system are also significant issues, and they will be mentioned according to research results for three different cases.

KONYA

Konya bike-sharing case revealed that 40 stations of the system were distributed to different parts of urban area by using trial and error method. This method in planning of bike-sharing means that site selection of stations is made by one authorized responsible person or a group of people, later unused stations are shifted after some time to the places that they can serve more to the people as an urban transport destination. It can be seen in Figure 35 that bike stations were mostly distributed around main urban center, and there are also extensions towards each direction from center. In Konya, the manager in Metropolitan Municipality Department of Urban Development, Koyuncu (2013), who is also the responsible person of Konya 'Smart Bike' system, has decided the distribution of locations of stations, and expresses this process as:

> The stations were needed to be distributed evenly to the city. Public buildings, universities, dormitories, bus terminal, areas around hospitals and existing bicycle lane routes were primarily preferred for the stations; besides, it was considered important to locate as many stations as possible to the places where visual angle of city surveillance cameras cover the station point of bike-sharing in terms of security. I never think about side streets, I preferred the points which are dense in terms of population… Trial and error method was effective in site selection of stations. Some of the stations were not used, and we shifted those to better places in terms of utilization. In addition, political reasons were also effective in site selection. In Karatay district of Konya, it can be easily estimated that bicycles could be mistreated, whereas we put stations there in order not to face any reaction from district municipality and local people.

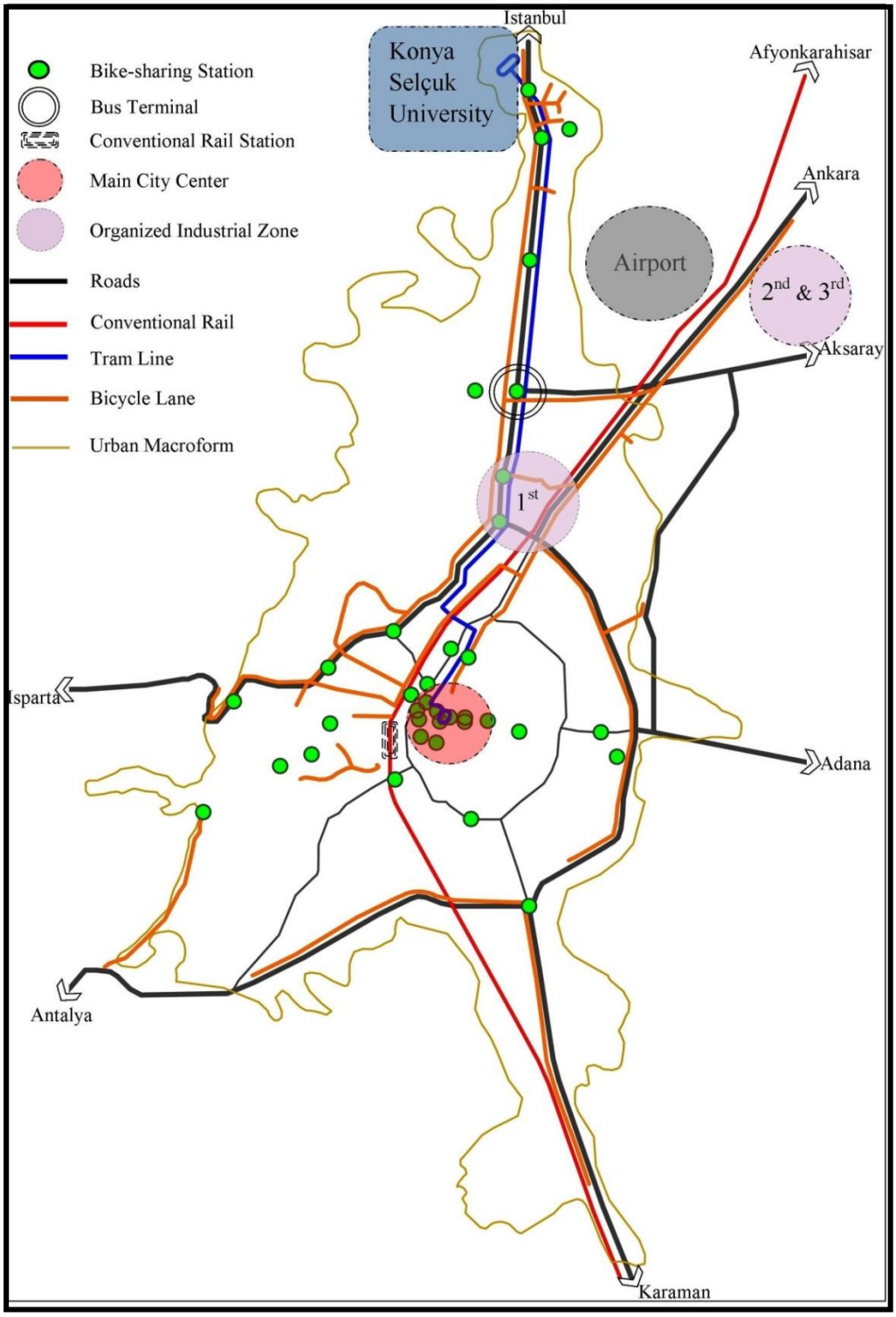

Figure 35. Distribution of Konya Bike-sharing Stations Including Existing Bike Routes

Source: (Personal Drawing)

In summary, bike stations of ‘Smart Bike’ system were distributed in accordance with some location criteria which are:

-Routes of existing bicycle lanes

-Attraction points

-Transport nodes

-The places facilitating movements towards center or opposite direction

As previously seen in Figure 36, some of the stations were located on bicycle lane routes in Konya. The support of bike lanes to bike-sharing certainly increases the efficiency of system and the number of uses as seen in especially European examples of bike-sharing. In Konya, bike lanes exist on exit roads of İstanbul, Ankara, Karaman, Isparta and Antalya, on peripheral expressway of the city, and on some parts of western side roads of the city. Therefore, those lanes help users of bike-sharing for their travel around or towards the city center. In Figure 37, an example of bike lane and bike-sharing integration is shown.

Figure 36. One of the Bicycle Lane and Bike-sharing Station integration in Konya 'Smart Bike' System

Source: (Personal Archive)

Another important emphasis for site selection is attraction points which are university, main city center, commercial activities, Mevlana Museum, municipality, industrial area, Meram recreational area, and hospital. For instance, there is one station at the entrance of Konya Selçuk University, two stations in Organized Industrial Zone, and one station near the shopping mall which is next to the bus terminal. This kind of a relationship between bike-sharing stations and those attraction points constitutes a positive impact for the use of the system as an urban transport mode, which increases service area of the system and accessibility of different land uses within the city.

Bus terminal and conventional rail station of Konya are also destinations of significant transport modes. At the beginning of initiation process of 'Smart

Bike', one bike-sharing station was located for each of these transport modes of the city. Today, bus terminal bike station is still working on Northern urban development corridor. This transport node also includes a tram station; therefore, these three stations constitute significant multi modal characteristics whose components are bus terminal, tram station and bike-sharing station. However, as seen in Figure 37, bike station in front of conventional rail station –showed with gray color- was implemented at the beginning, but it has been removed after some time. Besides, it is important to mention that tram and other public transport stations play the role of being urban transport node within the city; however, limited effort was made to use those nodes together with bike-sharing stations in Konya urban center.

Figure 37. Conventional Rail Station of Konya and Its Nonworking Bike Station

Source: (http://www.nextbike.com.tr/tr/konya/locations/)

The final analysis for site selection of bike stations is about movements within the city. There are several main activity centers in Konya which were taken into consideration while selection. These are mainly residential areas, Organized Industrial Zone, university, city center and Meram recreational area. Generally, it is obvious from the locations of bike stations in the city that university students use bicycles between center, their homes and their campus; some users use the system between city center and their homes; industry employees use between their homes and Organized Industrial Zone; and finally people sometimes prefer to

perform their movement from their home to Meram recreational areas with bike-sharing. As seen in Figure 38, the main activity centers of Konya urban center are in relationship with each other thanks to the 'Smart Bike' bike-sharing system.

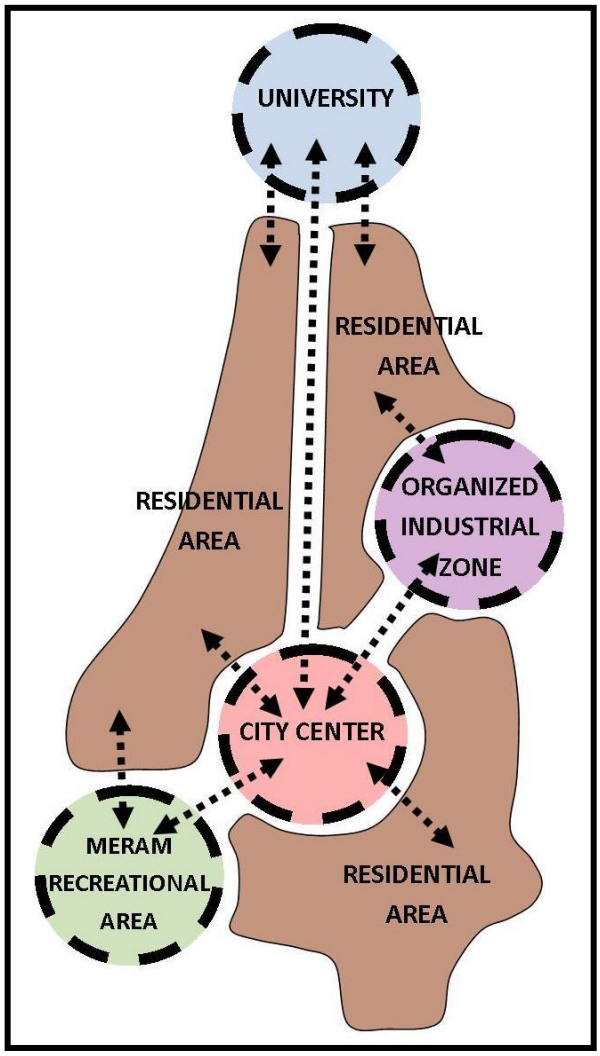

Figure 38. Urban Movements in Konya between Different Land Uses with Bike-sharing

Source: (Personal Drawing)

KAYSERİ

In Kayseri, site selection of a total number of 25 bike stations was done through a partially trial and error method as in Konya. Some of the unused stations were shifted to better places on which bike use frequency had been estimated as higher. However, the reason why the method is called as not a complete but partial trial

and error is that policy makers had a vision for gaining maximum benefit from bike-sharing in terms of urban transport. Kayseri bike-sharing case study shows an important example of strategic visionary thinking for bike stations.

A feasibility study was realized before site selection for bike stations in Kayseri (Demirdirek, 2013). Bike stations were not distributed to the whole city; they were focused on mainly the city center and the university (Figure 39). A tram line exists which serves the city along east-west direction in urban area. Bike-sharing system was constituted as an urban transport instrument which was planned to increase the service area of tram line by creating north-south extensions. According to the research carried out by Demirdirek and Gündoğdu, 'Kaybis' Kayseri Bicycle System was established to contribute to the urban transport network. It was planned by considering the targets in transport master plan to feed main public transport line. Passenger attraction points in the city was taken into consideration in site selection of stations, and the main aim of this system is enabling short and middle distance trips to be realized through bicycle within the city (Demirdirek & Gündoğdu, 2011).

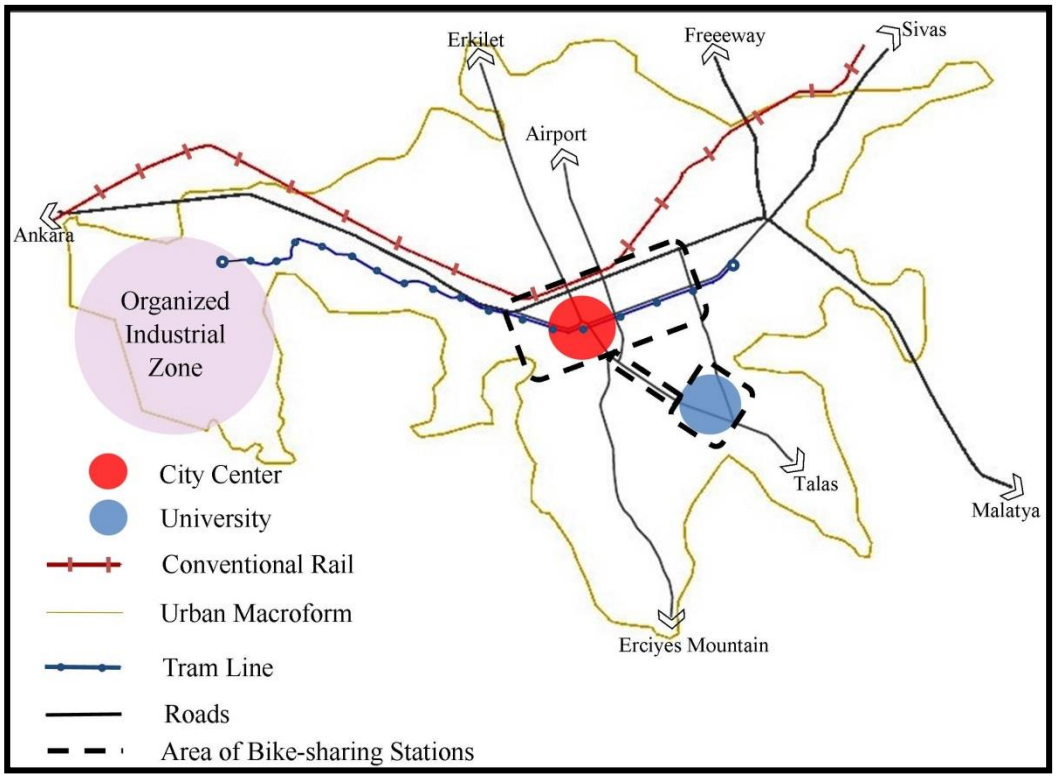

Figure 39. The Area of Bike-sharing in Kayseri Including Different Transport Modes and General Urban Layout

Source: (Personal Drawing)

In 'Kaybis' bike-sharing system, the initial aim was creation of a network together with public transport alternatives which are tram line and bike-sharing rather than using these two systems separate from each other. In time, after nine months of establishment of system -in April 2010-, the stations of Erciyes University were located in its campus area, and those were the stations which had been removed from Organized Industrial Zone of Kayseri. Demirdirek (2013), who is the Electrical and Electronics Engineer of 'Kayseri Ulaşım A.Ş.' firm, mentions this process as follows:

> It is not possible to penetrate urban rail system of Kayseri into the inner parts of the city; it can only follow a route on a main single line. Therefore, what we should do was carrying passengers from inner city to rail line which was the initial aim of establishment of bike-sharing. However, later on, this aim has evolved –particularly after the arrangement of University stations. Currently, the stations in university have become the most frequently used ones within the system; additionally, together with the university effect on bike-sharing, a sudden change occurred in the

> data of user ages. A significant proportion of youths and a significant increase in the number of female users are observed….. Initially, we had put two stations to Organized Industrial Zone (OİZ), but the distance between that industrial area and city center is too much, and we only have 25 bike stations. We have no chance to put any station on that kind of a distance. If we sprawl this system towards remote parts of the city, we should support the distance with additional stations. Consequently, since we could not provide bike station service between Organized Industrial Zone and city center, 'Kaybis' stations in OİZ did not work and we removed them.

In Figure 40, the exact locations of bike stations are shown including tram line integration and bike lanes. It can be seen that all the stations were distributed in main urban central area and the university. As a result of the analysis of Kayseri 'Kaybis' bike-sharing system, it is important to mention that several criteria can be concluded for site selection of bike stations. These are;

-Carrying passengers to tram stations from northern and southern parts of the city

-Attraction points (university, city center, Organized Industrial Zone)

-Bicycle lane integration

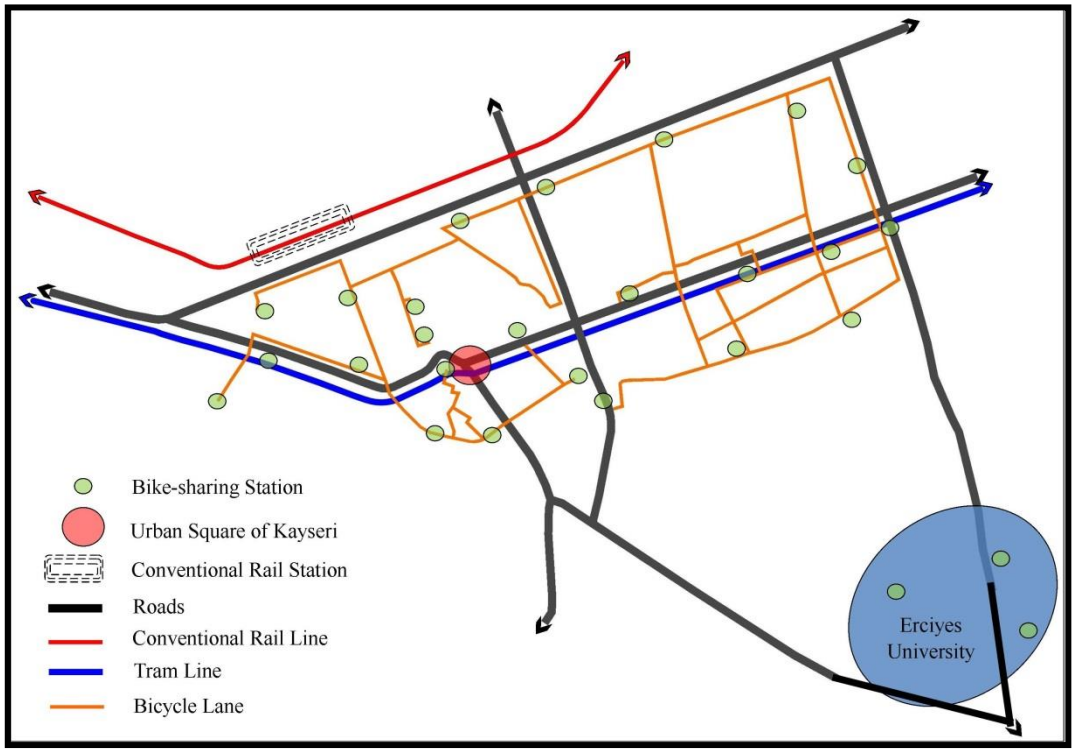

Figure 40. Distribution of Kayseri Bike-sharing Stations Including Existing Bike Routes and Connections with Tram Line

Source: (Personal Drawing)

The principal aim of 'Kaybis' was to support the efficiency of tram line in the city. Bike stations in northern and southern part of tram line play the role of transferring people to significant destinations. Such an integrated public transport network enables the movements along both north-south and east-west directions. Figure 41 shows which bike station is in relationship with which tram station specifically. Integration of bike-sharing to public transport is a previously planned strategy before the construction of the system, and today it can be thought as a successful example for other initiatives in Turkey.

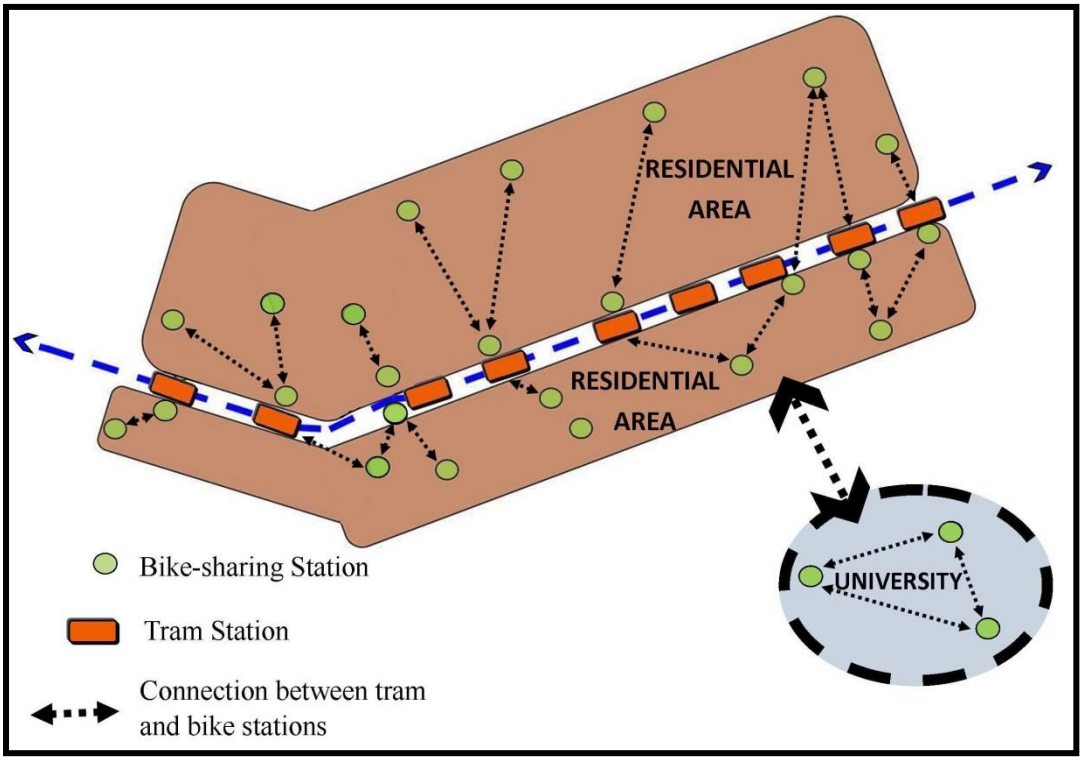

Figure 41. Urban Movements in Kayseri city center with Bike-sharing

Source: (Personal Drawing)

According to Demirdirek and Gündoğdu (2011), when the most frequently used stations are considered, it can be seen that 'Kaybis' system accomplished its mission of connecting rail system to inner urban areas successfully. The passenger flow from Inönü bike station, which is located on inner part of residential areas, to Hunat bike station, which is also integrated with a tram station, makes those stations most frequently used ones. In addition, a questionnaire carried out for 'Kaybis' states that 60% of bike-sharing users in Kayseri use this system to reach rail system stations

Attraction points also seemed to be significant for site selection of bike stations. Most of the stations were located at central part of urban area of Kayseri, which are on Sivas Road -especially integrated with tram station as seen on Figure42-, green areas and easily accessible points on northern and southern parts of the tram line (Figure 43). Additionally, university and Organized Industrial Zone integration of bike-sharing stations were other issues that policy makers had paid

attention. 'Kaybis' system of Kayseri was established on July 2009, at the beginning it was thought that Organized Industrial Zone of Kayseri had been an important working area and this western part of

the city should had been connected with main city center and residential areas. It was predicted that ‘Kaybis’ bike sharing system would be able to carry people from city center to the main industrial working area of the city; therefore, two bike stations were put there. However, about 15 km distance exists between central bike stations and the ones in Organized Industrial Zone. Therefore, those stations could not be used as expected before the establishment, and they did not work. This resulted in the removal and relocation of them on April 2010 to Kayseri Erciyes University. The main aim to transfer stations to university was carrying students from one place to another within the university and to city center.

Figure 42. Tram Station Integration of ‘Kaybis’ Bike-sharing

Source: (Personal Archive)

Figure 43. Integration 'Kaybis' Station with an Easily Accessible Green Area

Source: (Personal Archive)

The final criteria for site selection of bike-sharing stations can be concluded as the effort of bicycle lane integration. As previously mentioned in Figure 40, each bike sharing station located in city center exists also on a bike lane, because bike lanes were constituted according to the locations and service area of 'Kaybis' stations. Together with this policy, it was aimed to connect bike stations through bicycle lanes to support a safe bike-sharing transport.

In Kayseri, this 'Kaybis' system will be changed in near future completely including all of the bicycles and bike stations in terms of both the location of station, station design, number of station, operating mechanism and bicycle design. In other words, a local system is about to be innovated, and the components of it will be produced by using only domestic resources. Consequently, the number of stations will be increased, and new locations for new

stations will be assigned to new places. According to the statements of Demirdirek (2013), who is the Electrical and Electronics Engineer of 'Kayseri Ulaşım A.Ş.' firm, bike station site selection for the newly innovated Kayseri bike-sharing system will be made considering two main criteria which are:

-*Tram line & bike station relationship:* the locations of bike stations should serve cyclist transferring to tram stations (existing tram line and extension projects will be considered)

-*Demands coming from people:* newly built stations should be located near to the areas from which bike station demands were received (universities, public institutions, dormitories, public spaces etc.)

İSTANBUL

Istanbul is the most populous city in Turkey, which brings along very high levels of mobility and major problems of traffic congestion. In the last decade, bicycle use has been encouraged by policy makers of the city by creating bicycle lanes, bicycle parks and bike-sharing system. This system in Istanbul, which is between Kadıköy and Kartal coastal line for approximately 19 km, has been in service since May 2013 with 10 stations and 100 bicycles. In Istanbul, site selection of bike stations for 'Isbike' system was preferred to be made on crowded attraction points of this coastal corridor; therefore, this decision made the system be used just for recreational aim. In Figure 27, a general layout about where the system is decided to be constructed in İstanbul can be seen together with general urban macroform and main highway connections. Kaya (2013), who is the responsible person of Bicycle Unit of İSPARK, expresses the site selection process as follows:

> Main components of this system are bicycles and stations, and also site selection of those stations is crucial for the future of the system. Our initial criterion was putting them on attraction points. However, the distance between stations is 1km or 1.2km which is too long; actually, it should be 500-600 meters at most. The conditions at that time necessitated such a long distance for our system…..After the failure of the construction of a similar system in İstanbul historical center around Sultanahmet for tourists,

it was important that the stations of this 'İsbike' system were constructed on a place that people could get used to easily. Later on, Kadıköy-Kartal coastal corridor was selected, because cycling culture exists for local people, and there is a previously constructed bicycle lane on that corridor…. Such kind of a wide bicycle lane does not exist on anywhere else in İstanbul. Then, we looked for places for stations where people come together on that coastal line. For example, Dalyan Green Area, which is the second station in Kadıköy, is the end of Bağdat Avenue, and this green attraction area is a place that people frequently come and enjoy their time. Then, one of the further stations is located near to a big supermarket in the district of Maltepe. However, again it is important to emphasize that the distance is too long between those 10 stations, and the number of stations should be increased.

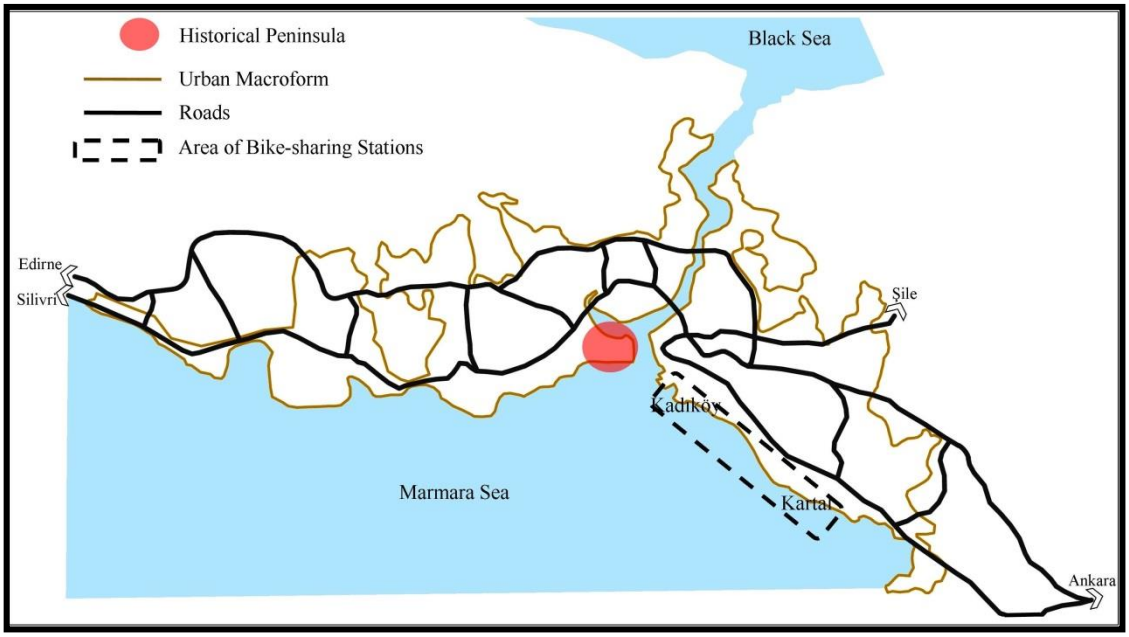

Figure 44. The Area of Bike-sharing in İstanbul on Kadıköy-Kartal Coastal Corridor

Source: (Personal Drawing)

The stations of İstanbul bike-sharing system -İsbike- were distributed along the coastal recreation area beginning from Kadıköy-Caddebostan beach with a bicycle lane and ending with the sea bus pier of Kartal. As seen in Figure 45, bike stations were distributed evenly in terms of the distance between them. A randomly site selection attitude was not applied in the process; on the contrary, some criteria were paid attention for exact points of stations which can be inferred as:

-Existing cycling culture on coastal line

-Attraction points and estimated movements

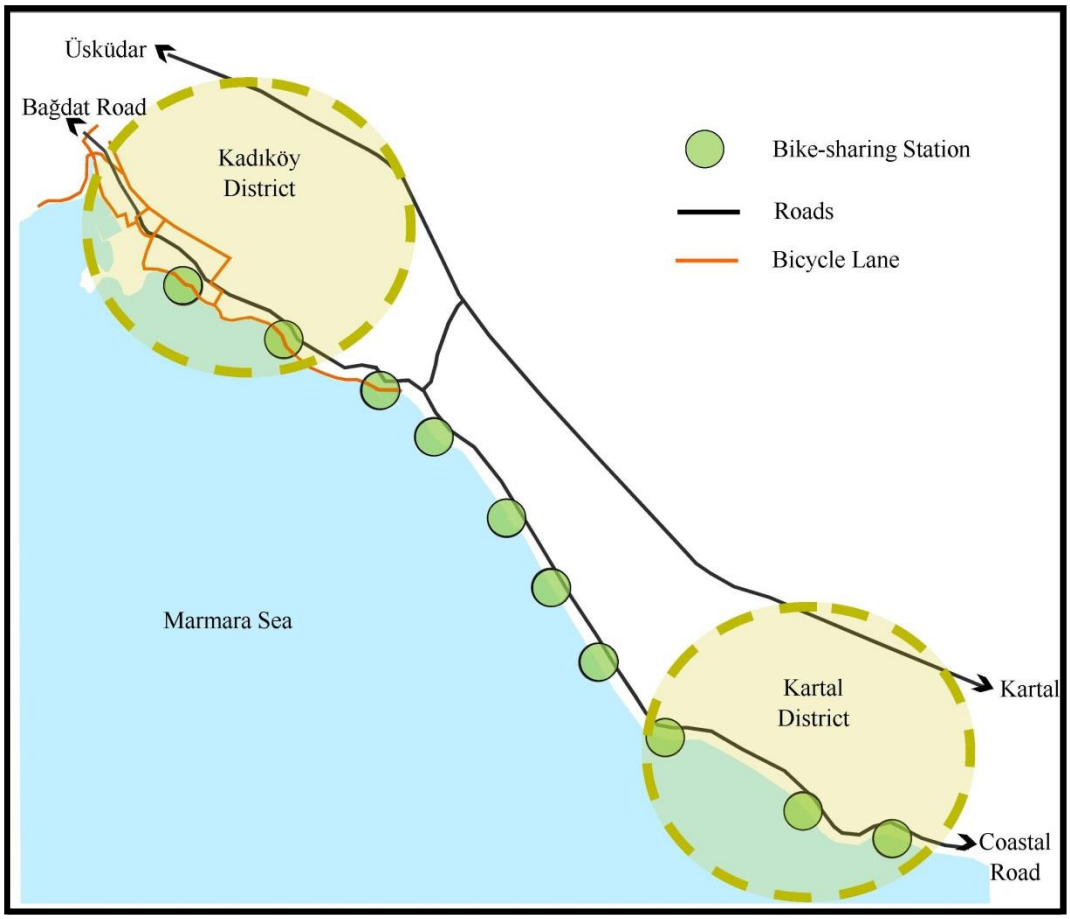

Figure 45. Distribution of İstanbul Bike-sharing Stations Including Existing Bike Routes

Source: (Personal Drawing)

The location of the bike-sharing system in Kadıköy coastal side is a unique place in İstanbul where the locals have already embraced cycling culture. Local people have been using coastal recreational area with their bicycles as a leisure time and sport activity. As seen in Figure 46, there is a kind of a combination of green area, bike lane, walking lane, and the sea side. Therefore, this situation seemed as a potential to policy makers of 'İSPARK' for the construction of bike-sharing. In other words, the people living near to this coastal line were estimated to tend to use those public bicycles effectively, and as an initial criterion, this area was selected for establishment of bike-stations.

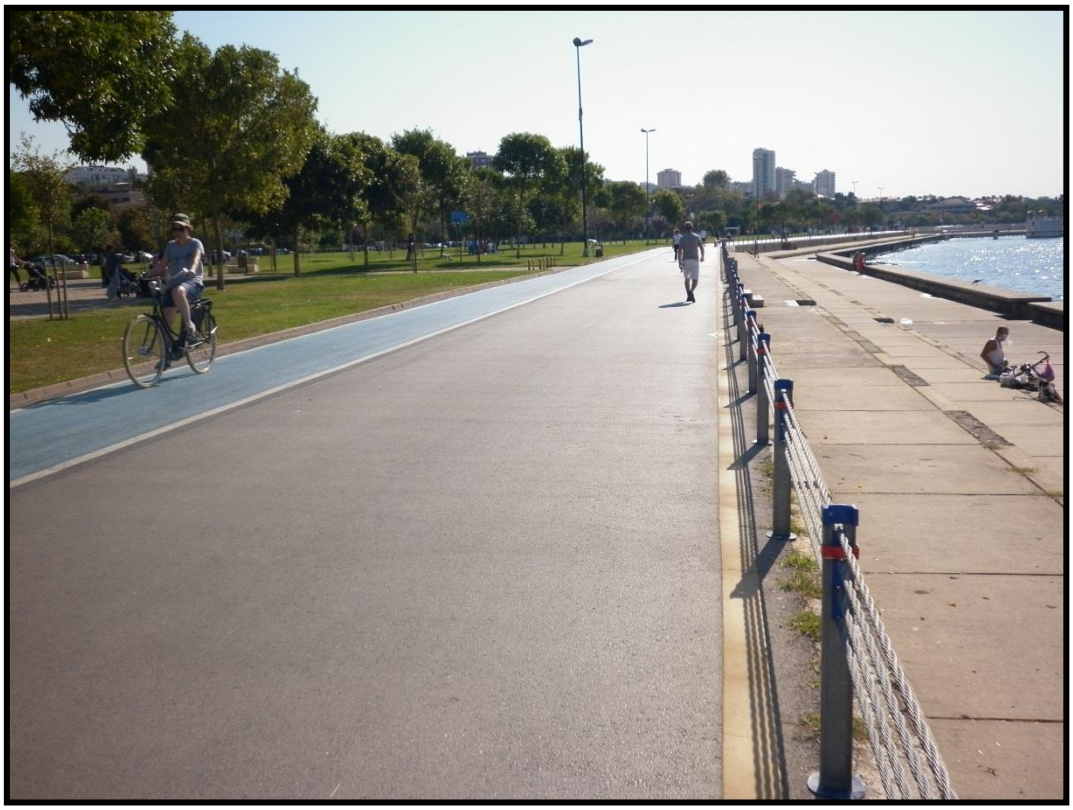

Figure 46. A View from Caddebostan Coastal Side Which is Also the Initial Part of Bike-sharing

Source: (Personal Archive)

Then, the most important basis for site selection can be defined for this case as determining attraction points which are, for instance, sea bus piers, beaches, social and cultural facilities and green areas. The meaning of those attraction points on the route of bike-sharing is that people frequently come together for different aims. It was thought that their basic needs of having a sporty leisure time activity could be met by publicly used bicycles starting from those attraction points on coastal line. Therefore, this results in linear movements between those attraction points. Figure 30 shows that attraction points on Kadıköy-Kartal coastal corridor are in relationship with each other through 10 bike stations.

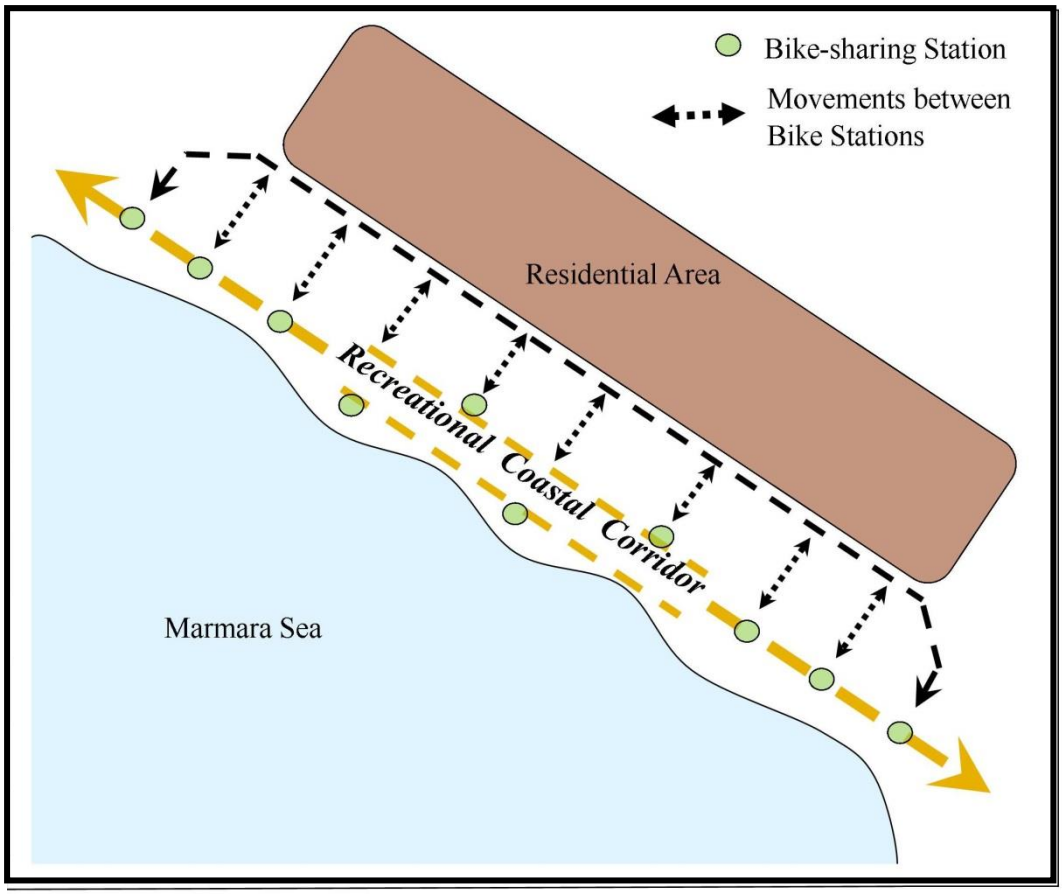

Figure 47. Movements on Kadıköy-Kartal Coastal Corridor with Bike-sharing

Source: (Personal Drawing)

In summary, Konya, Kayseri and İstanbul examples show different characteristics from each other for site selection. Generally, Konya 'Smart Bike' system experienced this process as putting them on major attractions points in urban area mainly focusing on city center. In Kayseri, the locations of 'Kaybis' system was designed mainly to serve tram network, which means carrying passengers from the northern and southern parts of the city to the tram stations. Unlike to those two cases, the stations in İstanbul were located outside the city center area and along main recreational as well commercial attraction points on the recreational coastal line between Kadıköy and Kartal districts. In addition, bike-sharing enables different kinds of urban movements in Konya, Kayseri and İstanbul, which gives

inferences about how to distribute different land uses in urban planning considering travel behavior of cyclists through bike-sharing.

- ***Planning and construction aim of the system***

Bicycle use can be an alternative mode in urban transport as seen especially in many European cities, and bike-sharing is a supportive tool for bicycle use in urban areas. Different bike-sharing cases from different parts of the world show that this system has rapidly become widespread in the past decade, and has received the attention of policy makers and users to be used for the aims of an urban transport mode as well as a leisure time activity. Therefore, the main questions are about why there is a need for planning such systems, and what the aim was to insert bike-sharing to different parts of those three Turkish cases of Konya, Kayseri and İstanbul.

KONYA

Konya bike-sharing system was designed to serve people both for their leisure time activities, such as recreational and cultural trips and sport, and for their urban trips within the city, such as from their home to work or university to their home. Responsible person of bicycle roads in Konya, Ceylan (2013), who is working in Konya Metropolitan Municipality Directorate of Road Making, expresses the aim of Konya 'Smart Bike' system as follows:

> There are places in Konya to which no public transport mode serves; therefore, this system can be used for the aim of urban transport. For example, I sometimes take a bike from the station which is near to my work, and after my travel from work to home, I put it in another station which is close to my home. This seems as the first aim of using bike-sharing. Then, university students use the system for their leisure time travels together with the contribution of northern bicycle lane network. In addition, there are also trips realized by local people from city center to Meram recreational area and opposite direction for again having leisure time activity. Also, tourists use the system for daily travels.

KAYSERİ

In Kayseri, a more planned bike-sharing design policy was followed compared to the Konya and İstanbul cases. The initial aim of 'Kaybis' was determined as connecting the tram system with inner parts of urban central area. Almost all of the bike stations of the system are in planned in a way to feed into a tram station. Later on, after the creation of university stations, another aim of connecting university students to the city center was added. Besides, the system can also be used for the aim of leisure time activity mainly in the city center together with the help of bicycle lanes on the roads around the main urban center. In short, it can be mentioned that the principal aim of the construction of the bike-sharing system in Kayseri is to serve urban transport. According to Demirdirek (2013), who is the Electrical and Electronics Engineer of 'Kayseri Ulaşım A.Ş.' firm mentions the aim of construction of 'Kaybis' system as follows:

> In Kayseri, the number of motorized vehicles has increased in recent years as in Turkey. Together with this bicycle sharing system, people can have cheap, easy and environmentally friendly transport and the opportunity to make sport in the city… As we expected before, the fundamental aim of use of bike-sharing in Kayseri is carrying passengers to tram stations. Apart from that, tour and sport aims are also important for the system.

İSTANBUL

As mentioned before, the İstanbul 'İsbike' system was completely designed for recreational and sport aims on Kadıköy-Kartal coastal line, and the locations of stations were determined to achieve those aims. However, 'İsbike' system is seen as a pilot project for İstanbul, and it is intended that there will be other bike-sharing systems in İstanbul to serve mainly as an urban transport mode and public transport stations. Kaya (2013), who is the responsible person of Bicycle Unit of İSPARK, states the aim of system as follows:

> The system was initially established for touristic recreational aim; later on, people saw that it is an enjoyable sports activity and they started to ride those bicycles for mostly the benefit of their health. However, in future, the main aim will be the integration to urban transport.

Those three bike-sharing cases from Turkey state that there are three different types of construction aim exist: in Konya, for both urban transport and recreation

purposes; in Kayseri, almost completely for urban transport trips; and in İstanbul completely for recreational aims.

- ***Bicycle road infrastructure in relation with bike-sharing***

Bicycle lane can be seen as a facilitator for bicycle use in urban areas that enables people to reach from one point to another either for recreational or urban transport purposes. Bicycle lane infrastructure can directly impact the safe and effective usage of bike-sharing systems; therefore, bike-sharing systems should be supported with this infrastructure to enable safe and rapid transfer between stations. Additionally, bicycle lane plays the role of connecting one station to another; therefore, the relationship of bike stations and bicycle lane can be accepted as a crucial element for the efficiency of bike-sharing systems. Turkish cases of Konya, Kayseri and Istanbul show different characteristics within the context of this heading.

KONYA

In Konya, one of the criteria of bike station site selection for bike-sharing was creating connections within the existing bike lanes. As seen in Figure 48, existing bike lane network do not penetrate into the main historical city center and cannot relate with central bike stations; however, the connection exists with some of bike-sharing stations but only with peripheral ones. Besides, the future projection of Konya municipality shows that new bike lanes will be constructed particularly in core city center. Thus, almost all bike stations in the system will be connected with bicycle lane, and this condition may help increase the efficiency of bike-sharing in Konya.

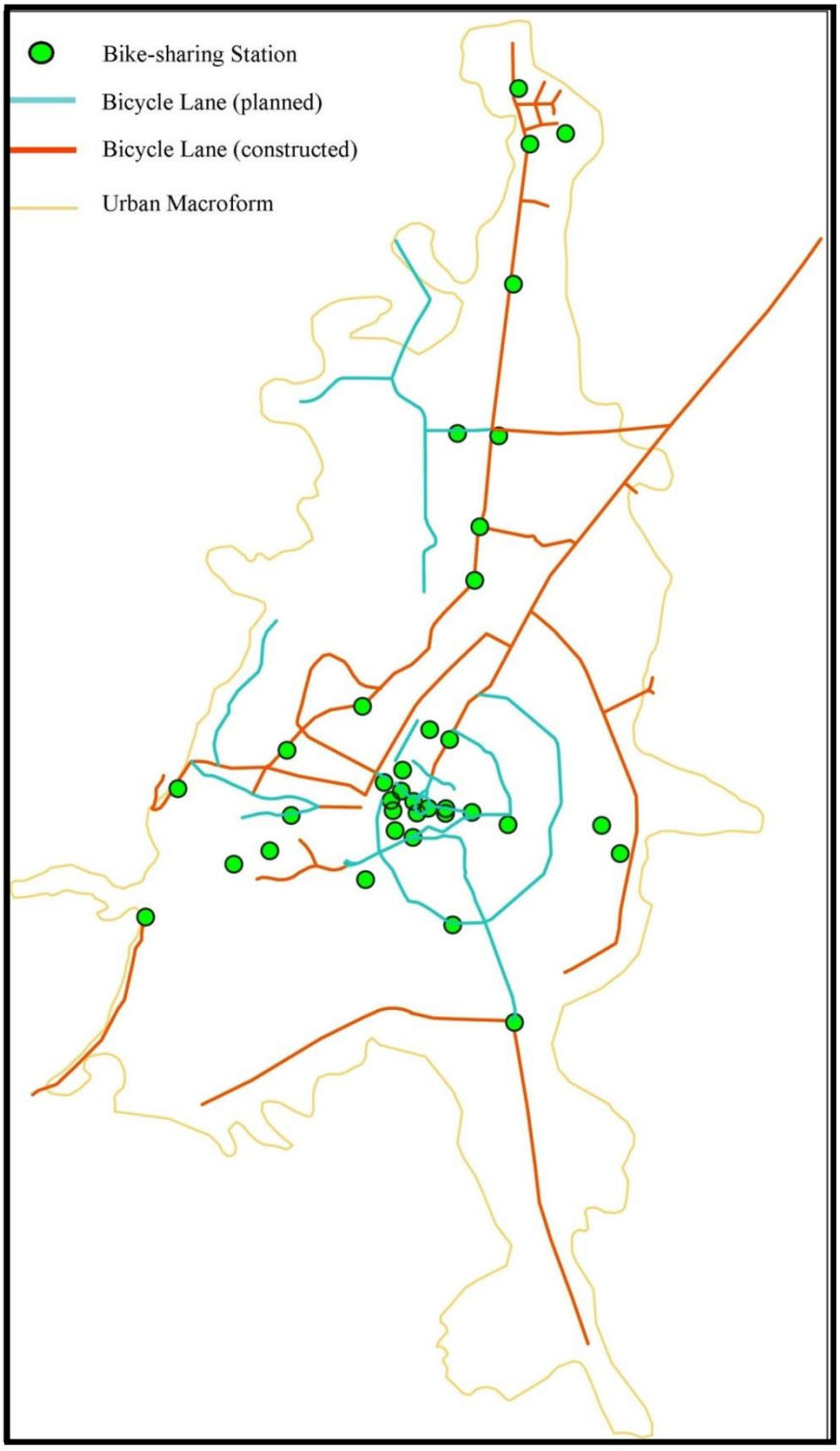

Figure 48. Bicycle Lane Network in Konya together with Its Relationship with Bike-sharing Stations

Source: (Personal Drawing)

KAYSERİ

In Kayseri, the scenario of connection between bike stations and bike lanes is slightly different from the one in Konya. Bike lanes in Kayseri were created after the construction of 'Kaybis' bike-sharing system and arranged according to the locations of bike stations. Therefore, all bike stations in the system except for the ones in Erciyes University are on one part of the bicycle lane network in city center (Figure 49). However, three university stations which had been removed from Western part of Kayseri -from Organized Industrial Zone- were not connected with any bike lane. Similarly the three new university stations were not connected to the ones in main urban center through bicycle lane, and therefore the efficiency and safety of the connection between university stations and city center stand as a debatable issue.

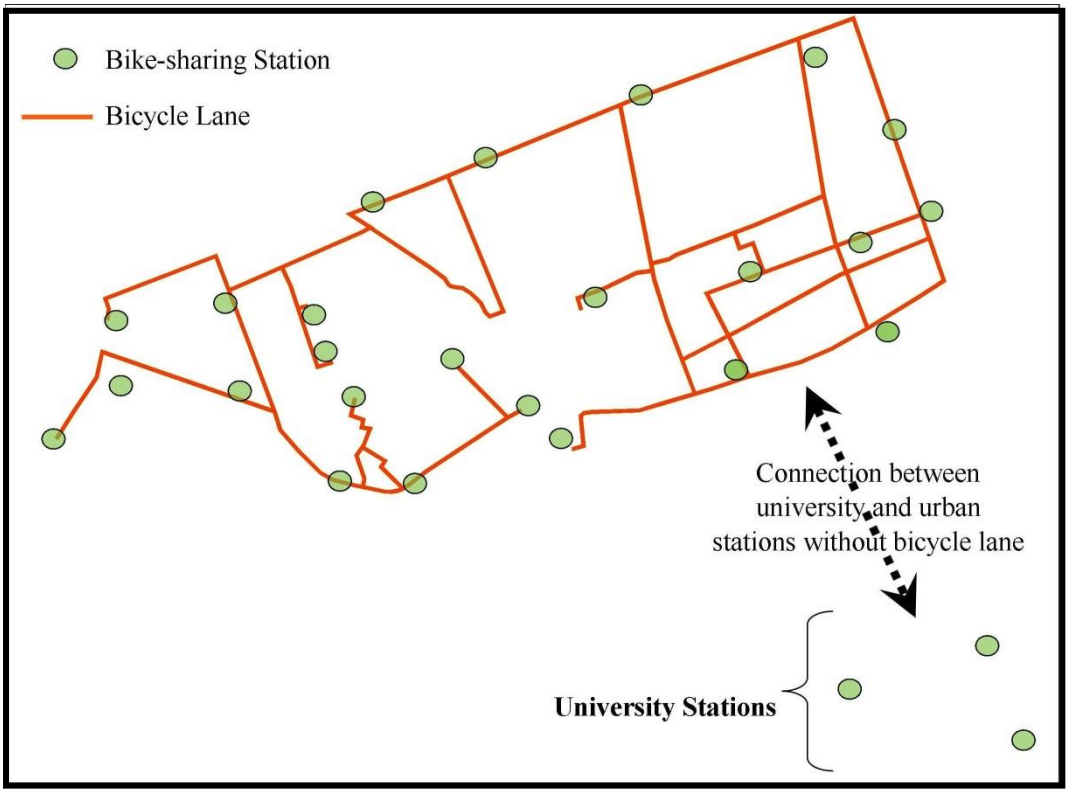

Figure 49. Bicycle Lane Network of Kayseri Directly Related with Urban Bike-sharing Stations

Source: (Personal Drawing)

İSTANBUL

In Istanbul, Kadıköy-Kartal recreational coastal corridor in Anatolian part of the city provided policy makers of bike-sharing the opportunity to connect all the stations thanks to the natural and recreational characteristics of this corridor. As shown in Figure 50, there was an already constructed bicycle lane network. In fact only three stations of 'Isbike' bike-sharing system, namely Caddebostan Beach, Entrance of Dalyan Park and Bostancı Pier, are in relation with this bike lane network. However, the other seven stations on that corridor can also be accepted as connected safely with each other due to the public coastal green characteristic of this corridor.

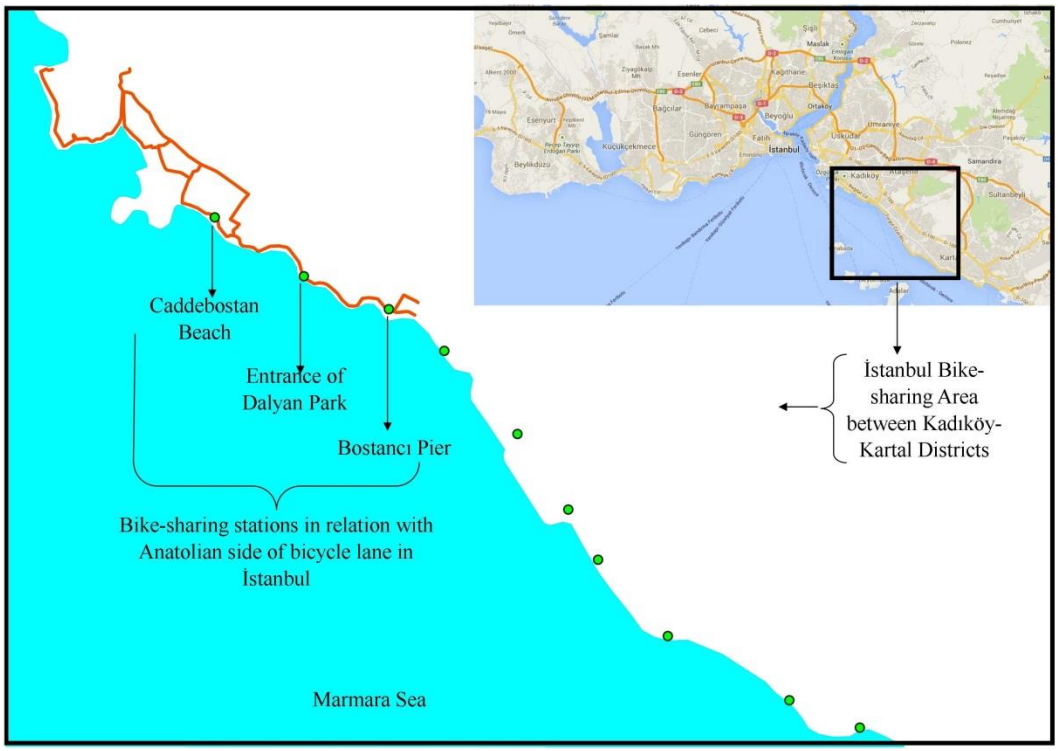

Figure 50. Bicycle Lane Network in Anatolian Side of İstanbul together with the Relationship of Three Bike-sharing Stations

Source: (Personal Drawing)

In summary, it can be said that policy makers of bike-sharing systems in Konya, Kayseri and İstanbul made their effort to combine as many bike-sharing stations as possible with bicycle lanes, because the safer the bike-sharing trips either for

urban transport or leisure time activity aims through bike lane, the more efficient and successful the systems will be.

Table 18. Planning Background of Bike-sharing Systems in Konya, Kayseri and İstanbul

PLANNING BACKGROUND	KONYA	KAYSERİ	İSTANBUL
--Is the system based on a transport plan; or any sort of plan?	No Only general bicycle policies exist in some plans	No Bike-sharing system is justified by the statement in Transport Master Plan about supporting general public transport line of the city	No
--Initiation of the project (Who launched the decision of bike-sharing?)	Personal efforts or vision of authorities in municipality	Clear Channel - service provider firm- made a presentation to the municipality to construct this system	Personal efforts or vision of policy makers in İSPARK municipal firm.

Table 18 (continued)

--Bike station site selection	Trial and error method **<u>Criteria for site selection:</u> -Routes of existing bicycle lanes -Attraction points -Transport nodes -The places facilitating movements towards center or opposite direction	Feasibility study was made **<u>Criteria for site selection:</u> -Carrying passengers to tram stations from northern and southern parts of the city -Attraction points (university, city center, Organized Industrial Zone) -Bicycle lane integration	Distribution of stations to coastal corridor evenly **<u>Criteria for site selection:</u> -Existing cycling culture on coastal line
--Planning and construction aim of the system	Both urban transport and recreational	Urban transport	Completely recreational
--Bicycle road infrastructure in relation with bike-sharing	Connection between bike station and existing bicycle road exists, and will be increased in future	Bike lanes constructed together with bike-sharing system (almost completely connected with bike stations)	Three stations are directly related with the existing coastal bicycle road

4.3.2. System Design

For bike-sharing, one of the most significant elements that influence the operation and usage of the system is the design of these systems. Bike-sharing consists of some kinds of main parts which should be designed effectively before the construction. These are bicycles and stations in general, and the use process of these systems.

In this section, the results of the analysis of bike-sharing systems in the three Turkish cases will be stated under some sub-headings. In terms of system design, those sub-headings will be analyzed for Konya, Kayseri and İstanbul based on personal observations and experience, inferences and interviews applied with policy makers. The analysis reveals information about the continuity of system in bad weather conditions, sufficiency of the number of bicycles, 4th generation bike-sharing advances and locking systems of bicycles, station protection from external effects, and station design in general.

- ***Existence of station shelter***

Station shelter for bike-sharing acts as a protector for bicycles and stations from bad weather conditions. If there is a protector for bike station, removal of bicycles and the whole system will not be necessary in any season. As described below, there have been system pauses in the case studies of Konya and Kayseri in order to prevent bicycles from being exposed to the damaging effects of rain or snow.

KONYA-KAYSERİ-İSTANBUL

Stations in Konya, Kayseri and İstanbul bike-share systems do not have any protector for bicycles and stations (Figure 51). Therefore, the user either cannot find a bike at station due to removal process in bad weather conditions or should use the public bike in its deteriorated, wet or unclean circumstance. Therefore, shelter or protector for bike stations is actually significant for system continuity during a year.

Figure 51. Bike-sharing Station Examples from Konya, Kayseri and İstanbul without Having Station Shelter

Source: (Personal Archive)

- ***Sufficiency of total number of bicycles within the system***

At the initiation stage of establishment of a bike-sharing system, a definite number of bicycles are assigned to each station, and a total number of bicycles are determined for the whole system according to the estimated need and demand of people. However, the number of bicycles within the system may become insufficient in time due to unexpected demand. At this part of the study, the analysis seeks to find out whether the number of bicycles is enough or not for the three systems in Turkey. The analysis depends heavily on the opinions of the policy makers interviewed.

KONYA

In Konya, there are 400 bicycles and 40 stations within the 'Smart Bike' system. Personal cycling experience by using the bicycles of this system has shown that it is sometimes difficult to find a good-looking and rideable bicycle, or sometimes any bicycle at all at the stations. This might be because of two reasons, which are insufficiency of the number of bicycles in the system and existing bicycle maintenance program. Koyuncu (2013), who is the manager in Konya Metropolitan Municipality Department of Urban Development, stated that;

> Both the number of bicycles and stations is enough in the system, and there is no future plan for increasing those bike-sharing components. Additionally, they have already been under tendering condition; therefore, we do not have a chance to rearrange their number.

In short, there is a need to increase the number of bicycles in the system; however, policy makers do not see this as an essential issue.

KAYSERİ

In Kayseri, 300 bicycles exist, which are distributed to 25 stations of the 'Kaybis' system. Contrary to the system in Konya, 'Kaybis' system has had available bicycles during the day at stations depending on personal experience, and the number of bicycles has seemed sufficient to meet the demand. Demirdirek (2013), who is the Electrical and Electronics Engineer of 'Kayseri Ulaşım A.Ş.' firm, stated the following:

> We have experienced problems of not having sufficient number of bicycles available at stations; however, these are the problems that we can overcome in the process of improving the system… For example, a station has 24 docking points, and we can only fill 16 or 17 of them in order to reserve some empty spaces so that the users can find a place to lock the bicycle. However, 16-17 bicycles for this station are certainly not enough for hundreds or thousands of users in the city.

İSTANBUL

In İstanbul, 100 bicycles and 10 stations were assigned to Kadıköy-Kartal coastal corridor. According to Kaya (2013), who is the responsible person of Bicycle Unit of İSPARK, explained that

> Now, we have 100 bicycles; but, that much demand was not expected at the initiation of the system. An approximate number of 40000 people have used this system until now; consequently, there should be at least 200 bicycles at this coastal corridor. In fact, even 200 bicycles would not be enough.

On the other hand, according to personal cycling experience of the system, the number of bicycle seemed enough since empty or overloaded stations were not met.

- ***Locking mechanism***

In bike-sharing systems, bicycles are locked to appointed racks which are the places at stations for bicycles to be returned. Those racks at stations consist mainly of a locking system for bicycles, which can be either manual or automated locking mechanisms. Those two mechanisms of system design have different characteristics that affect the operation of systems. Manual locking systems include a manual lock on each bicycle within the system, and bicycles are manually put and locked to a rack at stations by user. In other words, a cyclist can

get a bike from station by inserting the code to the lock and unlocking the bike manually, and then bring it back to the station by locking it again after the trip. This manual locking mechanism enables the user to lock the public bike at anywhere else -for example any bicycle parking area in the city- during the trip, and then take it back from this place where the user locked temporarily. Therefore, manual lock on bicycle provides flexibility to users in terms of temporary breaks during the trip. On the other hand, automated locking system on racks at bike stations, which automatically makes the user take bicycle and return it back to the station, provide a faster process for beginning and ending of a bike-sharing trip. In addition, automated locking system on racks provides a more technology-based infrastructure to the system without keeping a manual lock on bicycles. Furthermore, the obligation to return the bike to a station with an automated locking system, as opposed to being able to manually lock anywhere in the city, helps increase the turnover and availability of bicycles at stations. However, from the users' point of view inexistence of a manual lock on bicycles deprives users of locking bicycles to anywhere else during the trip due to threat of theft. Here, Konya, Kayseri and İstanbul bike-sharing cases will be analyzed in terms of their locking mechanisms.

KONYA-KAYSERİ-İSTANBUL

In Konya, manual locking system on bike stations was active between January 2011, which is the initiation of system, and September 2013. Within this period for Konya 'Smart Bike' system, there was a manual lock on each bicycle, and after getting the code monitored on main kiosk at station, bicycles could be got by entering it to the lock manually. Cyclists could be using that code during the trip for short term pauses. In September 2013, bicycles in Konya bike-sharing system were taken to maintenance, and the locking mechanism of stations was completely changed and became automated. In Kayseri 'Kaybis' and İstanbul 'İsbike' systems, operation has started with automated locking and continued that way (Figure 52).

Figure 52. Locking Mechanisms of Konya, Kayseri and İstanbul Bike-sharing Systems

Source: (Personal Archive)

The analysis of the three Turkish bike-sharing cases in terms of their locking mechanisms shows that automated locking is used for all those systems currently. In addition, when the effect of that kind of a locking mechanism to the operation and use of bicycles is considered, it is important to realize that existence of a manual lock on bicycles of Konya gave users the opportunity to have a flexible trip in terms of short term pauses, however this system was transferred to automated one as in Kayseri and İstanbul. Consequently, cyclists of those Turkish cities of bike-sharing have to get the bike and return it to just another station that means temporary bicycle locking to anywhere cannot be possible.

- ***Noticeability or visibility of stations***

Bike-sharing stations consist of station kiosk, bicycle racks and bicycles. Those components of stations should be visible enough for users in order for them to find a place to take or return the bicycle in the easiest manner. For instance, it is almost impossible to fail to notice the entrance of an underground metro, because it mostly has a symbolic post near its stations that can be easily seen from far distances. For bike-sharing case, if a cyclist of bike-sharing is familiar with the exact locations of stations in the city due to previous experiences, then they will have no problem in noticing the targeted station. However, sometimes even if there is a mobile application that shows the exact real locations of bike stations, still there may be situations in which bike station cannot be found easily due to little noticeability of bike-sharing components. As a result, visibility and noticeability issue is important for the efficiency of systems. Here, Konya,

Kayseri and Istanbul cases of bike-sharing systems will be investigated according to personal experiences and field observations.

KONYA-KAYSERİ-İSTANBUL

In Konya and Kayseri urban transport oriented bike-sharing systems, noticeability difficulties exist at some stations. Users can see the approximate location of stations relying on the map showing the bike locations; however, they may not easily see it once they arrive at the area. Therefore, an additional effort is required to locate the stations, which means time waste for the user. As for the Istanbul case, this problem does not exist at this initial line since all the stations of 'İsbike' bike-sharing system were positioned on the coastal line, and there does not seem to be any problems in finding the exact location of a station since alternative routes do not exist for the use of bike-sharing and all the bicycles are on that coastal line.

- ***Inclusion of characteristics from the fourth generation of bike-sharing for future***

Bike-sharing systems have experienced three historical generations, and each of them has had different characteristics in terms of improvements in system design. Today, most of the contemporary systems include the characteristics of third generation, and some of forth generation. In other words, bike-sharing users have been experiencing a transition period towards embracing the characteristics of forth generation -demand-responsive or multimodal systems- which are flexible bike stations, public transport integration of systems through smartcards, bike redistribution innovations, and technological improvements in the system such as GPS tracking, using solar power for the operation of systems, electric bicycles and touch-screen kiosks. Therefore, it is necessary to check Turkish cases to determine their future improvements and tendencies to be developed towards fourth generation characteristics.

KONYA

In Konya, the most significant inclusion of forth generation characteristics is that energy for bike stations is provided through solar power. As seen in Figure 53, each station in the system has a solar panel, which absorbs daily solar power and provides it to the operation of the relevant parts of the system that require energy, such as the electronic mechanism of kiosks. Due to this technology, there are no energy costs at stations except for the infrastructure cost of the solar panels.

Figure 53. Solar Powered Station in Konya 'Smart Bike' System as a 4th Generation Characteristic

Source: (Personal Archive)

KAYSERİ

In Kayseri, it was considered to put GPS to bicycles in order to allow them to be tracked from the control unit. This gives a chance to monitor where the bicycles are at any time. However, it was not implemented, and Demirdirek (2013), who is the Electrical and Electronics Engineer of 'Kayseri Ulaşım A.Ş.' firm, expresses its reason as follows;

> We examined GPS inclusion to the system, but we decided that it was not worthwhile. It has too much cost, and we have never experience a bicycle theft; therefore, there is no need to monitor bicycles while cycling. I can see the places where the user gets and returns the bicycle, and this seems enough. But, one thing is certain that GPS system is helpful for site

selection of additional stations to the system, because statistical data of cyclist movements in the city show the most frequently used route. Then we could know where to locate the stations.

İSTANBUL

In İstanbul, there have been two future projects on 'İsbike' system. The first one is bicycles with GPS for existing and prospective systems, and the other one is the addition of electric bicycles to the existing Kadıköy-Kartal bike-sharing line. Those electric bicycles will enable a ride up to 15 km distance without pedaling.

In summary, it is seen that only the system in Konya has included solar panels on stations as an apparent advancement of 4th bike-sharing generation, and the system in İstanbul has several future plans. However, in Kayseri, 4th generation has not been considered at present time or for future. Almost all the components of system will be changed in Kayseri through localization, and the system will be extended throughout whole city; however, this plan does not include any improvements with regards to new generation innovations.

Table 19. System Design of Bike-sharing Systems in Konya, Kayseri and İstanbul

SYSTEM DESIGN	**KONYA**	**KAYSERİ**	**İSTANBUL**
--Existence of station shelter	No	No	No
--Sufficiency of total number of bicycles within the system	According to policy maker: enough According to	According to policy maker: not enough According to	According to policy maker: not enough According to

Table 19 (continued)

--Locking mechanism	Until September 2013: Manual locking After September 2013: Automated locking	Automated locking	Automated locking
--Noticeability or visibility of stations	Low	Low	High
--Inclusion of any characteristics from fourth generation of bike-sharing for future	Provision of energy for station by solar power units	No plans	Future plans: -Bicycles including GPS (Global Positioning System) -Electric bicycles

4.3.3. Operational Issues

Operation of a public transport mode seems to be as much crucial as the planning or construction. To determine whether the system is user friendly or not, system operation should be cautiously designed. Bike-sharing systems can also be considered as a public transport mode, and their efficiency is directly related with the process that comprise the picking up of the bicycle from a station, travelling, and returning the bicycle to a station. This process can also be named as operation for bike-sharing.

Operational processes of bike-sharing should facilitate user friendliness and efficiency of systems. In the analysis of operational characteristics of bike-sharing systems in Konya, Kayseri and İstanbul, investigations were made about system continuity, mobile application, intermodality with smartcards, registration, ease of use, maintenance and bicycle redistribution, helmet wearing, and pricing.

- ***System continuity in all seasons and bad weather conditions***

Bike-sharing systems are established in cities to support either the aim of urban transport or recreational cycling; therefore, people have the opportunity to design their transportation behavior or plan their leisure time depending on these systems. For instance, a user can arrange his time for travel from home to work relying on the availability of a public bike at a station, because cycling from home to work by using bike-sharing system could have been a daily transport habit. Besides, another user may want to cycle in each weekend at a definite time with a public bike to use it for sport. Thus, for these two people, the important thing is just finding bicycle at stations. However, there may be a condition that bicycles are collected in bad weather conditions. Such a removal process of bicycles affects negatively the user friendliness of bike-sharing. Within this framework, Turkish cases of Konya 'Smart Bike', Kayseri 'Kaybis' and İstanbul 'İsbike' bike-sharing systems are analyzed below.

KONYA-KAYSERİ-İSTANBUL

In Konya, the bike-sharing system is not operated in all days of the year. Bicycles in the system are removed in rainy weather conditions to prevent the deterioration of the bicycles. According to Koyuncu (2013), the manager in Konya Metropolitan Municipality Department of Urban Development, *"the system cannot be used 12 months in a year, and the bicycles at stations are removed in intense winter conditions"*. In Kayseri, a similar condition exists about system continuity. Policy makers of bike-sharing system in Kayseri stated that the system of 'Kaybis' is closed temporarily in bad weather conditions. On the other hand, İstanbul bike-sharing system between Kadıköy and Kartal coastal corridor opened in May 2013 and during the whole year until May 2014 the system was not closed. In other words, the system has continued its operation in bad weather conditions of winter season too. Kaya (2013), the responsible person of Bicycle Unit of İSPARK, explained this issue in the interview stating that;

> In bad weather conditions, we thought of closing the system for maintenance and repair of bicycles, but then we gave up because of intensive demand that came from people to continue using it.

The cases shows that in Konya and Kayseri, system pauses happened in bad weather conditions because policy makers wanted to protect the system components from the effects of bad weather and also thought that people would not want to use bicycles of bike-sharing system in such weathers. In İstanbul, however, bicycle removal due to bad weather has not occurred yet. As a result, it is important to mention that system continuity exists in such a recreational system in İstanbul; however, in Konya and Kayseri, system pauses can affect daily urban transport behavior of users negatively since those systems are mainly aimed to serve urban transport.

- ***Mobile application for bike-sharing systems***

Nowadays, most people use smart phones which enable them to connect to the internet everywhere. This situation seemed as a potential for service provider firms of bike-sharing to make users get an online code for getting bicycles, access to the whole bike-sharing map for the district, and see the exact locations of bike stations for finding station of bike returning process. Generally, mobile application also includes the information about how many bicycles or empty bicycle racks exist in any station. Therefore, the existence of a mobile application increases the ease of use and efficiency of bike-sharing. Consequently, Turkish cases will be stated in terms of their inclusion of a mobile application as a facilitator for the user.

KONYA

In Konya, a mobile application exists which was created by Nextbike service provider. This mobile application has given the possibility to use all bike-sharing systems around the world constructed by Nextbike firm, such as the systems in Berlin, Dubai, Hamburg, İzmir or Konya. The first step for using the application is online registration by entering personal and credit card information. Then, the cyclist can use this application for three different aims. These are finding the exact location of bike stations, learning real time bicycle availability at stations, and obtaining a bicycle by entering the code of the desired bicycle to the application to produce the code of manual lock on bicycle (Figure 54). However, the problem

for this beneficial application in Konya is that almost nobody has been aware of it including both users and policy makers.

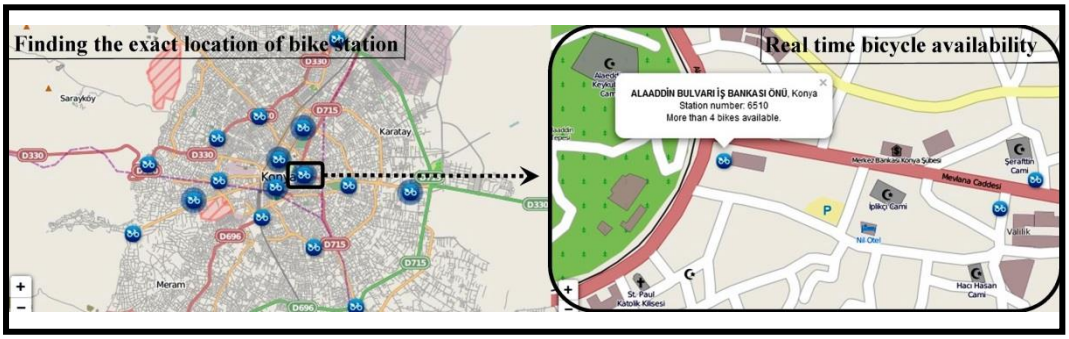

Figure 54. Location of Bike Stations and Bicycle Availability Demonstrated by Nextbike Mobile Application for Konya Bike-sharing system

Source: (http://www.nextbike.com.tr/tr/konya/locations/)

KAYSERİ-İSTANBUL

In Kayseri, 'Kaybis' bike-sharing system does not have any mobile applications. The system only included a map on the internet showing the locations of stations; but after some time, it has been removed due to wrong data on it. However, future program of renewal of the whole system includes a possibility for an effective mobile application and web site support. Similar to Kayseri, no mobile applications existed for 'İsbike' bike-sharing system, and currently there are no future plans for it it.

It is important to stress again that, the operation of 'Smart Bike' system in Konya through existing mobile application have been ignored by both users and policy makers. Nextbike service provider firm has produced such an application for Konya as made for some other bike-sharing systems in different cities in different countries. However, local policy makers in Konya have not been aware of it yet; therefore, this application has not been advertised to the people. Unlike Konya, the systems in Kayseri and İstanbul do not have any mobile applications; however, such kind of an advance is planned in Kayseri during the planned renewal of the system.

- ***Public transport integration of systems through smartcards (intermodality)***

Smartcard is a tool which enables passengers to use more than one public transport mode in sequence. Instead of using different kinds of public transport tickets for each mode, smartcard combines all these travels through transferring the right of using them. Therefore, under such smart card schemes, there can be an opportunity to make second or third or more public transport journeys for free or for a reduced price . Bike-sharing is also a system which can behave as a mode of public transport together with its opportunity to be used with smartcards. Using bike-sharing system with a common smartcard makes it become user friendly and have a more practical operational process. For example, in a travel from home to work, initially a person can get on a Light Rail System, and then get a bike from bike-sharing station by using same smartcard with a fast transition between those different modes. Thus, Turkish cases of Konya, Kayseri and Istanbul are analyzed below in terms of integration with other public transport modes with one common card to achieve intermodality.

KONYA

In Konya, bike-sharing system is used only with credit card registration, and any kind of membership card use has not existed. In addition, general public transport smartcard only allows people to use buses and tram in sequence; in other words, this smartcard is not valid for bike-sharing use in the city.

KAYSERİ

Unlike the system in Konya, credit cards have not been used in Kayseri bike-sharing system, only ‘Kaybis’ membership card has been valid for the system instead. Besides, special bike-sharing membership card can also be used in other public transport devices. In other words, this card enables the user to make transfers between tram, buses and bike-sharing, and a common credit inside the card is used for all transport modes. However, the opportunity, which is about using the ‘Kaybis’ system cheaper after the use of other public transport modes,

has not been realized; standard pricing is valid in any case and no reduced transfer fares exist. Another significant situation for 'Kaybis' system is that general public transport smartcard cannot be used for bike-sharing though. In other words the Kaybis card can be used on trams and buses too but public transport card cannot be used for Kaybis. If a person wants to use bike-sharing after public transport modes, he/she has to have the special 'Kaybis' card.

İSTANBUL

In İstanbul, 'İsbike' system has operated through both credit card and membership card. The integration with other public transport modes has not existed yet through bike-sharing membership card as in Kayseri. Neither the general İstanbul public transport smartcard, which combines the use of buses, rail lines and sea buses, is valid for use at İsbike. Kaya (2013), the responsible person of Bicycle Unit of İSPARK, has expressed the reason for not combining those cards with each other as follows:

> Through the personal membership card of bike-sharing, we can record the information of user when he/she gets the bicycle. On the other hand, everybody can have a general İstanbul public transport smartcard. If we allow bike-sharing to be used with this general public transport card, we will not be able to control who is getting the bicycle. With credit card or special membership card use, the user's identity can be seen from control unit; therefore, the system seems more secure.

In short, public transport modes and bike-sharing have been separated from each other in terms of smartcard use in Konya; on the contrary, a kind of partial smartcard integration has been realized in Kayseri. The reason to call it as partial means that bike-sharing membership can be used for also other public transport modes; however, general public transport smartcard cannot be used in 'Kaybis' system. In İstanbul, both membership card and credit card has been used, however; transfers to public transport cannot be made, because general İstanbul smartcard and 'İsbike' membership card are separated from each other. Moreover, none of those systems has provided the opportunity to use bike-sharing for free or cheaper in a period of time after using other public transport modes.

- ***Ease of use of the system for locals and visitors in terms of user registration process***

In order to start using the bike-sharing system in a city or district, registration procedure is the first thing that the cyclist should experience. At the end of this process, three alternatives can be seen for the operation of system:

-The user continues using the common public transport smartcard for different public transport modes including bike-sharing after a simple registration process.

-A membership card is used which is just special for bike-sharing.

-Credit card registration is done, and then bicycle getting and returning is realized with a personal code that comes to user's phone.

In order to increase operational efficiency of bike-sharing, system registration should be effortless and easy. Long registration processes and existence of procedures which are quite special to locality can restrict local people and especially domestic or foreign tourists who want to use bike-sharing in the city. Registration procedures of Konya, Kayseri and İstanbul bike-sharing systems have different characteristics from each other, and have different effects on those who want to use the bicycles of these systems.

KONYA

In Konya the 'Smart Bike' system offers a single way for registration which is done with credit cards. Any person from Konya or all other cities around the world can register to the system from the website of Nextbike service provider, or from any kiosk at bike stations in Konya by entering personal information and a credit card number. After completion of registration, 1 TL fee is taken from credit card. Later on, it is enough for the user just to enter personal password and the desired bicycle number to the system on kiosks at bike stations or through mobile application. This credit card registration facilitates domestic or foreign bike-sharing users to register to the system, and take and return the bike in a fast and

easy manner. On the other hand, it is important to state that any person who wants to use bike-sharing must have a credit card.

KAYSERİ

In Kayseri, again there is only one way to register to the 'Kaybis' bike-sharing system, which is getting a 'Kaybis' membership card after a formal process. Initially, the user of must fill in a registration form, and have two photos and a photocopy of their identity card for registration. Together with all of these, they should apply to the unit of Pass Process Center of Kayseri Municipality. However, the applicant cannot get 'Kaybis' membership card at that moment; registration process lasts one or two days. Then, after that time, they get the card and can start using the system. This long process applies for all people who want to use the system including local people in Kayseri and, domestic or foreign tourists coming from different cities and countries. Although credit card registration is easier and more user friendly for especially nonlocal people, policy makers in Kayseri have not preferred it to be valid in the process; because, people did not want to share their credit card information with a commonly used system for security concerns.

İSTANBUL

In İstanbul, the registration process seems as a combination of the ones in Konya and Kayseri, which means that both credit card registration and membership card application are valid within the system. Credit card application can be done from any bike station in the system. At first, the user registers to 'İsbike' system by entering credit card information from kiosks; after that, he/she can get the bicycle by using personal membership number. Another registration alternative is taking membership card by applying subscription points located near several stations within the system or İSPARK web site. The necessary documents for application are a photocopy of the identity card and one photograph. In other words, two registration methods in Konya and Kayseri coexist in 'İsbike' system.

In summary, credit card registration to bike-sharing seems quite user-friendly for both local people and tourists in Konya and İstanbul. However, while İstanbul

provides people the opportunity to use the system with membership card as well, there is no such an opportunity in Konya. Therefore, if the people who would like to use bike-sharing do not have any credit cards, they have no chance to cycle through this system which means that a kind of a limitation exists in Konya for the use of 'Smart Bike' system due to the registration method. On the other hand, in Kayseri, usage of system is possible only after a membership card is obtained, and the registration procedure is so long that it might have a discouraging effect on the use of the 'Kaybis' system. Besides, policy makers have not wanted to integrate credit card registration to the system due to security concerns of people and prospective decrease in the number of users of 'Kaybis' system. Thus, this system seems very user friendly and secure for continuous local bicycle users in Kayseri; however, it is quite hard to register to the system for visitors. In other words, local membership card registration for bike-sharing might be a deterrent for domestic and foreign tourists in Kayseri.

- ***Maintenance of systems and bicycle redistribution mechanisms***

Bicycles of bike-sharing system are publicly used during all day, and there is always a need to repair or maintenance program for bicycles, electronic mechanism of kiosks, locking systems and condition of bicycle racks. Without such programs, the components of system will be deteriorated in time. Therefore, a certain number of service staff should be responsible for the maintenance of bike-sharing systems. Additionally, bicycle redistribution between stations is also crucial for the efficient operation of these systems. Bike-sharing provides the opportunity for users to be free to take bicycle from one station and return it to any other station. As a result, some of the stations might become overloaded by bicycles during a day, and there is a need for transferring them from overloaded to emptier ones. Real time bicycle availability can be seen from central control center of bike-sharing; therefore, local governments employ a group of staff to arrange such kind of bicycle shift between stations continuously. Unless such bicycle redistribution mechanisms exists, there may be circumstances that users cannot find any bicycle at some stations or they cannot find any empty place to

return the bicycle due to overloaded stations. Such issues are analyzed for the three Turkish cases based on interviews with policy makers and operators.

KONYA

In Konya, a staff of Wall AG firm with four workers has been responsible for repair, maintenance and redistribution of bicycles in the system. They continuously control the stations, and enable bicycle flow between stations depending on the current data taken from 'smart Bike' control center about the overload of bicycles at any station within the system (Figure 55). Besides, the interviews with policy makers of bike-sharing in Konya have revealed that the system has worked very effectively in terms of maintenance and redistribution of bicycles, and those four people seem enough for the continuous operation of the system. On the contrary, depending on personal observation and experience of system use, a considerable amount of bicycles seemed to be in need of repair and maintenance; in addition, sometimes, it has been difficult to find a usable bicycle at stations.

KAYSERİ

Similar to the operation in Konya, bicycles and stations of 'Kaybis' Kayseri bike-sharing system have been maintained by 3-4 staff with a vehicle from *'Kayseri Ulaşım A.Ş.'* firm, which is associated with Kayseri Metropolitan Municipality (Figure 55). According to personal observations and experiences about riding bicycles of 'Kaybis' system, bicycles in the system appeared in good condition, working well and well-maintained; additionally, bicycle sufficiency at stations seemed satisfactory. On the other hand, the manager of the system from *'Kayseri Ulaşım A.Ş.'* firm thinks that the number of assigned staff for bike-sharing is not enough, and states that:

> There might be situations that users cannot find any bicycle at a station. However, we will overcome this problem in the process of further development of the system. Particularly, we have experienced this problem at university bike stations to which we should have made bicycle transfer five or six times a day. We have put an effort as much as we could to overcome this problem; but it has not always been possible to overcome it

completely since we only have one single maintenance vehicle. For instance, within the system in Barcelona, there are 150 responsible staff for this work; however, in Kayseri, we only have three or four staff that are responsible from maintaining bicycles, repair of electronic breakdown of stations, and also transfer of bicycles.

Figure 55. Bicycle maintenance and Reloading Staff in Konya and Kayseri Bike-sharing Systems

Source: (Personal Archive)

İSTANBUL

In İstanbul, several workers are responsible for the in-field operation of 'İsbike' system as in Konya and Kayseri. A service vehicle works on Kadıköy-Kartal coastal line during the day, and this vehicle together with its responsible staff deal with bicycle redistribution and repair, and possible problems at stations or on electronic infrastructure of system (Figure 56). Personal experiences and observations for 'İsbike' bike-sharing system have shown that the quality and sufficiency of bicycles were satisfactory enough for daily recreational cyclists.

Kaya (2013), who is the responsible authority of bicycle unit in İSPARK, stated that:

> In Paris, the bike-sharing system has had an important share in urban transport; but, it seems difficult to imagine the operation of an approximate number of 30,000 bicycles in the system, the maintenance of kiosks, and the security of system…. My principle aim is actually integrating this system to urban transport; however, the operation is so hard…. The establishment of stations and bicycles to the area is easy; but, the operation is difficult. For example, we have one service vehicle, one driver for this vehicle, one repairman, and additionally two staff members as controllers.

We have worked intensively including Saturday and Sunday; but as I mentioned before, the operation is quite hard….and we have a high quality level of maintenance for bicycles.

Figure 56. Bicycle maintenance and Reloading Vehicle in İstanbul Bike-sharing Systems

Source: (Savaş, 2013)

As a result, three or four people have been employed in Konya, Kayseri and İstanbul bike-sharing cases. The systems in Kayseri and İstanbul have seemed better operated in terms of maintenance of the main components of systems and bicycle redistribution mechanisms when compared the one in Konya. Moreover, manager of 'İsbike' in İstanbul has considered the maintenance and redistribution in good quality, but quite difficult by means of excessive effort put by the responsible staff, and the manager of 'Kaybis' has thought that despite the intensive work of staff, redistribution and maintenance could not be enough for such a system. On the other hand, manager of 'Smart Bike' system has considered the system as very well operated with its effective maintenance and redistribution despite the deficiencies inferred from personal observations.

- ***Pricing***

Bike-sharing system is a service for urban transport or leisure time activity that local governments provide for the people, and there is a fee for using the system, which changes according to duration of use. Generally, the initial use of half an hour is free in many examples from the world; however, for some systems a pricing policy is applied from the beginning of use to get revenue. User charge for bike-sharing can be another determinant for the decision of use or for cycling duration, which can directly affect the efficiency and success of systems. Here, pricing policies of Konya, Kayseri and İstanbul bike-sharing cases are investigated below.

KONYA-KAYSERİ-İSTANBUL

Before explaining the pricing policy applied to users while riding, it is important to state initial registration fees. In Konya, only credit card registration together with pricing through it is available. At first, 1 TL fee is charged to each user while registration, and then, after getting the bicycle from a station, a part of the credit card monetary limit is blocked to compensate possible theft risk. In Kayseri, together with necessary documents to get the membership card for 'Kaybis', 15 TL fee should be paid for registration, and minimum amount of 5 TL should be loaded to card in order to start using the system. In İstanbul, no membership fee is necessary for 'İsbike' membership card. While using credit card for registration, 50 TL credit card limit is blocked, and an amount of fee that changes depending on the duration of use of cyclist is taken from this limit, then upon the return of the bike this previously blocked limit is returned back to the credit card. After registering and getting the bicycle from these three systems, a pricing policy is applied for each system as mentioned in Table 20.

Table 20. Pricing Policies in Konya, Kayseri and İstanbul Bike-sharing Systems

KONYA (*)	KAYSERİ (*)	İSTANBUL
• First 30 min: free Then 1 TL for each hour	• First 30 min: free	• 0-1 hour: 2 TL
	• 30 min - 1 hour: 0,50 TL	• 1-2 hours: 3 TL
	• 1 - 1,5 hours: 1 TL	• 2-3 hours: 5 TL
	• 1,5 - 2 hours: 1,50 TL	• 3-5 hours: 8 TL
	• 2 - 2,5 hours: 2,50 TL	• 5-7 hours: 11 TL
	• 2,5 – 3 hours: 3,50 TL	• 7-10 hours: 14 TL
	• 3 – 6 hours: 5 TL	• Daily rental (24hours): 25 TL
	• Daily rental (24hours): 10 TL	
(*) These systems were offered to users for free for about one year from the initiation.		

Depending on this pricing table, bike-sharing systems in Konya and Kayseri may be used as if they are completely free; because, for example, after riding the bicycle for about half an hour, the user can leave it to any station and right after that get another bicycle from the station in order to make the use of time start again from the beginning. Therefore, if the user repeats such kind of a take and return process each half an hour in sequence, he/she does not have to pay to the system. This seems to make a significant encouraging impact for the use of bike-sharing in Konya and Kayseri. This may mean that the operators rely largely on the initial registration and membership fees. On the other hand, the users in İstanbul have to pay 2 TL fee for any trip duration till the end of one hour which

means that bike-sharing in this city makes the operator -İSPARK- get more revenues. However, it should be remembered that membership is for free. Kaya (2013), the responsible person of Bicycle Unit of İSPARK in İstanbul, has stated the following for the pricing policy of 'İsbike' system:

> 1 hour is 2 TL that is cheap I think, because the demand is very high for these bicycles. If it had been cheaper or free, some people would not have found any bicycle at stations…. If there was a situation that the first 30 minutes is free, the user would get the bicycle from one station and return it to another station before 30 minutes is up, and get another one. Therefore, bicycles would have never been rented. The principle aim is not earning extra money from this system; for example, maintenance or spare part costs of bicycles are quite high, and that much money is necessary for them. However, if we have the rule that the first 30 minutes is free, bicycle renting will disappear, and those who really need the system will not find bicycle at stations.

In summary, bike-sharing users can use the system for free in 30 minutes time in Konya and Kayseri. When it is thought that a travel from one direction to another in the city does not usually take much more time than 30 minutes with bicycle, those 'Smart bike' and 'Kaybis' systems can be considered as mostly free systems. Moreover, Demirdirek (2013), the Electrical and Electronics Engineer of 'Kayseri Ulaşım A.Ş.' firm, has mentioned that bike-sharing system is a system which is not favorable to be paid for, and the new localized system in Kayseri will be completely free. On the other hand, 'İsbike' system in İstanbul presents users a system to be paid for in any case that costs approximately same price with any other urban transport vehicles like metro, tram or bus in İstanbul. However, policy maker of this system in İstanbul have justified this policy for relatively high price of bike-sharing by mentioning high operation costs of the system.

- ***Helmet wearing obligation***

The most significant things that guarantee cycling safety for users is the existence of bicycle roads in the city and also bicycle helmet wearing. Bicycle helmet decreases the possibility of being injured in possible accidents while cycling, and wearing it must be a prerequisite rule to cycle anywhere in the city. Consequently, this issue should also be an important subject of bike-sharing. The effect of helmet

wearing obligation for bike-sharing increases the reliability as well as the public image of these systems by increasing safety; but, some of the users may not want to use a helmet while cycling due to discomforting effect of it. Such kind of a dilemma is also analyzed for the Turkish cases as presented below.

KONYA-KAYSERİ-İSTANBUL

Helmet wearing is not obligatory in any of the three Turkish cases while riding public bicycles of bike-sharing. In Konya, helmet seems not commonly used. Moreover; policy makers have not taken any precautions to encourage using a helmet. The responsible person of bicycle roads in Konya, Ceylan (2013), who is working in Konya Metropolitan Municipality Directorate of Road Making, has expressed his opinions as follows:

> If there are publicly useable helmets at bike stations, there should also be a security system to prevent helmet thefts. Another challenge that can be faced is publicly used characteristic of them. I do not know that this helmet wearing problem can be solved, but it should exist while cycling.

For Kayseri 'Kaybis' system, Demirdirek (2013), who is the Electrical and Electronics Engineer of 'Kayseri Ulaşım A.Ş.' firm, has stated the difficulty of wearing helmet while cycling in bike-sharing systems and gave the following information:

> Putting helmets to the stations in order to make willing people use is the thing that I want to realize in future. It is necessary for the users who have desire to use. However, on the other hand, I think making helmet wearing obligatory is wrong, for instance, if you face such kind of an obligation in this city, you never want to wear it under that sunny weather. Helmet is a disturbing element in especially hot weathers.

The İstanbul 'İsbike' system does not include any helmet providing services either for its users. There is only a phrase on introductory brochure of the system, which reads as *'Provision of accessories, such as helmet etc., belongs to the user".* In short, the significance of helmet wearing for safety has been ignored in all these three cities, and policy makers have not considered it as a crucial element for cycling.

Table 21. Operational Issues of Bike-sharing systems in Konya, Kayseri and İstanbul

OPERATIONAL ISSUES	KONYA	KAYSERİ	İSTANBUL
--System continuity in all seasons and bad weather conditions	Removal of bicycles in bad weather conditions	Removal of bicycles in bad weather conditions	Not closed in any weather conditions
--Mobile application for bike-sharing systems	Exists	Not exist	Not exist
--Public transport integration of systems through smartcards (intermodality)	Not realized	Partially realized (bike-sharing membership can be used for also other public transport modes; however, general public transport smartcard cannot be used in 'Kaybis' system)	Not realized
--Ease of use for the system in terms of user registration process	-Easy registration process (only with credit card)	-Difficult procedural registration (only with membership card)	-Easy registration (both with credit card and membership card)

Table 21 (continued)

--Maintenance of systems and bicycle redistribution mechanisms	Several responsible staff with a service vehicle	Several responsible staff with a service vehicle	Several responsible staff with a service vehicle
--Pricing	-First 30 min: free -Then 1 TL for each hour	-First 30 min: free, - 1 - 1,5 hours: 1 TL - 1,5 - 2 hours: 1,50 TL… - 2 - 2,5 hours: 2,50 TL	- 0-1 hour: 2 TL - 1-2 hours: 3 TL - 2-3 hours: 5 TL - 3-5 hours: 8 TL…
--Helmet wearing obligation	Not obligatory	Not obligatory	Not obligatory

4.3.4. Supportive Complementary Policies

The general structure of urban transport is constructed and developed depending on strategies and visions of policy makers. For example, a light rail system construction, bicycle road making or deciding the locations of public transport stations are the issues that politicians in local government should deal with. In Turkey, in the analysis of bike-sharing systems, policy making means the decisions taken by policy makers in local government for the general design issues or operational systems of bike-sharing which affect the efficiency, development and future objectives. In order to understand the general perspective of local authorities on bike-sharing in Konya, Kayseri and Istanbul, some policy sub-headings were investigated which are about encouraging policies for bike-sharing, incorporation of bike-sharing into wider non-motorized transport policies, and advertisement policies for the system.

- ***Encouraging policies to increase the use of systems***

In order to increase the use of bike-sharing, some policies that are directly or indirectly related with the system are needed to be implemented. For example, without the existence of a bicycle lane network in a city, use of bike-sharing to travel from one destination to another would be limited to some group of cyclists because of safety considerations. Local governments of Konya, Kayseri and İstanbul have used several of the policy tools mentioned below to improve the efficiency of their bike-sharing systems which are;

-developing bicycle lane infrastructure to increase user safety,

-easy registration for local people and tourists,

-public transport integration with smartcards,

-integration of bike stations with the stations of public transport.

However, all of the above issues were already described as they were part of system planning and operation. This section seeks to find out whether there are wider policies of urban planning and transport planning to support the usage of bicycles in the cities.

KONYA

There is already a strong cycling culture in Konya and bicycles are being used for urban trips. However, apart from supporting the bike-share system with planned bike lane construction, there are no other supportive urban or transport policies. For example, managing and limiting spatial growth and sprawl with a view to keep travel distances viable for cycling is not an issue discussed or considered by planners. There are no policies to restrict or better manage car traffic and car parking, for example through higher car parking fees in central areas, with a view to discourage car dependence and encourage the usage of bike-share system. There is a pedestrianisation effort in the city center; however, since the bike lanes

do not penetrate the city center, it is difficult to claim that this is a policy that is particularly supportive for bike-share usage.

Similar to Konya, policy makers in Kayseri have tried to make bike-sharing integrated almost totally with bicycle lane network which had been created together with 'Kaybis' bike-sharing system (Figure 40). The most distinct supportive transport policy that can help encourage the usage of the bike-share system is the integration with tram stations. However, general public transport card of Kayseri cannot be used in 'Kaybis' system; and this is a shortcoming that reduces the potential benefits of this integration. Other than that Kayseri does not have any policies to restrict and discourage car usage or to limit city growth either.

İSTANBUL

In İstanbul, too, there are no policies that may support the further usage of the system by discouraging car usage and encouraging cycling. However, it should be noted that this system is extremely limited in size yet for any city-wide policy to be implemented. In other words, for such a small system with limited coverage in comparison to the size of the city, it would not be realistic to expect any car traffic management measures. The lane is already along a car-reduced area that is a recreational corridor.

- ***Is the system constructed for supporting non-motorized transport as an upper scale sustainable transport vision? Are policy makers aware of the significance of it?***

Taking the decision of constructing a bike-sharing system for policy makers to an urban area is an urban transport policy issue. This policy should be an outcome of an upper scale vision to support non-motorized transport, together with policies for pedestrian access and car-free areas in city centers. . Cycling is not a direct alternative to automobile for particularly long distance trips; however, in central areas and up to a certain distance, it can help create pedestrian and car-free areas.

Of the analysis below questions whether a policy for non-motorized transport, i.e. cycling and walking, exists for the Turkish cases.

KONYA

Konya is the most developed city in terms of bicycle lane construction in Turkey; in addition, cycling has been used as an urban transport mode due to the existing cycling culture supported by transport policies of local governments. Bike-sharing system of Konya -'Smart Bike'- has also become a significant element of bicycle travel in the city for various aims. For instance, bike-sharing system has enabled different kinds of movements in the city between residential areas, university, Organized Industrial Zone, recreational areas and city center which seems that the system contributes the improvement of non-motorized transport in Konya. The ongoing bike-lane constructions and the launching of the bike-share system show that there is an interest in improving this mode of transport; however, it is difficult to claim that there is a more comprehensive policy for improving non-motorized transport, walking and cycling as a component of a strategy for more sustainable transport. Policy makers in the municipality are aware that this system can encourage bicycle use in the city, but it was not explicitly stated that that the bike-sharing system in Konya was constructed to support directly non-motorized transport and attain sustainable transport goals. The manager of Konya Metropolitan Municipality Department of Urban Development, Koyuncu (2013), stated the construction aim of the system in the interview as follows:

> The responsible authorities in municipality have realized bike-sharing system from the experiences in foreign countries, and have aimed to contribute to the image of the city of Konya through this system as well. In addition to this, bicycle roads have already existed; therefore, the main aim can be mentioned to stand as encouraging people to use bikes and increasing bicycle use in general.

Although a sustainable transport strategy is not mentioned, there was willingness to increase bike usage and awareness that this system can help this objective. The project is not further supported with other more comprehensive policies for non-motorized transport however: pedestrian areas exist in the city and there have

been plans to expand car-free areas in the city center; however, these are not integrated with the bike-share project.

KAYSERİ

The 'Kaybis' system in Kayseri has also focused on supporting bike usage, but their efforts were more significant since they launched a strong integration of the bike-share system with tram stations. The integration of the bike-share system with the tram can also help encourage more public transport usage and reduce car usage. This system in Kayseri seems as the leading example in Turkey, where the politicians have a high level of awareness with regards to the planning of the system in integration with the tram so that public transport can be promoted further and car dependence reduced. However, there does not appear to be much consideration for wider pedestrian area projects and creation of car-free areas, whereas these bike-share systems can provide such opportunities.

İSTANBUL

Existing İstanbul 'İsbike' system was not constructed to contribute directly to the improvement of non-motorized urban transport since it is not functioning as an urban transport system. The stations of it were located along the recreational coastal corridor between Kadıköy and Kartal districts. However, this system is considered as a first pilot bike-sharing project in İstanbul that should be monitored in time. According to the outcomes of this monitoring process, managers of the system want to launch bike-sharing at some other districts in İstanbul with other public transport stations. In brief, the existing recreational 'İsbike' system is not an outcome of visionary upper scale thinking to support non-motorized urban transport; on the contrary, it was only thought to be worked to support leisure time needs of people. However, the intention and awareness of policy makers for using bike-sharing as an urban transport mode itself also exist for future projects. Kaya (2013), the responsible person of Bicycle Unit of İSPARK, expresses his opinions as follows:

> Our main aim is integrating this system to urban transport; but, we do not have any culture for such kind of integration. For example, bicycle roads should be constructed in İstanbul which have different width standards. There are no vehicle roads in İstanbul that can meet the need for these standards. Let's assume that as if there is a capacity to construct bicycle roads. And now, there is not any bicycle culture….At first, we have wanted to construct these systems to coastal lines in İstanbul in order to make people recognize. Then, our objective has become to integrate bike-sharing to urban transport after this gradual recognizing period, because bicycle use is considered just as a leisure time activity in Turkey at the present time. Nobody regards it for urban transport.

It is seen again that there is awareness for increasing bike usage in the city; however wider policies for non-motorized transport, including pedestrianisation projects, are not on the agenda. Due to the limited size of the system, it would not be realistic to expect such vigorous projects yet.

In summary, upper scale vision for supporting urban transport together with the principal characteristic of being non-motorized directly exists in the construction process of the system in Kayseri. Besides, on the one hand, Konya 'Smart Bike' system was not designed directly to improve non-motorized transport through considering bike-sharing as a sustainable urban or public transport mode; however, it serves for inner-short or middle distance travels. Contrarily, on the other hand, İstanbul 'İsbike' system was primarily designed to support leisure time needs of the people living between Kadıköy and Kartal districts; therefore, it serves almost never to the well-being of urban transport as a supplementary tool as the one in Kayseri. However, policy makers of 'İsbike' are highly aware of the benefits of bike-sharing for non-motorized urban transport by integrating bike stations to other public transport stations, however, in practice, they have not implement any system serving non-motorized urban transport. Their principal objective for future bike-sharing constructions in İstanbul is to connect those two distinct types of urban transport modes such as bike station and bus station. Consequently, it can be stated that awareness of authorities on the benefits and potentials of this system is obvious in Kayseri by means of practical evidences, and other two distinct systems in Konya and İstanbul cannot be considered as direct outcomes of supporting non-motorized transport or urban public transport.

However, in Konya, existing bicycle use awareness and implementations of bicycle road making seems also too significant for the future of bike-sharing.

- ***Efforts for encouraging and effective announcement of bike-sharing***

In order to make bike-sharing be used by the expected number of people, citizens should be informed about these systems through advertising or awareness campaigns. If people do not know the main features and how to register or use bike-sharing, the efforts of policy makers to construct and develop the system do not make any sense. In Konya, Kayseri and Istanbul, some kinds of announcement efforts were done at the initiation of systems, as described below.

KONYA

In Konya, a general bicycle festival is held every year on May, which is not directly related with the bike-sharing system; however, it increases general bicycle awareness and contributes to the improvement of bicycle culture of Konya. Additionally, introductory brochures were prepared and distributed to people about ‘Smart Bike’ bike-sharing system in Konya at the initiation of the system. Another advertisement policy for this system was that it was available to public to be used for free for approximately one year after its opening.

KAYSERİ

In Kayseri, the 'Kaybis' system, which is the first bike-sharing initiative in Turkey, was advertised through introductory brochures explaining the benefits, rules, pricing regulation and registration. Besides, when the system started to operate, a stand was opened near to a bike-sharing station to inform local people about the system together with its registration process. In addition, an opening ceremony was held together with the participation of the Mayor of Metropolitan Municipality and press members of different TV channels and newspapers. Similar to Konya, in Kayseri too the 'Kaybis' system was allowed to be used for free during its initial year which can be considered as an introductory advertisement policy for the system.

İSTANBUL

In İstanbul, 'İsbike' bike-sharing system started to operate in May 2013 together with an opening ceremony near to a central bike station. The ceremony was made with the participation of representatives of managerial authority -İSPARK-, press members of different TV channels and newspapers. Unlike Konya and Kayseri, the system in Istanbul was not offered to its users for free at any time period.

All these three systems adopt advertisement issues as key elements at the initiation which means that policy makers have been aware that it is crucial to make people know about the use of system to increase the number of users as much as possible. No matter how the aim of systems vary as supporting urban transport, enabling leisure time cycling in the city or contributing the image of the city, advertising was considered as a core issue to be paid attention in order to make people accustomed to bike-sharing.

Table 22. Supportive Complementary Policies of Bike-sharing Systems in Konya, Kayseri and İstanbul

SUPPORTIVE COMPLEMENTARY POLICIES			
	KONYA	**KAYSERİ**	**İSTANBUL**
--Encouraging policies to increase the use of systems	- bicycle lane infrastructure - easy registration - no policies to discourage car-usage	- bicycle lane infrastructure - smartcard integration with public transport - integration of bike stations with public transport stations -no policies to discourage car-usage	- bicycle lane infrastructure - easy registration no policies to discourage car-usage

Table 22 (continued)

--Is the system constructed for supporting non-motorized transport as a sustainable transport strategy? Are policy makers aware of the significance of it?	Policy makers wanted to further increase bike usage. But no vision exists for a wider non-motorized transport improvement including pedestrian areas.	Policy makers designed the system to serve public transport and hence to encourage more public transport usage. But no vision exists for a wider non-motorized transport improvement including pedestrian areas	Policy makers want to support cycling and create a culture for cycling through bike-sharing; but, in this pilot project, only recreational aim exists. No vision exists for a wider non-motorized transport improvement including pedestrian areas

Table 22 (continued)

--Efforts for encouraging and effective announcement of bike-sharing	- general bicycle festival each year - introductory brochures about bike-sharing - System offered to users for free in the opening year	- introductory brochures about bike-sharing - opening a stand for advertisement at the beginning - opening ceremony with press members of different TV channels and newspapers System offered to users for free in the opening year	- opening ceremony with press members of different TV channels and newspapers

4.3.5. Future Plans

Technical and operational attributes of bike-sharing have continuously been developing around the world, and local governments are about to follow these new technologies to improve the efficiency of the system. Thus, the future advancements of a bike-sharing system in terms of technical equipment, supporting urban transport more and system extensions or new system construction in a city seem to be significant for this research. Under the heading of future of bike-sharing systems in Konya, Kayseri and Istanbul, several sub-themes will be investigated which are about system extensions, station or new system demands coming from people, and planned physical improvements of the components of bike-sharing systems.

- ***Is there any plan for system extensions to serve urban transport more?***

In order to determine whether any kind of extension for systems will be made the policy makers of the bike-share systems were interviewed, and some findings were tried to be concluded for Konya, Kayseri and İstanbul.

KONYA

In Konya, 'Smart Bike' system was established in 2011 depending on the tendering conditions applied with the firm 'Wall' for the construction, operation and maintenance. Because of strict tendering conditions between Konya Metropolitan Municipality and this private firm, there cannot be any system extension or technical advancement in terms of station number, new system construction to another part of the city or physical components of bicycles and stations until the due date of the agreement. According to Koyuncu (2013), who is the manager in Konya Metropolitan Municipality Department of Urban Development, the number of bicycles and stations within the 'Smart Bike' system seem enough, and there are no plans to increase them in the future. Since the system exists under the tendering conditions, they do not have any chance to make a change to the system.

KAYSERİ

In Kayseri, the system is about to be changed completely including all of the bicycles and bike stations in terms of both the location of station, station design, number of stations, operating mechanism and bicycle design. Kayseri Ulaşım A.Ş. Firm, that is the operator of 'Kaybis' system, is to become the first initiative in Turkey that will produce a completely localized bike-sharing program without being dependent on foreign source, technologies and tenders. The principle aim of this local firm in Kayseri is, firstly, to establish a completely new bike-sharing system instead of the existing one, which was constructed by 'Clear Channel', a foreign private firm. Secondly, another principle aim is constructing new bike-sharing systems to other cities of Turkey as a response to excessive demand they receive from local governments. According to Demirdirek (2013), who is the

Electrical and Electronics Engineer of ‘Kayseri Ulaşım A.Ş.’ firm, a new bike-sharing system will be constructed as a local initiative in Kayseri. The main changes and additional innovations to ‘Kaybis’ system can be summarized as:

-Removal of all existing stations,

-Discarding all existing ‘Kaybis’ bicycles,

-Keeping just the efficiently working locations of bike stations, relocating newly designed and produced stations to those places and introducing additional stations towards particularly the areas that newly constructed tram line will exist,

-Designing the structure of new stations of the new system,

-Introducing new bicycles to the new system together with increasing their number,

-Preparation of an efficiently working web site and smart phone application which will show the exact locations of bike stations and real time availability of bicycles at stations,

-Making new software that regulates the operation of system including bicycle getting and returning, real time availability, and redistribution of bicycles between stations,

-Operating new system for free without getting any money.

The above list indicate a radical modernization and expansion of the system, although it must be noted that complete removal and replacement of the existing system is a risky move in a city that operates a system that already has substantial users. A completely new system will again require a time period for the users to understand and get used to.

İSTANBUL

In İstanbul, ‘İsbike’ system was constructed in May 2013, and it was estimated to lead other projects in İstanbul focusing on supporting recreational aim along

coastal corridors. There are five more new system construction projects on various coastal areas in İstanbul. In Table 23, main features of existing and planned bike-sharing systems can be seen.

Table 23. Existing and Planned Bike-sharing Systems in İstanbul

	Location	**Distance of the line**	**Station number**	**Bicycle number**
OPERATED	***(existing)****Kadıköy-Kartal coastal line*	19 km	10	100
PLANNED	***1-****Beşiktaş-Sarıyer coastal line*	22 km	15	150
	2-*Florya-Yeşilköy coastal line*	6 km	5	50
	3-*Zeytinburnu-Eminönü coastal line*	12 km	10	100
	4-*Büyükçekmece coastal line*	6 km	5	50
	5-*Avcılar coastal line*	6 km	5	50
TOTAL		71 km	50 stations	500bicycles
* 4 bike-sharing systems with 400 bicycles until 2015 *10 bike-sharing systems with 1500 bicycles until 2020				

Source: (Savaş, 2013)

In Figure 57, it can be seen that all planned bike-sharing systems in İstanbul will be constructed along recreational coastal corridors. In addition, Figure 58 and Figure 59 show the real locations of systems on the map in sequence referring to Table 23 and Figure 57 by its special numbers on it.

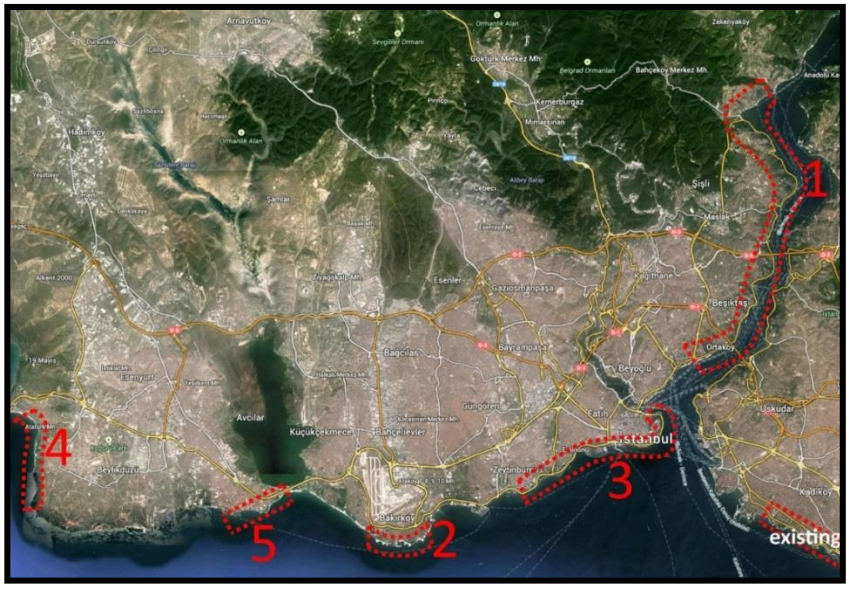

Figure 57. Locations of Planned Bike-sharing Systems in İstanbul

Source: (Personal Drawing)

Figure 58. Locations of Beşiktaş-Sarıyer, Florya-Yeşilköy and Zeytinburnu-Eminönü Bike-sharing Systems

Source: (Savaş, 2013)

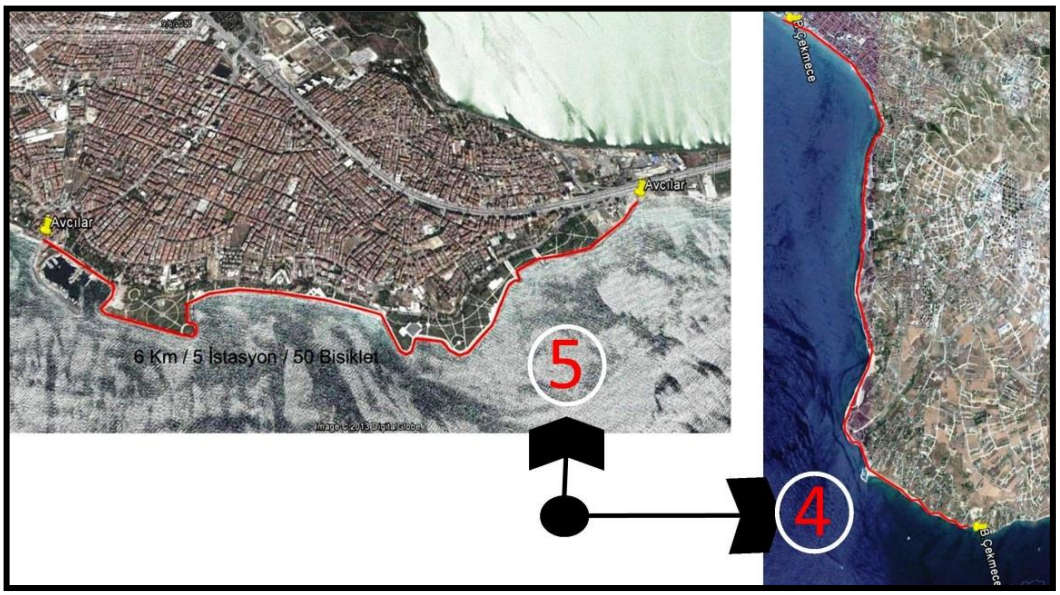

Figure 59. Locations of Büyükçekmece and Avcılar Bike-sharing Systems

Source: (Savaş, 2013)

In summary, future intentions for three bike-sharing cases are quite different from each other. In Kayseri, innovation of a localized bike-sharing program enables policy makers make future extension plans for 'Kaybis' in terms of new stations, new bicycles and new software. In İstanbul, new system constructions were planned on different coastal corridors of İstanbul. The critical thing here is that these new systems also seem to serve recreational trip purposes rather than urban transport. On the other hand, in Konya, there are no future extensions or new system constructions planned or considered.

- ***Demand coming from people for station addition or new system construction***

Bike-sharing is a system that advertises itself to the people through its continuous operation in the city. Therefore, it is common that local people may demand new station areas to places close to their residential area, working place, or any place which is desired to be travelled to by these publicly owned bicycles. Three Turkish bike-sharing cases also attract the attention of local people, and the

number of users has exceeded the number that policy makers expected before. Analyzing such demands can give clues about future potential of system extensions and determining general interest of people.

KONYA

In Konya, Koyuncu (2013), the manager in Konya Metropolitan Municipality Department of Urban Development, mentioned that the people in special dormitories in Konya demanded bike stations near to their building.

KAYSERİ

In Kayseri, Demirdirek (2013), the Electrical and Electronics Engineer of 'Kayseri Ulaşım A.Ş.' firm, stated that many people from many parts of the city, particularly from 'Kocasinan' district, contact policy makers via phone or e-mail to present their demands for station addition. Apart from that, policy makers of 'Kaybis' have been negotiating with many cities such as Bolu, Çorum, Giresun, Karaman, Karşıyaka (already constructed), Kocaeli, Muğla, Samsun (already constructed), Yalova, Aksaray, Burdur for the construction of new local-technology bike-sharing system that Kayseri has been developing. In addition to this, different universities are interested in this issue of circulation of people within the university through publicly owned bicycles. Ankara University in the city of Ankara is an example demanding new system construction from policy makers of 'Kaybis' system.

İSTANBUL

For İstanbul case, Kaya (2013), the responsible person of Bicycle Unit of İSPARK, stated that there were station demands coming from people for locations at the European side of İstanbul in which urban traffic is extremely congested especially in the districts of Mecidiyeköy, Maslak and Beşiktaş, universities in İstanbul, and different district municipalities. Besides, some universities in İstanbul have demanded inner campus bike-sharing system construction.

In short, station demand shows the potential for system extensions or new system constructions in the cities that bike-sharing system is applied. The people and institutions from many other parts of cities of Kayseri and İstanbul, which have been deprived from bike station, have been demanding the extension of bike-sharing. Moreover, authorities from universities have communicated with policy makers of Kayseri and İstanbul for inner campus areas that shows the potential of use of bike-sharing by students.

- ***Are there any planned physical improvements on the components of systems?***

Physical improvements on quality or features of bicycles, stations or software for bike-sharing aim to serve a more comfortable trip to cyclists and increase the general interest to the system. Bike-sharing is a system which has been continuously developing in other parts of the world together with its components, and that kind of physical improvements constitute a significant part of future advance for Konya, Kayseri and İstanbul cases too to reach the quality level of best bike-sharing cases in the world.

KONYA

In Konya, the locking mechanism of bicycles of 'Smart Bike' system was planned to be changed from manual locks to electronic automated ones. Apart from that, there are no plans that exist for the physical components of bike-sharing in Konya due to tendering conditions between the private firm and the local government.

KAYSERİ

In Kayseri, localization of bike-sharing program will be realized as mentioned in previous heading, and all the components of the system including bicycles, station design and quantity, and system operating software will be changed and improved. For example, stations will be designed to be more compatible with the urban environment together with increased capacity for racks to contain more

bicycles. Besides, a new web site and a mobile application will be produced to increase efficiency and user friendliness of system.

İSTANBUL

In İstanbul, different kinds of physical improvements will be made on bicycles of the 'Isbike' system. The first renovation is adding GPS to each bicycle to follow from the control center where the cyclist goes. Second one is the additional electric bicycles to system. Later on, the third renovation within the system is the development a new technical electronic locking mechanism instead of RFID (radio frequency identification tracking) to prevent bicycle theft as much as possible.

In short, 'Smart bike', 'Kaybis' and ' Isbike' systems will experience different kinds of changes within the system which will increase the user friendliness, and definitely the efficiency of system in the end. In Konya, existing physical equipment of the system have been considered to be sufficient, and changes are not planned to be realized in near future.

Table 24. Future Plans of Bike-sharing Systems in Konya, Kayseri and İstanbul

FUTURE PLANS			
	KONYA	**KAYSERİ**	**İSTANBUL**
--Is there any plan for system extensions to serve urban transport more?	No, the system is dependent to tendering conditions, which restricts building of new lines and stations.	Yes, localization of system and a complete renovation of system.	Yes, five more new planned bike-sharing programs serving recreational aim mainly.

Table 24 (continued)

--Demand coming from people for station addition or new system construction	-station demands from special dormitories	-station demands from district municipalities -new system demand from different cities such as Muğla, Kocaeli and Bolu - new system demand from universities for inner campus areas	-station demands from district municipalities - new system demand from universities for inner campus areas
--Are there any planned physical improvements on the components of systems?	- automated locking mechanism instead of manual one	- new bicycle and station design - new software and website for operation	- addition of GPS to each bicycle - addition of electric bicycles - a new technical electronic locking mechanism instead of RFID (radio frequency identification tracking)

4.4. Main Findings of the Analysis

Previous section gives the analysis of planning background, bike-sharing system design, operational issues, supplementary policies to encourage the system and finally, planned future improvements by policy makers. In this section of main

findings of research are structured over the question of what the strengths, weaknesses and rooms for improvement in Konya, Kayseri and İstanbul Bike-sharing cases are.

Findings of the field research for 'Smart bike', 'Kaybis' and 'İsbike' bike-sharing systems gives a framework for strengths, weaknesses and rooms for improvements. In Table 25, the findings of the three Turkish cases are brought together to determine strengths, weaknesses and rooms for improvements depending on the sub-topics of general headings discussed in the previous section.

Table 25. Strengths, Weaknesses and Rooms for Improvement of Konya, Kayseri and İstanbul Bike-sharing Cases

Meanings of the symbols used in the table:

- ✓ → **strength**
- X → **weakness**
- ✓ (!) → **room for improvement**

	KONYA ***Smart Bike***	**KAYSERİ** ***Kaybis***	**İSTANBUL** ***İsbike***
The plan base or upper scale vision of system	**X**	**X**	**X**
Locations of stations	**X**	✓	✓ **(!)** (new station additions to inner parts of urban area is needed)
Serving as an urban transport mode	✓ **(!)** (directly aiming to serve urban transport is missing)	✓	**X**

Table 25 (continued)

The contributions of bicycle road&lane infrastructure to the system		✓ **(!)** (bicycle roads are needed at city center)	✓ **(!)** (an extension and separated bicycle roads are needed	✓
User friendliness of system	***Station shelter***	**X**	**X**	**X**
	Locking	✓ **(!)** (manual locks are needed)	✓ **(!)** (manual locks are needed)	✓ **(!)** (manual locks are needed)
	Station noticeability	**X**	**X**	**X**
	System continuity during a year	**X**	**X**	✓
	Mobile application	✓	**X**	**X**
	User registration	✓	**X**	✓
Inclusion of forth generation characteristics		✓	**X**	✓
Quantitative sufficiency of bicycles		**X**	✓	✓
Smartcard integration with public transport		**X**	✓	**X**
System maintenance and redistribution of bicycles		**X**	**X**	**X**
Pricing		✓	✓	**X**

Table 25 (continued)

Helmet wearing	**X**	**X**	**X**
The approach of policy makers for considering this system as an urban transport mode	**X**	✓	✓ **(!)** (an intention exists to extend the system to serve urban transport)
Efforts for Encouraging and effective announcement of system	✓ **(!)** (minimal level of introductory efforts are not sufficient enough)	✓ **(!)** (minimal level of introductory efforts are not sufficient enough)	✓ **(!)** (minimal level of introductory efforts are not sufficient enough)
Existence of policy makers' intentions for improvements	**X**	✓ (Localization)	✓ **(!)** (planned systems are good intentions, but they should serve urban transport more)

According to the above table, some inferences can be concluded as common weaknesses of bike-sharing in these three cities. First of all, these three systems do not have any plan base or any upper scale vision or strategy. In other words, it can be said that these systems were randomly initiated, often as a result of a proposal by a private service provider firm. As a result, these projects do not originate from a comprehensive plan or a sustainable urban transport strategy, and they are not prepared in coordination with urban development plans or in integration with urban transport plans. There is an example of good integration with public transport infrastructure; however, in none of the cities the bike-share systems were supported by complementary policies, such as restrictions on

automobile (for example reduction of car parks or high parking fees in the city center) and improvement of non-motorized transport in general (for example pedestrianization projects, creation of car-free streets or areas).

Another weakness is that station shelters do not exist in any stations of the three systems, which is an important design aspect for users since shelters keep bikes clean, dry and usable. Station shelter enables the system stayed opened in bad weather conditions during all seasons; however, in these three cases system pauses exist in a year or bad weather conditions, which affect the use of system negatively. In addition, bike station noticeability is weak in the Turkish cases. While cycling it is hard to notice the bike station for a person who does not know the exact location. Therefore, distinguishable notifiers can be used at bike stations. Another common weakness of the systems is about the system maintenance and bicycle redistribution. In all three cases, maintenance and redistribution are made with a staff containing 3-4 people and a service vehicle. As a result of this small number of maintenance staff, policy makers and personal observations show that there are difficulties in transferring sufficient number of bicycles between stations when needed.

Furthermore, helmet wearing is a general problem of bike-sharing in Turkey. Cycling safety is one of the most significant principles for bicycle use in any area of a city. Bike-sharing is aimed at making people cycle for different aims, and helmet wearing has been deeply under-recognized in Turkey both in general cycling habits and in bike-sharing systems.

All these aspects require improvement for the Turkish cases. In addition, the advertising of the systems can be further improved. Certain efforts were put forth at the initiation of systems, such as introductory brochures, news at different TV channels, and opportunity to use the system for free. However, even today, there are still many people who do not recognize and have no knowledge of the bike-sharing system in their cities.

There are also certain strengths of the bike-share systems, as seen in the above table. Although the system in Istanbul is a recreational system, when the policymakers' plans for future system expansions are considered, it can be said that there is an awareness to build these systems to make cycling a more efficient and publicly-accepted mode of urban transport.

There is also an awareness to develop these systems together with bike lanes and bike roads, or in integration with such existing bike infrastructure. All system providers are also aware of fourth generation technology components for these systems and they are planning to incorporate them into the existing system.

Interviews with policy makers also show that local governments are willing to construct bike-sharing in their cities, not only for the reasons of free construction due to advertisement agreements with private firms, but also due to excessive demand coming from public. In addition, they also consider these systems as a way to enhance the image to the city. These can be considered as positive, because all these factors are likely to result in a rapid spread of bike-sharing in Turkey. However, a delicate issue exists here as mentioned above: Most bike-sharing projects are launched without considering the system as a component of a wider transport plan. This often means that the potential of these bike-share systems in terms of creating a more sustainable urban transport system and a more livable urban area is often overlooked and opportunities are missed. These main findings are further elaborated in the next chapter, which concludes the study with recommendations for policymakers and proposals for further research.

CHAPTER 5

5. CONCLUSION

In this final part of the study, firstly, the research will be summarized in general terms. Then, the main findings will be discussed and further elaborated with a view to provide lessons from the current experience and recommendations as policy inputs for future initiatives in Turkey. Finally, further research areas will be highlighted and proposals will be made for future research in bike-share systems.

5.1. Summary of the Research

It has been shown through the review of the relevant literature that most urban areas adopt an urban transport strategy to make urban transport more sustainable, and the improvement of alternatives to the car plays an important role in this. Alternatives to the car comprise public transport, cycling and walking, and while there are projects for each of these modes, there has recently been an increase in the number of projects promoting cycling and particularly programs called bike-share systems. In Turkey too bike-sharing is on the agenda of many cities, following the first implementation of this system in 2009 in Kayseri. In addition to this first example in Kayseri, five other cities have recently launched this system and many more are being planned. However, there has not yet been a comprehensive analysis about this experience in Turkey. There are no studies that show what has been experienced in the planning, construction and operation of these systems in Turkey, what the mistakes or correct attitudes of policy makers have been for their bike-sharing systems, and how much these systems are advanced compared to the experience of best-practice cases around the world. Therefore, the aim of this research was to analyze and provide a better understanding of the bike-share experience in Turkey, particularly in the three cities that became pioneers for this system in Turkey: Konya ‘Smart bike’, Kayseri ‘Kaybis’ and İstanbul ‘İsbike’.

In order to attain this research aim, firstly a literature review was carried out, which provided an introduction to bike-sharing systems together with a discussion

on the unsustainability of car use and the emergence of cycling as an alternative mode that needs to be supported and improved. After mentioning automobile dependence as an unsustainable issue, sustainable solutions to this was stated as public transport, walking and cycling. Then, the consideration of bicycle use as a sustainable transport mode was explained including its emergence as an urban travel vehicle, benefits and planning-infrastructural measures. The significance of bike-sharing systems was clarified at this point by presenting its emergence and historical background of three generations, benefits and effects, costs and challenges, management models, and finally, three successful cases from three different continents, which are Velib (Paris/France), BIXI (Montreal/Canada) and Public Bicycle (Hangzhou). A fundamental point drawn from the experience of these systems was that all three systems mainly serve as an urban transport mode, which helps decrease car dependency. Based on the outcomes of the analyses of these cases in the world as well as the outcomes of the literature review, a list of criteria was formed to serve as the basis of analysis and assessment for the Turkish bike-share case studies. Hence, after presenting the research methodology, three bike-sharing cases from Turkey –in Konya, Kayseri and İstanbul- were analyzed comparatively under five main headings which are:

- Planning background
- System design
- Operational issues
- Supportive complementary policies
- Future plans

Finally, main findings of the research for ‘Smart bike’, ‘Kaybis’, and ‘İsbike’ systems were demonstrated focusing on their strengths, weaknesses and isues that were determined as those where there was room for improvement. The analysis revealed certain criteria as extremely crucial for policymakers that may consider building such bike-share systems in their cities. The main themes of those fundamental criteria can be summarized as:

- Bike-sharing systems for the aim of urban transport

- Bike-sharing as a well-integrated component of public transport
- Integration of bike-sharing into urban plans or transport plans
- Existence of well-designed and safe bicycle roads & lanes
- User friendliness of bike-sharing
- The use of technology
- Encouraging policies and effective announcement of systems

5.2. Main findings and Lessons Learned

In this part, firstly the points that particularly draw attention in the analysis of these three bike-sharing experiences are explained, and some generalizations are also made for Turkey. Then, a discussion is carried out focusing on the main issues inferred from the research.

As a result of the analysis of 'Smart bike' system in Konya, one of the most noticeable strengths is the existing bicycle culture among citizens. The most significant reasons to decide the implementation of a bike-sharing system in Konya seems to be the reliance on that cycling culture as well as a will to maintain it. Moreover, even though there are not any bicycle lanes in core city center, previously constructed bicycle lanes and segregated bicycle roads in other parts of the city are the principle parts of that culture ; therefore, existing cycling infrastructure and cycling culture are seen as the prominent strengths for the development of bike-sharing in Konya. On the other hand, insufficiency of bicycles in terms of their quality and quantity stands as a weakness at first sight. Particularly, personal observations show that general quality of bicycle fleet in Konya is poor in comparison to other system and therefore the fleet is in need of a renewal or repair. In addition, bicycles at mostly used stations sometimes run out rapidly; and as a result, shortage in good quality bicycles is experienced.

In Kayseri, two main significant and unique characteristics of the system constitute the strengths of the system. The first one is that 'Kaybis' system has almost completely been serving as a part of urban transport mode. This seems unique for Turkey, because 'Kaybis' is the only bike-sharing system that supports main urban public transport line (*'Kayseray'* tram line) through a well-designed

positioning of bike stations. The second one -also another unique one for Turkey- is the complete renewal of the system with local technology and production, which was planned to be realized in the mid of 2014. Managing authorities of the system complained about the difficulties in dealing with foreign technologies and products and they invested in developing the first domestic bike-sharing system in Turkey including its bicycles, stations and software. In other respects, one of the most obviously seen weaknesses of bike-sharing system in Kayseri is limited amount of bicycle lanes together with its shared characteristic. Bicycle lanes in Kayseri have remained limited to city center; therefore, cyclists cannot travel to outer parts of main urban center without having safety concerns since they have to be in mixed traffic. Additionally, the existing bicycle lanes are not fully separated from urban vehicle traffic. Another weakness of the system in Kayseri is the difficult registration process that ignores the visitors to the city. The system can only be used by 'Kaybis' membership card and getting this card necessitates one or two days together with formal documents. Such a discouraging effect can also be considered as a weakness for the system.

In İstanbul, the most prominent characteristic of 'İsbike' system is having good quality bicycles and stations. Among three bike-sharing cases investigated on site, 'İsbike' has stayed one step ahead in terms of quality of bicycles, unproblematic station design with its well operated software, all of which stand as strengths. However, the most prominent weakness of the bike-sharing system in İstanbul seems to be that it is just a coastal recreational system without station connections with any other public transport stations.

When the main characteristics of the three bike-sharing systems in Turkey are considered together with some of the newly opened systems in other cities (although not analyzed in detail as a case here in this study), the following common strength and weakness points can be stated:

- Particular weaknesses of bike-sharing in Turkey:
  -- Not considering the system as an alternative public transport mode

-- Lack of integration with public transport, which could extend the service area of bike-sharing system towards the areas that the integrated public transport mode covered

-- Lack of a plan before the initiation of system

-- Lack of integration into urban development plans and urban transport plans

-- The contribution of bicycle lane & road infrastructure

-- Limited number of staff responsible for maintenance of bicycles and stations, and bicycle redistribution between bike stations

-- Deficiency in effective announcement of bike-sharing

-- Lack of helmet wearing while cycling

- <u>Particular strength points of bike-sharing in Turkey:</u>

  -- Great interest coming from public to bike-sharing initiatives in Turkey

  -- The will of policy makers in local governments for demanding the construction of bike-sharing

After mentioning the prominent findings about strengths and weaknesses in particular to three cases and for Turkey, another question to be answered was '*How do policy makers of these systems evaluate the system that they operate: successful, deficient or developing'*. According to policy makers of bike-sharing systems in Konya, Kayseri and İstanbul, concluded from in-depth interviews, the systems that they operate has almost been problem-free and quite successfully operated. They commonly mention that they have always received positive reactions from the users, and the usage of the system is quite higher than what they expected at the initiation of the system. Besides, they cannot easily call the system as developing -except for the one in Kayseri- because of strict tendering conditions that they are dependent on at least for five years with the private firm. For instance, at the end of the tendering condition with *Clear Channel* firm in Kayseri, policy makers have decided to apply a complete localization of the operation and all the components of system. Consequently, what policy makers see in the cases of Turkey is an almost perfectly operating and problem-free bike-

sharing system; however, as a result of the analysis applied in research areas, these systems have significant weaknesses with respect to worldwide literature review and good-practice cases from the world. There is a difference between the perception of policy makers and the research findings concerning the weaknesses of the systems.

One of the general results of the analysis of Turkish cities is that there is a need to discuss the scale issue for bike-sharing in Turkey. What kind of a bike-sharing system can be designed in terms of the spread of bike stations in two different city scales: multi-center metropolitan city (İstanbul, Ankara, İzmir…) or single center smaller cities in terms of land and population (Konya, Kayseri…)? In a small scale city, bike-sharing can be expected to serve the entire city by encompassing all the locations with bike stations. In other words, positioning a bike station at any urban area -even to the peripheral locations- in a city can connect the people living there to the city center or their working area in rideable short travel distances. On the contrary, in metropolitan cities, travel distances are quite long, and the topographical structure for cycling may not always be convenient in very place in an urban area. Therefore, it cannot be expected, for example, that a bike-sharing user travels 30km from one place to another. In large cities, the planning and design of bike-sharing can be structured to be completely transit oriented. In other words, a kind of a bike station bunching can be realized around main stations of public transport; therefore, bike-sharing takes the role of transferring people from their living or working place to a metro, LRT, bus or any other public transport station. In short, bike-sharing can serve as a separate public transport mode itself in small scale cities; nevertheless, it can own the role of being a connector for people to public transport stations as an application of Transit Oriented Development (TOD) including bike-sharing as a mode of transport.

Another point that is needed to be discussed as a result of the research is bike-sharing safety in Turkey. For cycling in general, there are two main safety indicators: bicycle road infrastructure and helmet wearing while cycling. Transport policies in the cities of Turkey have been oriented to motorized

transport -particularly to individual private transport by automobile-, and cycling as an urban transport mode has remained under-recognized. Therefore, well-designed bicycle road construction to facilitate inner city urban travels by bicycle has not been taken into account seriously by policy makers, which constitutes a significant problem for also the consideration of bike-sharing as an urban transport mode. In Turkey, Konya does not have any bicycle road in core city center, and none of the bicycle lanes in Kayseri are separated from motorized traffic. These are the two cities that have the most developed cycling culture and implementation. Therefore, one of the most significant prerequisites of bike-sharing -existence of bicycle road infrastructure- cannot be said to be achieved in terms of safety considerations. Secondly, helmet wearing is another critical issue for bike-sharing safety. There have not been any obligatory measures in any of the cases in Turkey for helmet wearing for bike-sharing; such a critical safety component has been left optional to users. However, bike-share users do not use helmets probably because they find it not comfortable, or perhaps because they do not own one. In good-practice cases in the world, people generally have their individual helmets for bike-sharing; however in Turkey, this issue is not cared about for bike-sharing and for even cycling in general.

At the beginning of the thesis research, the literature review showed that automobile dependence could not be sustained, and that bike-sharing can be considered as an effective alternative for urban transport. For Turkey, the question is whether the existing and prospective bike-sharing systems can be an alternative mode to automobile by decreasing the use of it (at least in short distances and in central areas of cities)?

In Turkey, automobile use for daily urban transport has continuously been supported by car-oriented transport policies, such as new road building, widening of existing roads at the expense of pedestrian sidewalks, and construction of grade separated junctions, while investments in public transport and non-motorised modes of transport (walking and cycling) have remained limited. Nevertheless, there is now an interest in bike-sharing projects in many cities. The coexistence of

automobile dominated urban transport policies and bike-sharing as a new alternative transport mode in Turkey reveals that it is difficult to consider bike-sharing systems for decreasing car usage without implementing restrictions for automobile usage, such as taxes and charges, parking restrictions and pricing in city centers, creation of pedestrian and car-free areas or streets. Introduction of complimentary policies, which can support public transport and walking while making automobile usage less convenient and more expensive, can have a positive impact on bike-sharing and its role as a sustainable urban transport mode.

On the other hand, this research for bike-sharing in Turkey revealed that this system has not been initiated as a part of sustainable urban transport policy package; in other words, bike-sharing has randomly been realized by policy makers without planning it as an outcome of an urban transport plan or upper scale vision and strategy. In Turkey, such kind of an urban transport policy package should primarily contain policy considerations including decreasing automobile use by restricting it, and improving public transport; and later on, bike-sharing should be accepted as a sustainable urban transport mode.

The effective practice of bike-sharing is directly related with the attitude of policy makers in local governments as decision makers of these systems. In Turkey, private companies construct bike-sharing services in exchange for the rights to advertise on city street furniture and billboards. Therefore, it is difficult to claim that these systems are the outcomes of a visionary thinking that has its roots in a sustainable transport policy plan or vision. For example, in İzmir, such randomness results in unawareness between district municipality of Karşıyaka and İzmir Metropolitan Municipality as the implementation of two different and independent bike-sharing systems coexist in Karşıyaka District and in urban center of İzmir without compatibility and interoperability between the systems. Both systems should have been considered as a part of a common and coherent sustainability strategy to obtain an integrated sustainable urban transport policy.

5.3. Recommendations for Policy Makers for Future Implementations: Planning, Design and Operational Principles

Based on the analysis of the bike-sharing experience in Turkey, five prerequisite planning, design and operational principles are concluded for policy makers who plan to construct bike-sharing systems in their cities. These are as follows:

- *Bike-sharing systems should serve as an urban transport mode*

Excessive -and rapidly increasing- automobile use is a considerable urban problem of recent decades of the world, and Turkey has also been experiencing dramatic results of increasing automobile dependency such as excessive traffic congestion, environmental damages or uncontrollable urban spatial growth patterns supporting further use of automobiles. It should be realized by both policy makers and public that such an unsustainable urban transport policy and travel behavior cannot be sustained for future in Turkey. On the other hand, bike-sharing is standing as a significant potential to serve the sustainability of urban transport in Turkey considering best cases in the world i.e. in Paris, Barcelona, Hangzhou or Montreal. This research shows that a major concern Turkey in terms of bike-sharing experiences is that not all cities that implement this system consider it as an alternative mode of urban transport. Many local governments -except for the ones Kayseri and Konya- consider bike-sharing as a supportive tool for the recreational cycling need of people instead of regarding bike-sharing as a potential to solve the sustainability problem of urban transport. Policy makers in the world have realized the significance of the use of bike-sharing as an effective urban transport policy, and in Turkey, bike-sharing should serve as an urban transport mode together with a sensitive design of the locations of bike stations.

- *Bike-sharing should be introduced as a well-integrated component of public transport*

The use of bike-sharing for the aim of urban transport can intensively be supported by the integration of stations of bicycle and any other public transport mode. Such station integration enables the extension of service area of bike-

sharing system towards the areas that the integrated public transport mode covers. Lack of integration with public transport is almost a common deficiency for the experiences in Turkey, which should be considered as a core planning problem. Consequently, bike station site selection is an issue that should be studied carefully by planners.

- *Bike-sharing should be integrated into urban planning and transport plans*

Integrating bike-sharing into transport plans, urban plans and strategies prevents the randomness of the initiation of bike-sharing. For instance, as mentioned in Chapter 2, Velib bike-sharing system in Paris was an outcome of an upper scale livability and greening strategy, and this system is one of the most effectively used bike-sharing systems in the world as an urban transport mode. Pre-determined transport strategies and plans enable bike-sharing to become an effective tool in achieving the goal of sustainable urban transport together with supportive policies for restrictions on automobile use and encouraging public transport, walking and cycling. Bike-sharing cases in Turkey demonstrate that none of the systems depend on a transport or urban development plan, which stands as a common weakness for Turkey. In other words, all the systems in Turkey are private sector led and randomly initiated by policy makers of local governments through the partnership with private companies. However, bike-sharing should be an outcome of urban planning and transport plans to achieve the goal of serving as a sustainable urban transport mode.

Figure 60 shows the relationship between first three principles of bike-sharing in Turkey.

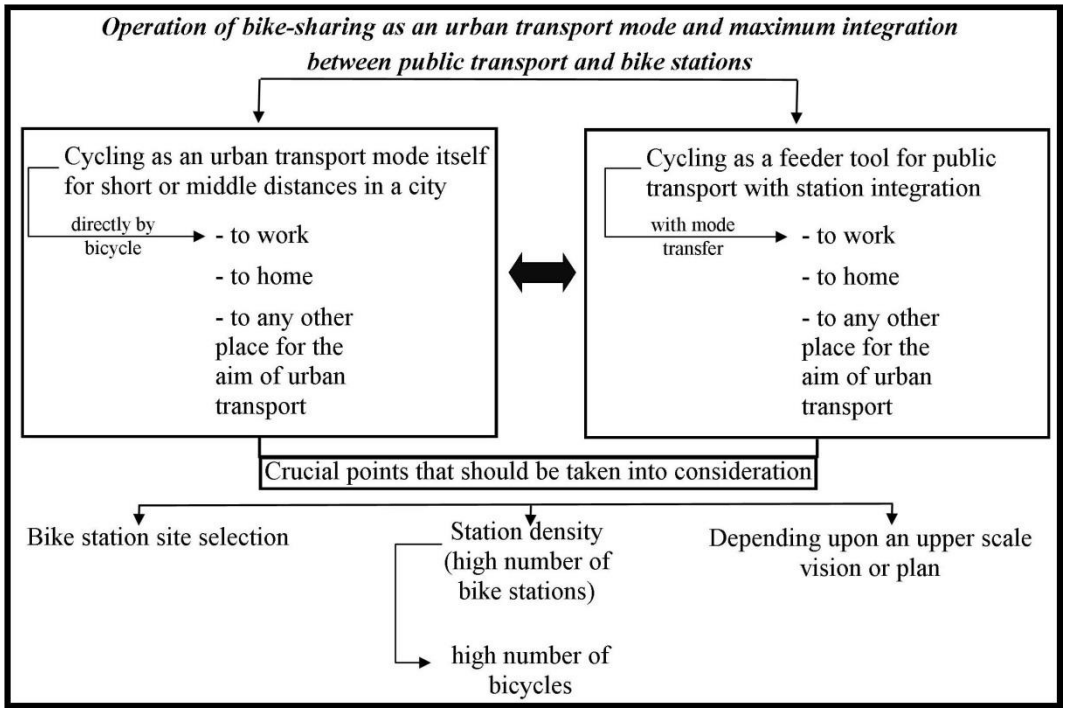

Figure 60. The Relationship between Three Principles of Bike-sharing in Turkey: Bike-sharing as an Urban Transport Mode, Public Transport Integration, and Integration of Planning

- *Existence of well-designed and safe bicycle roads in the city is a fundamental issue for bike-sharing*

Cycling safety is one of the most considerable prerequisite for bike-sharing. Bicycle lane or road infrastructure is the main provider of safe and effective use of bike-sharing systems, and these systems should be supported with this cycling infrastructure. In addition, existence of bicycle roads contributes the creation of a cycling culture in cities, which constitutes a significant base for bike-sharing. In Turkey, lack of bicycle roads is a considerable weakness for cycling in general and bike-sharing. Before the initiation of bike-sharing, bicycle road infrastructure should be sensitively designed to enable safe and rapid transfer between bike stations. Figure 61 summarizes the relationship between existence of bicycle roads with cycling culture and safety.

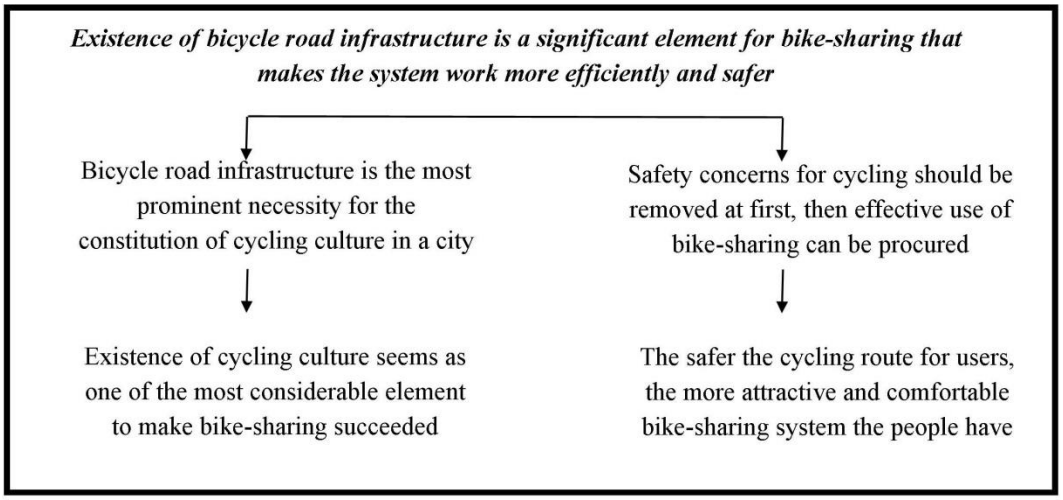

Figure 61. Existence of Bicycle Roads as a Significant Principle for Bike-sharing in Turkey

- *User friendliness of system is directly effective on whether to prefer bike-sharing or not*

Bike-sharing systems have several determinants of user friendliness, which are easy registration, coexistence of manual and automated locking, existence of station shelter, noticeable stations, and existence of mobile application. Registration of bike-sharing should not force users to deal with long processes at the initiation. Credit card registration with its advanced security programs or using existing public transport smart card for also bike-sharing are appropriate and efficient solutions for cities in Turkey. Manual locking mechanism on bicycles of this system enables the user to lock the bike at anywhere else during cycling, and then take it back from this place where the user locked temporarily. Therefore, manual locking enables flexibility to users for temporary breaks during the trip. On the other hand, automated locking presents a faster process for beginning and ending of a bike-sharing trip together with a more technology-based infrastructure. For Turkish cases of bike-sharing, coexistence of both mechanisms, or at least enabling automated locking at stations are significant. Another determinant of user friendliness is existence of station shelter. Unprotected bike stations discourage bicycle use during or after bad weather conditions, and create seasonal system pauses. As a result, existence of station shelter is an essential part

of system design and operation. Noticeability for bike stations is also a crucial issue in terms of system design. If bike stations are not noticeable enough for cyclists, its use as a mode of urban transport will be meaningless due to time consuming nature of returning the bicycle to station. Related to this issue, the significance of mobile applications for bike-sharing systems becomes prominent to determine exact location of bike station as well as real time bicycle availability of the system. In conclusion, more indicators can also be analyzed for user friendliness of bike-sharing; however, these main determinants are concluded as a result of literature review and successful practices from the world, and policy makers in Turkey should be expected to fulfill these operational and design requirements. Figure 62 highlights the five selected components of user friendliness of bike-sharing in Turkey.

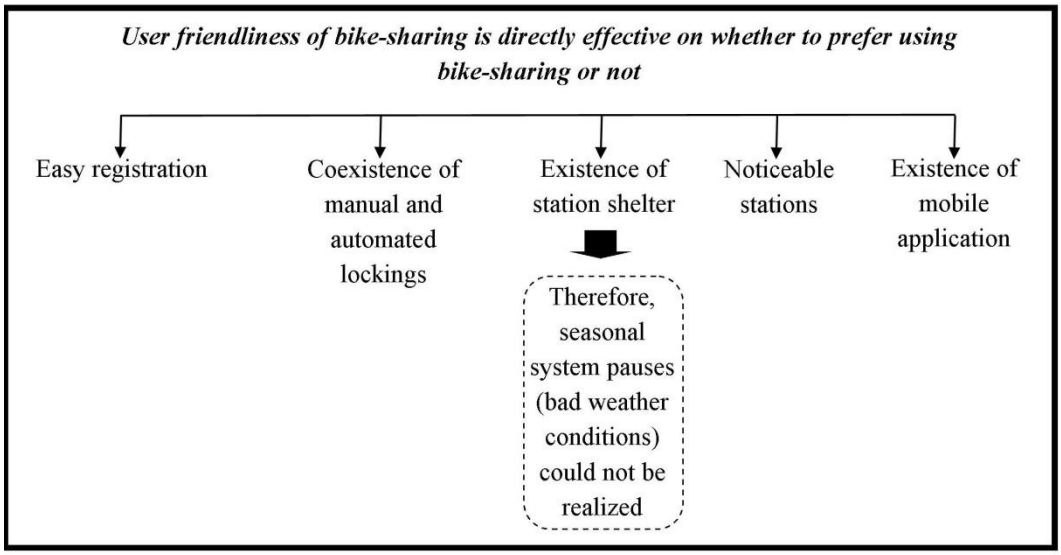

Figure 62. User Friendliness of Bike-sharing as a Criterion for the Cases in Turkey

- *Advanced technology use for the operation of bike-sharing is crucial*

The necessity of the use of technology can be considered from the perspectives of both user and policy maker. For user the advantages are the use of mobile application for exact locations of bike stations and availability of bicycles at any stations, existence of electric bicycles -as a component of 4th generation of bike-sharing-, automated locking mechanisms, smartcard integration with other public

transport modes to make bicycle travel free or discounted. Furthermore, there are advantages for policy makers: GPS positioning on bicycles to prevent bicycle thefts, solar powered stations to minimize energy cost necessary for the maintenance of stations, advanced software enabling control of system from one control center, and data collection for future planning phases. As a result, policy makers in Turkey, who intend to initiate bike-sharing, should consider advanced technology for the operational efficiency of the system. Figure 63 shows the significance of the use of advanced technology for both users and policy makers.

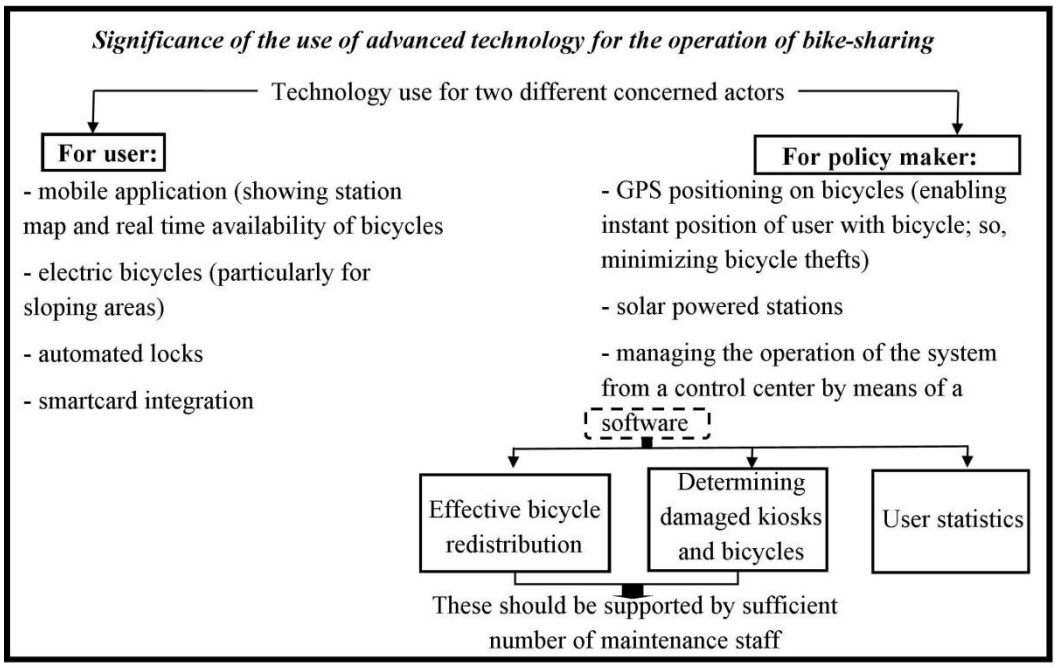

Figure 63. Advanced Technology Use for Bike-sharing as a Necessity for the cases in Turkey

- *Encouraging policies and effective announcement of bike-sharing systems are crucial for the sustainability*

Encouraging policies for bike-sharing can be classified into three main groups. The first one is effective pricing policy, meaning that the user should not pay too much -or cost free for at least first half an hour- for using bike-sharing. Secondly, effective announcement and advertisement of bike-sharing is also important, because citizens should be informed about bike-sharing as much as possible to attract users to the system and increase its usage and share in urban transport trips.

Thirdly, cycling safety is another encouraging policy. In Turkey, bicycle roads have not been effectively used as a supportive tool for bicycle use and bike-sharing by policy makers of local governments. Additionally, helmet wearing has not been a considerable issue enough for cycling particularly for the cyclists using the system as a mode of transport. Although many users consider helmet wearing as uncomfortable, it should be considered as a prerequisite component of bike-sharing and cycling in general. Figure 64 includes the main components of encouraging policies of bike-sharing for policy makers in Turkey.

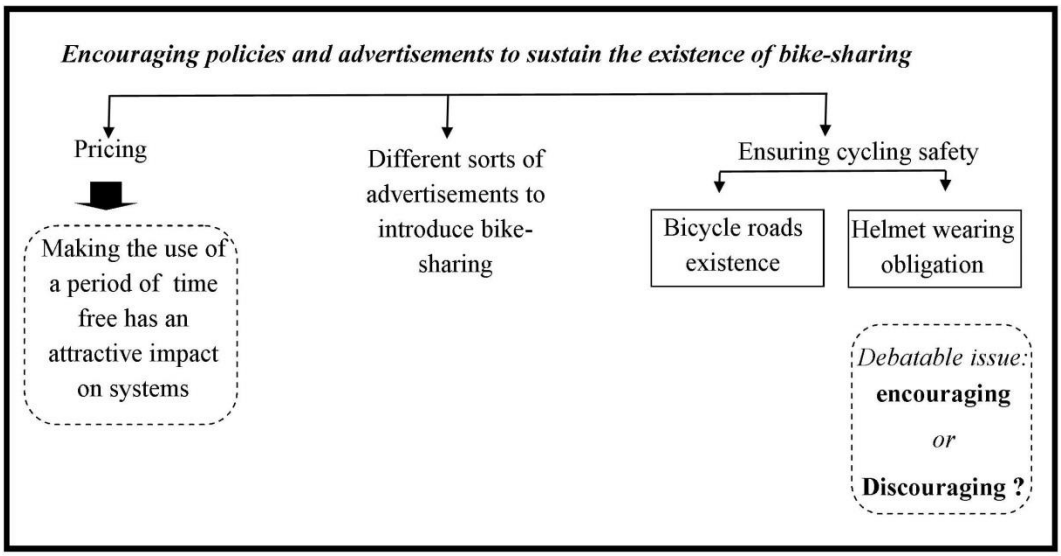

Figure 64. Encouraging Policies for Bike-sharing cases in Turkey as a Necessary Principle

All these principles are concluded from the analysis of bike-sharing in Turkey. In addition, one final conclusion, which should be taken into account by policy makers, is needed to be inferred from the general literature and other researches on bike-sharing. In order to consider bike-sharing in Turkey as an alternative sustainable urban transport mode, which can help reduce car dependency in cities,, it should be a part of a general sustainable transport policy package in which restrictive measures for automobile use exists. Consequently, policy makers should initially formulate an integrated transport plan or strategies focusing on eliminating the negative effects of unsustainable growth trends in urban transport; and then, bike-sharing should be considered as one of the

sustainable modes of urban transport as an innovative outcome of bicycle use as an urban transport mode.

5.4. Further Research

The main focus of this research was on three pioneer examples of bike-sharing in Turkey, namely Konya, Kayseri and İstanbul. In this study, analysis was carried out under five principle sub-themes, which are planning background, system design, operational issues, supportive complementary policies and future plans. These sub-themes were inferred from the literature review and the analysis of good practice cases around the world. Within the research, five in-depth interviews were conducted with policy makers of the systems; and the field research helped to identify strengths and weaknesses of the three Turkish case studies and provided a better understanding of the bike-share planning and operation experience in Turkey.

In order to further develop this research, an extensive user questionnaire survey can be conducted in Konya, Kayseri and İstanbul. The survey may comprise questions on the reasons why users prefer the bike-sharing system, the most frequently preferred bike stations, shortcomings of the system from the users' point of view, and the type of transport mode transfer they make before or after cycling. Therefore, user perspective may also be included and more satisfactory policy inputs can be produced, comprising strategies, such as increasing the service capability of bike-sharing for urban transport, removing insufficiencies within operational processes or the physical components of the systems, changing locations and the bicycle capacity of bike stations according to from the questionnaire results, and developing station integration between public transport and bike stations.

Bike-sharing is implemented in Turkey through the collaboration between local governments and private firms in exchange for the rights to advertise on city street furniture and billboards. In this condition, tendering restrictions prevent local governments to plan system extensions or making changes in the operation for five years. In Kayseri, it is planned to localize the existing 'Kaybis' system by changing every component of it, including station and bicycle number and design,

and operation of the system; because the system has completed its time limitation imposed by tendering conditions between 2009-2014. However, tendering time limitation is valid for Konya and İstanbul, and how they will continue after that period is not clear. The experience of Kayseri in localizing the system must be studied and monitored closely, and an analysis of system performance must be made both to assess the situation before-and-after the new local system and to compare the state of the systems using local technology with those that continue to operate the system with private service provider firm.

The effect of management of the systems through an incorporated company (*Anonim Şirketi)* is also a research area that can be analyzed further. Management of a bike-sharing system means taking care of maintenance or repair of components, bicycle redistribution and anything for system continuity. These services can be carried out by an incorporated company after the construction of system. The system in Kayseri was operated by 'Kayseri Ulaşım A.Ş.', and the one in İstanbul was by 'İSPARK A.Ş.'. The main issue that might be intended to be investigated for Konya, Kayseri and İstanbul bike-sharing cases whether the transfer of these services to a corporation has negative or positive impacts on the systems.

After the selection of Konya, Kayseri and İstanbul bike-sharing implementations as the cases of this research, many new cities, such as İzmir, Samsun and Antalya, have started to operate bike-sharing systems, and numerous others are planning such implementations. This research can be expanded to cover the analysis and experiences of these new systems too so that a better understanding is provided for the strengths and weaknesses of the Turkish cases. By increasing the number of cases, more lessons can be learned from the existing experiences, and sound policy recommendations can be formulated to make bike-sharing systems more successful and effective from the point of users, operators and urban transport systems.

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APPENDICES

APPENDIX A: TURKISH SUMMARY

SÜRDÜRÜLEBİLİR ULAŞIM İÇİN PAYLAŞIMLI BİSİKLET SİSTEMLERİNİN PLANLAMA VE İŞLETMESİ: KONYA, KAYSERİ VE İSTANBUL ÖRNEKLERİ

Kentsel alanda bir yerden başka bir yere hareket etmek kaçınılmaz bir ihtiyaçtır. Bu ihtiyacın hangi alternatif ulaşım modu ile gerçekleştirildiği de oldukça önem kazanmaktadır ve kentsel ulaşımın sürdürülebilirliğine olumlu ya da olumsuz etkileri bulunmaktadır. Örneğin, bir kentsel alanda hareket ederken, mesafeye bağlı olarak bunun bisiklet ya da yürüme ile ya da özel otomobil ile yapılması gelecek için sürdürülebilir bir çevre, sosyal doku ve ekonomik denge sağlanması açısından oldukça önemlidir. Bu noktada kentsel ulaşım için neyi artık sürdüremeyeceğimizi, sürdürülemez ulaşımın ne olduğu ve sürdürülebilir alternatiflerinin neler olabileceğini tartışmak kent planlama disiplinine ve kentsel politika yapım süreçlerine katkı sağlamak açısından belirleyici bir konumda olacaktır.

Bu araştırma, paylaşımlı bisiklet sistemi uygulamalarındaki planlama ve işletme yaklaşımlarını analiz etmektedir. Bu yaklaşımdaki dünya genelindeki deneyimler incelenmiştir ve dünyadaki en iyi uygulamalar, bu sistemlerin bazı başarılı planlama ve uygulama kriterlerini ortaya çıkarmak üzerine bir bakış açısıyla araştırılacaktır. Bu kriterler, Türkiye'deki bu paylaşımlı bisiklet sistemlerini değerlendirmek üzere analizin çerçevesini oluşturmak içindir. Kayseri, Konya ve İstanbul'daki paylaşımlı bisiklet sistemlerinin ilk üç örneği değerlendirilecektir. Temel amaçlar, Türkiye'deki paylaşımlı bisiklet sistemlerinin güncel deneyimlerini daha iyi anlamayı sağlamak, şimdiye kadar uygulanan sistemlerin güçlü ve zayıf yanlarını ortaya çıkarmak ve gelecekteki sistemlerin planlama, uygulama ve işletmesi için politika önerileri sağlamaktır.

Dünyadaki birçok kentte kentsel ulaşım önemli bir problem alanı haline gelmiştir. Artan özel araç sahipliği ve kullanımı trafik sıkışıklığı, enerji bağımlılığı ve hava kirliliği problemlerini ortaya çıkarmıştır ve bunun sonucunda, farklı ulaşım alternatifleri sürdürülebilir kentsel ulaşımı sağlamak üzere gündeme gelmiştir. Son yıllarda dünyanın farklı yerlerindeki kentlerde sürdürülebilir ulaşım alternatifi olarak paylaşımlı bisiklet sistemleri öne çıkmaktadır. Türkiye'de ise son beş yılda öncü örneklerinin görüldüğü ve her geçen gün yaygınlaşan paylaşımlı bisiklet sistemleri bazı kentlerde uygulamaya geçmiştir.

Sürdürülebilir ulaşımı anlatmadan önce, kentsel ulaşımda neyin sürdürülemez olduğunu tartışmak araştırmanın konusu açısından daha anlamlı olacaktır. Günümüzde artık araç bağımlılığını temel alan kentsel ulaşım politikaları ve bireysel ulaşım davranışı sürdürülemez bir durum olarak karşımızdadır. Otomobil kullanımı, çevresel, sosyal ve ekonomik olumsuz etkileri sonucunda sürdürülmemesi gereken ve alternatifleri iyileştirilerek ve özendirilerek kullanımı en aza indirilmesi gereken bir kentsel ulaşım alternatifidir. Çevresel açıdan bakıldığında petrol bağımlılığı, sera gazı emisyonları, kontrolsüz kentsel saçaklanma ve trafik sıkışıklığı önemli problemler olarak karşımıza çıkmaktadır. Sosyal sürdürülebilirlik bakış açısıyla otomobil bağımlılığı konusuna yaklaşıldığında sokak yaşamının ve topluluk bilincinin ortadan kaybolması, sosyal olarak kendi içerisinde kapalı uydu yerleşimlerin ortaya çıkması ve toplum içerisinde araç sahipliğinin belirlediği kimliğin yarattığı olumsuz etki otomobil bağımlılığının getirebileceği olumsuz sosyal etkilerdir. Ekonomik açıdan konu incelendiğinde ise özellikle trafik kazaları ve çevre kirliliğinin getirdiği parasal kayıplar, sürekli yol inşa etme ihtiyacı sebebiyle oldukça fazla ulaşım altyapı maliyeti, saçaklanan kent parçaları için gerek altyapının temin edilmesi için gerekli olan finansal kaynak, verimli tarım arazilerinin yol altyapı yatırımları sonucu kaybedilmesi ve kentsel alanın kaybedilmesi gelecek için ekonomik açıdan sürdürülemez sonuçlar doğurmaktadır.

Ulaşımın sürdürülemez olduğu böyle bir ortamda çözümün nasıl olabileceği tartışılacak olursa, iki temel durum söz konusudur. İlk olarak, otomobil

kullanımının bazı ulaşım politikaları ve düzenlemeler ile kısıtlanması önceliklidir. Sonrasında ise otomobil kullanımına alternatif olarak toplu taşımanın çeşitli modlar ile geliştirilmesi, kentlerin yürümeyi alternatif bir ulaşım türü olarak mümkün kılan şekilde tasarlanması ve bisikletin bir ulaşım modu olarak benimsenmesi oldukça önemlidir.

Öncelikli olarak uygulanması gereken kentsel ulaşım politikası otomobil kullanımını kısıtlayacak nitelikte olmalıdır. Araç sahibi olmak için ödenen vergilerin arttırılması, yakıt vergilerinin arttırılması, özellikle kent merkezlerinde araç park etmenin güçleştirilerek kent merkezlerinin araçsız kullanımının arttırılması ve trafik yavaşlatıcı önlemler ile araç kullanımının güçleştirilmesi sürdürülebilir ulaşım için öncelikli olarak hayata geçirilmelidir. Bunun yanında sürdürülemez ulaşımın olumsuz etkilerini gidermek için uygulanması gereken bir diğer önemli politika otomobilin alternatiflerinin geliştirilmesi ve kullanımlarını kolaylaştırıcı önlemler ve yatırımların yapılmasıdır. Alternatif ulaşım modları arasında en belirgin olanı, otobüs, metro, tramvay, metrobüs gibi çeşitli toplu taşıma alternatiflerinin geliştirilerek özel araç kullanımının azaltılmasıdır. Bu alternatif ulaşım biçimlerinin çeşitlenmesi, sıklığının fazla olması ve kalitesinin yüksek olması etkin şekilde sürdürülebilir ulaşıma hizmet etmesini sağlayacak kriterlerdir. Bunun yanında kentlerde -özellikle kent merkezlerinin- yürümenin farklı kentsel kullanımlara erişmek için etkin bir alternatif olarak kullanılmasını sağlayacak planlama kararları ortaya koymak önemli bir diğer konudur. Son olarak ve araştırmanın odağını oluşturan alternatif ulaşım modu bisikletin bir tür kentsel ulaşım aracı olarak kullanılmasıdır. Dünyada pek çok farklı ülkede bisiklet alternatif bir ulaşım çeşidi olarak kullanılmaktadır. Bisikletin bilinen anlamda rekreasyonel bir spor aracı olmasının yanında, kentsel ulaşım davranışı olarak benimsendiğinde kentlerde oluşacak bisiklet kültürü, ulaşımın gelecek için sürdürülebilirliğine önemli derecede katkı yapabilecek bir unsurdur. Bunu geliştirmek için dünyada pek çok kent bisiklet yolları, bisiklet park alanları ve paylaşımlı bisiklet sistemleri gibi farklı altyapı yatırımları yaparak bisiklet kullanımını kolaylaştırıcı ve özendirici politikalar ve stratejiler geliştirmektedir. Özellikle bazı Avrupa ülkelerinde, hiçbir kirlilik yaratmayan ve kaynakları ve yol

kapasitesini asgari seviyede kullanan bisiklet kullanımı kentsel ulaşım için sürdürülebilir bir alternatif olarak ortaya çıkmıştır ve bunun yanında, son zamanlarda paylaşımlı bisiklet sistemleri bu sürece olumlu katkı yapmıştır. Kentsel alanda insanları bir istasyondan bisiklet alıp sonrasında insanlar için uygun olan herhangi başka bir istasyona bırakmasına cesaretlendiren, belli sayıda bisiklet istasyonunu sunan paylaşımlı bisiklet sistemleri bunun ötesinde bisikletin kentsel ulaşım aracı olarak kullanılmasını sağlar. Temel olarak bu sistemler, kentte farklı noktalarda ihtiyaç odaklı olarak serbest rota seçimiyle bir yerden bir yere günlük kent içi ulaşımın sağlanması amacıyla kullanılmaktadır. Paylaşımlı bisiklet sistemleri sürdürülebilir ve çevreci bir kentsel ulaşım biçimidir. Aynı zamanda bu sistemler toplu taşımanın da istasyon entegrasyonu ile önemli bir parçası olabilmektedir. Paylaşımlı bisiklet sistemi, kentsel ulaşımda nispeten yeni bir yaklaşım olmasına rağmen, günümüzde Avrupa'da, Asya'da, ve Kuzey ve Güney Amerika'da çok sayıda örneği bulunmaktadır. Türkiye'de de son zamanlarda birçok kent bu sistemi başlatmayı planlarken, Konya, Kayseri ve İstanbul gibi bazı kentlerde bu sistem başlamıştır.

Paylaşımlı bisiklet sistemlerinin literatürde de sıklıkla son yıllarda tartışılmış birçok faydası ve kentsel ulaşımın sürdürülebilirliğine katkısı bulunmaktadır. Bunlar genel olarak bisiklet kullanımını arttırmak, toplu taşıma kullanımını istasyon bütünleşmelerini arttırarak geliştirmek, sera gazı etkisini azaltmak, insan sağlığını korumaya yardımcı olmak, otomobil kullanımını azaltmak, günlük ulaşım için bisiklet kullanımını bir davranış biçimi ve ulaşım alternatifi olarak bisiklet kültürü şeklinde yerleştirmek, kentsel mekan kullanımını ve kentsel saçaklanmayı azaltmak şeklinde özetlenebilir.

Araştırma kapsamında önemli bir diğer kısım da dünyadaki başarılı olmuş ve gelişen paylaşımlı bisiklet sistemlerinin incelenmesidir. İlk olarak Paris kentindeki 'Velib' örneği incelenmiştir. Sistem 2007 yılında işletilmeye başlanmıştır ve Paris kenti için hazırlanan 'Espaces Civilises' (yeşillenme ve yaşanabilirlik) isimli 2001 yılında hazırlanan projesinin en önemli parçalarından biridir. Avrupa'daki 1800 istasyon ve 20,000 bisikletiyle en fazla istasyona ve

bisiklete sahip olan, servis alanı en geniş olan (tüm Paris kenti), kayıtlı kullanıcısı en fazla olan e günlük kullanım hacmi en fazla olan sistemdir. Sistemde toplam 160 çalışan, 130 motosiklet ve 20 servis aracı bulunmaktadır. Sistemin kuruluş amaçları temel olarak kent merkezindeki araç kullanımını azaltmak ve insanlara daha çevre dostu olan bu sistemi bir tür ulaşım alternatifi olarak benimsetmek olarak ortaya konmuştur. Sistem istasyon yer seçiminde dikkat edilen en önemli kriter ortalama her 300 metreye bir istasyon yerleştirmek olmuştur. Sistemde toplu taşıma ile istasyon bütünleşmesi azami düzeye getirilmeye çalışılmıştır. Sonuç olarak 'Velib' sistemi kentte bisiklet kullanımını %70 oranında artırırken, araç kullanımında da %5 oranında bir azalmaya yol açmıştır. Araştırma kapsamında incelenen 2. başarılı paylaşımlı bisiklet sistemleri örneği de Kanada'da Montreal kentindeki 'BIXI' sistemidir. Sistem kelime anlamı olarak bisiklet-taksi birleşiminden türemiştir. Paylaşımlı bisiklet sistemi 2009 yılında kurulmuş olup, kuruluş amacı ise otomobilin sebep olduğu zararlı etkileri en aza indirmek ve çevreye olumsuz etkilerinden kurtulmak olarak ortaya konmuştur. Sistem dahilinde 411 istasyon ve 5120 bisiklet bulunmaktadır. 'BIXI' sistemi Kuzey Amerika'daki en büyük ve dünyadaki de en kapsamlı sitemlerden biridir. Montreal kentinde kentsel ulaşım talebinin yönlendirilmesinde paylaşımlı bisiklet sistemi durakları ile toplu taşıma hattı duraklarının konum olarak bütünleşmesi oldukça önemsenerek istasyon yer seçimi tasarlanmıştır. İstasyon yer seçimindeki temel kriter ise bisikletleri ortalama 250-300 metrede bir istasyon olacak şekilde 15 kilometrekarelik bir yarıçapta Montreal ketine konumlandırmaktır. Sistemde dikkat edilmiş olan bir diğer önemli nokta ise bisiklet istasyonları ile toplu taşıma istasyonlarının konumsal olarak bütünleşerek ulaşımın sürdürülebilirliğine katkı yapmasıdır. Araştırma kapsamında incelenen son örnek is Çin'in Hangzhou kentinde kurulmuş olan ve başarıyla işletilen 'Public Bicycle' sistemidir. Sistem 2011 yılında işlemeye başlamış, 60600 bisiklet ve 2416 bisiklet istasyonu ile dünyadaki en büyük sistemdir. Hangzhou kentinde bisiklet kullanımı diğer ulaşım alternatifleri de göz önüne alındığında %43 olarak belirlenmiştir ve paylaşımlı bisiklet sistemleri de bu orana oldukça yüksek oranda katkı yapmaktadır. Sistemin başlangıcı yerel yönetim tarafından desteklenmiş ve işletmesi de bir kamu kurumu

şirketine bırakılmıştır. Sistemin temel kuruluş amacı, paylaşımlı bisiklet sistemleri ile toplu taşımanın mümkün olabilen en üst seviyede bütünleşebilmesidir.

Literatür taraması ve seçilmiş yabancı ülkelerdeki paylaşımlı bisiklet sistemleri örnekleri incelendikten sonra çalışmanın amacı ve temel araştırma soruları belirlenmiştir. Öncelikle çalışmanın amacı Türkiye'deki paylaşımlı bisiklet sistemleri deneyimlerini özellikle üç öncü kent odaklı olarak analiz etmek ve bu konuda daha iyi bir kavrayış sağlamak olarak belirlenmiştir. Araştırma soruları da şu şekilde oluşturulmuştur:

- Konya, Kayseri ve İstanbul'daki paylaşımlı bisiklet sistemlerinin, literatür taraması ve dünya örnekleri analizinden gelen bilgiler ışığında güçlü yanları, zayıf yanları ve gelişim gösterilebilecek alanları nelerdir?
  - Sistemlerin planlama arka planı nasıl şekillenmiştir?
  - Sistem tasarımı açısından bakıldığında, sistemlerin genel elemanlarının durumu nasıldır?
  - Sistemlerin işletme konuları nasıl şekillenmiştir?
  - Paylaşımlı bisiklet sistemleri için destekleyici-tamamlayıcı politikalar var mıdır?
  - Sistemlerin gelecekteki gelişimi için bazı niyetler var mıdır?
- Sistemlerin politika yapıcıları kendilerini nasıl değerlendiriyorlar: başarılı, eksiklikleri olan ya da gelişme aşamasında olan?
- Türkiye'deki gelecekteki uygulamalar için politika girdisi olarak belirlenebilecek olmazsa olmaz kriterler nelerdir?

Araştırmanın sonraki kısmında öncelikle Türkiye'den seçilen öncü kentler olan Konya, Kayseri ve İstanbul özelinde genel olarak bisiklet kullanımı incelenmiştir. Türkiye'de genel olarak bisiklet kullanımı çoğunlukla bir serbest zaman eğlence aracı olarak görülmüş ve bisiklet altyapı yatırımları da bu amaca hizmet edecek şekilde tasarlanmıştır. Diğer bir deyişle, bisiklet kullanımının bir tür ulaşım aracı olarak görülmesi son birkaç yıla kadar politika yapıcılar ve kullanıcılar tarafından göz ardı edilmiş bir durum olarak karşımızda durmaktadır. Ancak son yıllarda İzmit, Konya, Kayseri, Gaziantep, Adana, Eskişehir gibi bazı kentler bisiklet

yolları inşa ederken bisiklet kültürü oluşturma çabasında olan kentlerdir. Konya, Kayseri ve İstanbul kentleri açısından konu incelendiğinde, Konya kenti Türkiye'de bisiklet yolları altyapısı ve oluşturulmuş bisiklet kültürü açısından en gelişmiş kenttir. Kentte özellikle 2001 yılında yapılan ve bisiklet kullanımına yönelik altyapı yatırımlarını da içeren Ulaşım Planı sonrası önemli atılımlar yapılmış ve günümüze gelindiğinde en yaygın bisiklet kullanımına sahip kent haline gelmiştir. Ancak Konya'da bisikletin bir kentsel ulaşım aracı olarak kullanılmasındaki en önemli sorun, kent merkezinde bisiklet kullanıcılarının güvenliğini sağlayıcı ve bisikletli seyahatlerini kolaylaştırıcı henüz herhangi bir bisiklet yolu altyapısı yatırımı yapılmamıştır. Kayseri kenti bu açıdan incelendiğinde, Türkiye'de bisiklet kültürü oldukça yaygın bir diğer kent olduğu görülür. Kentte birçok insan günlük ulaşım ihtiyaçlarını kendi özel bisikletleri ya da paylaşımlı bisiklet sistemleri dahilindeki kamusal bisiklet aracılığı ile sağlamaktadır. Ancak bu noktada dikkat çeken durum, kentte son birkaç yıla kadar herhangi bir bisiklet yolu altyapısının bulunmuyor olmasıdır. 2009 yılından itibaren ise paylaşımlı bisiklet sistemlerinin kurulması ile birlikte, taşıt yolu ile bütünleşik kent merkezinde bazı paylaşımlı bisiklet şeritleri oluşturulmuştur. Ancak bisiklet yolu altyapısının henüz yetersiz oluşu, bisikletin kentsel ulaşım aracı olarak kullanılması konusunda önemli bir eksiklik ortaya çıkarmaktadır. İstanbul kenti incelendiğinde ise, serbest zaman eğlencesi ve spor aktivitesi olarak bisiklet kullanımı sahil şeritlerinde önemli oranda bulunmaktadır. Ancak İstanbul'daki temel problem, kentin dünya ölçeğinde önemli bir metropol olması ve bisiklet kullanımının bazı doğal-fiziksel özellikler sebebiyle kent içi ulaşıma entegre edilememesidir.

Türkiye deneyimleri paylaşımlı bisiklet sistemleri özelinde incelenecek olursa, 2014 Temmuz ayı itibariyle kurulan ve kurulması planlanan paylaşımlı bisiklet sistemlerinin bulunduğu kentler şunlardır: Konya, Kayseri, İstanbul (Kadıköy-Kartal), İstanbul (Florya-Yeşilköy), İzmir kent merkezi, İzmir-Karşıyaka, Samsun, Muğla, Antalya, Eskişehir, Kocaeli, Giresun ve Yalova. Araştırma kapsamında incelenen kentler ve sistemleri de Konya-Akıllı Bisiklet, Kayseri-Kaybis ve İstanbul-İsbike sistemleridir. Bu sistemlerin öncelikle alan

çalışmasında, yapılan kişisel gözlemler, incelenen yazılı ve görsel dokümanlar ve politika yapıcılar ile yapılan birebir derinlemesine görüşmeler sonucunda bazı temel başlıklar belirlenmiştir ve yapılan çalışma -öncelikli olarak mevcut durum analizi- bu başlıklar odak alınarak şekillendirilmiştir: planlama arka planı, sistem tasarımı, işletme konuları, destekleyici tamamlayıcı politikalar ve son olarak sistemin geleceği konusundaki planlardır.

Yapılan araştırma sonucunda bulgular kısaca özetlenecek olursa, sistemlerin öncelikli olarak bir plan temeline oturup oturmamasının incelenmesi gelmektedir. Burada temel amaç Konya, Kayseri ve İstanbul'daki paylaşımlı bisiklet sistemlerinin herhangi bir imar planına, Ulaşım Ana Planına, üst ölçekli mekansal planlara ya da mekansal strateji planlarına dayanıp dayanmadığını belirlemektir. Sonrasında, bu üç kentteki paylaşımlı bisiklet sistemleri için temel inceleme alanlarından bir diğeri sistemlerin tasarımıdır. Bu çerçevede, istasyonlardaki kilitler, istasyonların farkedilebilirliği, istasyon kapalılığı gibi sistemin elemanlarına özgü bazı tespitler yapılmıştır. Daha sonra, işletme konuları ele alınmıştır. Bu kapsamda, sistemin tüm yıl boyunca açık olması ya da olmaması, sistem için mobil telefon uygulamasının varlığı, akıllı toplu taşıma kartları ile paylaşımlı bisiklet sistemlerinin toplu taşımaya entegre edilmesi, sisteme kayıt olma kolaylığı ya da zorluğu, sistemlerin devamlılığı için bakım mekanizmalarının oluşturulması, fiyatlama, kask takma zorunluluğu olması ya da olmaması durumları incelenmiştir. Dördüncü olarak destekleyici tamamlayıcı politikalar üç kent için incelenmiştir. Bu kapsamda incelenen konular şunlardır: paylaşımlı bisiklet sistemlerinin kullanımını cesaretlendirici politikalar, sistemlerin sürdürülebilir ulaşıma hizmet eden bir ulaşım alternatifi olarak tasarlanıp tasarlanmadığı, sistemin tanıtımı ve duyurusunun etkin şekilde yapılmasıdır. Son olarak, sistemlerin geleceği, kullanıcılar tarafından iletilen istasyon eklenmesi ya da yeni sistem kurulması talepleri ve sistemlerin 4. Jenerasyon paylaşımlı bisiklet sistemlerinin hangi özelliklerini içerdiği çerçevesinde ortaya konmuştur.

Araştırmanın temel bulguları ve çıkarımları kısmında öncelikle bu üç kentteki gözlemlenen belirgin güçlü ve zayıf yanlar belirlenmiştir. Konya için belirlenen güçlü yanlar temel olarak, kentteki mevcut bisiklet altyapısı ve bisiklet kültürüdür. Zayıf yan olarak ise, paylaşımlı bisiklet sistemleri içeriğindeki toplam bisiklet sayısının ve kalitesinin yetersiz olması gelmektedir. Kayseri için güçlü yanlar olarak belirlenebilecek konulardan birincisi, kentteki Kaybis paylaşımlı bisiklet sisteminin bir tür kentsel ulaşım aracı olarak hizmet etmesinin amaçlanması; bir diğeri, yerel teknoloji ve üretim sistemleri kullanılarak sistemin 2014 yıllı içerisinde tamamen yerelleştirilmesinin düşünülmesidir. Kentteki zayıf yanlar olarak ortaya konabilecek konular ise kentteki bisiklet yollarının hem paylaşımlı olması hem de kapsadığı alan olarak yetersizliği ve paylaşımlı bisiklet sistemine kayıt olma konusundaki güçlüklerdir. İstanbul kentindeki paylaşımlı bisiklet sistemi ele alındığında, bisikletlerin ve istasyonların kalitesi güçlü yan olarak karşımıza çıkmaktadır. Zayıf yan olarak ise en belirgin durum, paylaşımlı bisiklet sistemlerinin yalnızca rekreasyonel gezinti ve spor amacına hizmet etmesi ve toplu taşıma ile bütünleşememesi gelmektedir. Buradan Türkiye ölçeğinde paylaşımlı bisiklet sistemleri konusunda güçlü ve zayıf yanlar olarak genellemeler yapılmıştır. Buna göre Türkiye'deki paylaşımlı bisiklet sistemlerinin genel zayıf yanları sistemin alternatif bir ulaşım aracı olarak görülmemesi, toplu taşıma ile bütünleşmede eksiklik, sistem kurulmadan önce bir plan ya da strateji dahilinde düşünülmesi, sistemin kentsel ulaşım planı ya da imar planlarıyla bütünleşememesi, bisiklet yolu altyapısından yeterli katkı alınamaması, bisikletlerin ve istasyonların bakım, onarım ve işletmesi için görevli personelin yetersizliği, sistemlerin reklamının ve duyurusunun yeterince yapılamıyor olması, paylaşımlı bisiklet sistemlerindeki bisikletleri kullanırken kask takma zorunluluğunun olmaması olarak ortaya konabilmektedir. Türkiye ölçeğinde belirlenebilecek güçlü yanlar ise kentte yaşayan vatandaşlardan ve politika yapıcılardan sistem inşası ya da sistemin genişletilmesi konusunda talebin oldukça üst seviyelerde olması olarak karşımızda durmaktadır.

Bu üç kentte politika yapıcıların kendi sistemlerini ve kendi performanslarını nasıl gördükleri sorusu oldukça önemlidir. Üç kentte de politika yapıcılar genel olarak

kendilerini başarılı görmektedirler. Ancak Kayseri ve İstanbul'daki sistemlerin politika yapıcıları kendi sistemlerinin gelişmeye açık olduğunu ve bu konuda çalışmalar yaptıklarını ayrıca belirtmektedirler.

Tüm bunların yanında, yapılan araştırma sonucunda yapılabilecek bazı tartışma konuları bulunmaktadır. Öncelikli olarak Türkiye için düşünüldüğünde, uygulanması düşünülen kentlerin farklı ölçeklerde olması nasıl bir tasarım ve istasyon yer seçim politikası izleneceği konusunu farklılaştırmaktadır. Konya, Kayseri, Eskişehir gibi orta ölçekli kentlerde paylaşımlı bisiklet sistemleri bisiklet istasyonları kentin tümüne yayılarak bağımsız bir toplu taşıma sistemi olarak hizmet verebiliyorken; İstanbul, Ankara, İzmir gibi metropol kentlerde paylaşımlı bisiklet sistemleri bir tür kentsel ulaşım aracı olarak kullanıldığında istasyonların tüm kente yayılması söz konusu olamamaktadır. Üstelik buna elverecek topografik kolaylıklar da çoğu zaman bulunmamaktadır. Bu durumda, Türkiye'de metropol ölçekli kentlerde uygulanması gereken politika, paylaşımlı bisiklet sistemlerinin kümeler halinde ana toplu taşıma istasyonlarına entegre edilerek bütüncül bir toplu taşıma sisteminin bir parçası olarak hizmet vermesinin sağlanmasıdır. Türkiye'de paylaşımlı bisiklet sistemleri konusunda tartışmaya değer bir diğer konu kask kullanma zorunluluğunun olması ve etkileri konusudur. Kask kullanımı bisiklet sürüş güvenliğini sağlarken bir yanda da paylaşımlı bisiklet sistemleri kullanıcıları rahatsızlık duydukları sebebiyle kask kullanmayı neredeyse tamamen göz ardı etmektedirler. Bu da paylaşımlı bisiklet sistemlerinin güvenliği konusunda açıklara sebep olmaktadır.

Araştırmanın sonucunda cevaplanması gereken en önemli sorulardan biri, paylaşımlı bisiklet sistemlerinin araç kullanımını azaltarak etkin bir kentsel ulaşım aracı olarak kullanılması Türkiye'de mümkün olup olmadığıdır. Türkiye'de yerel ve bölgesel ölçekte ulaşım politikaları ve yatırımları yol yapımı, kavşak düzenlemeleri ve yol genişletme çalışmaları şeklinde olup araç kullanımını özendirici niteliktedir. Böyle bir ortamda, yalnızca bisiklet kullanımını özendirici uygulamalar hayata geçirip çeşitli politikalar üreterek araç bağımlılığını azaltmak oldukça güçtür. Öncelikli olarak yapılması gereken, araç kullanımını kısıtlayıcı

bazı düzenlemeler yapılıp sonrasında paylaşımlı bisiklet sistemlerinin oluşan bisiklet kültürü ile araç bağımlılığını azaltması beklenmelidir. Bu durumda paylaşımlı bisiklet sistemleri temel olarak sürdürülebilir kentsel ulaşım politika paketinin bir ürünü olarak kent mekanına yansıdığında sürdürülebilir ulaşıma hizmet etmesi ve bir tür kentsel ulaşım aracı olarak kullanılması beklenebilir. Bunun yanında paylaşımlı bisiklet sistemlerinin üst ölçekli bir plan ya da politika bütünlüğü dahilinde ortaya çıkması yerel yönetimlerdeki politika yapıcıların da uyumlu hareket etmesi ile birebir ilişkilidir. Örneğin, İzmir kentinde hem büyükşehir belediyesi hem de Karşıyaka ilçe belediyesi kendi sınırları dahilinde birbirlerinden tamamen bağımsız iki ayrı paylaşımlı bisiklet sistemi kurmuşlardır. Bu iki sistem, sürdürülebilir ulaşımın bir parçası olarak bütünleşik şekilde çalışması gerekirken, bu tip bir durum söz konusu olamamıştır. Diğer bir deyişle, yerel yönetimlerin paylaşımlı bisiklet sistemleri kurulumunda rekabetçi değil işbirlikçi bir ortamda politika ve tasarım ilkeleri üretmeleri gerekmektedir. Sonuç olarak paylaşımlı bisiklet sistemlerinin üst ölçek program dahilinde ortaya konması, araç bağımlılığını azaltıcı etki yapması ve sürdürülebilir ulaşıma katkı yapması açısından oldukça önemlidir.

Sonuç olarak, araştırma sonunda Türkiye'de paylaşımlı bisiklet sistemlerini uygulamaya geçirmek isteyen politika yapıcılara planlama, tasarım ve işletme önerileri getirilmiştir. İl olarak şu söylenebilir ki, paylaşımlı bisiklet sistemleri bir kentsel ulaşım aracı olarak hizmet etmelidir. İkincil olarak, paylaşımlı bisiklet sistemleri toplu taşımanın iyi entegre olmuş bir elemanı olarak planlanmalı ve tasarlanmalıdır. Üçüncü olarak, paylaşımlı bisiklet sistemleri kent planlamaya ve kentsel ulaşım planlarına entegre edilmelidir. Dördüncü olarak, iyi tasarlanmış ve güvenli bisiklet yollarının kentte bulunması paylaşımlı bisiklet sistemlerinin etkinliğine ve başarısına doğrudan katkı yapan bir unsurdur. Bir diğer politika önerisi şu şekildedir: paylaşımlı bisiklet sistemlerinin kullanıcı dostu olması ve kullanımlarının kolay olması sistemlerin tercih edilmesi ya da edilmemesi konusunda önemli bir belirleyici konumundadır. Altıncı olarak, paylaşımlı bisiklet sistemlerinde ileri teknoloji kullanımı, politika yapıcılar ve kullanıcılar açısından oldukça önemli konumdadır. Son olarak, paylaşımlı bisiklet sistemlerini

cesaretlendirici politikaların kurgulanması ve etkin şekilde sistemin duyurulması sistemin başarısı ve etkinliği için önemli belirleyici bir konumdadır. Tüm bu politika önerilerinin yanında önemli olan konu, paylaşımlı bisiklet sistemleri etkin bir kentsel ulaşım aracı olup araç bağımlılığını azaltması bekleniyorsa, öncelikli olarak otomobil kullanımını kısıtlayıcı düzenlemelerin yapılması gerekmektedir.

APPENDIX B: TEZ FOTOKOPİSİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü ☐

Sosyal Bilimler Enstitüsü ☐

Uygulamalı Matematik Enstitüsü ☐

Enformatik Enstitüsü ☐

Deniz Bilimleri Enstitüsü ☐

YAZARIN

Soyadı : Erçetin

Adı : Cihan

Bölümü : Kentsel Politika Planlaması ve Yerel Yönetimler

TEZİN ADI: Planning and Management of Bike Sharing Systems for Sustainable Urban Transport: Konya, Kayseri And Istanbul Cases

TEZİN TÜRÜ : Yüksek Lisans ☐ Doktora ☐

1. Tezimin tamamından kaynak gösterilmek şartıyla fotokopi alınabilir. ☐
2. Tezimin içindekiler sayfası, özet, indeks sayfalarından ve/veya bir bölümünden kaynak gösterilmek şartıyla fotokopi alınabilir. ☐
3. Tezimden bir bir (1) yıl süreyle fotokopi alınamaz. ☐

TEZİN KÜTÜPHANEYE TESLİM TARİHİ: