AN ANALYSIS OF RAIL TRANSIT INVESTMENTS IN TURKEY:

ARE THE EXPECTATIONS MET?

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Özge ÖZGÜR

ABSTRACT

AN ANALYSIS OF RAIL TRANSIT INVESTMENTS IN TURKEY:

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Rail transit investments require highest amount of investment costs of all modes and considering the high cost involved, it is particularly important that their performance justifies this high cost and that expectations from these investments are met. Therefore, in the world, it has become an important field of research to study the performances of rail systems in order to assess whether these expectations are met.

In Turkey, there is a growing interest in constructing rail transit systems in the cities. However, there has been limited number of studies on the performance of these investments. There are researches on individual systems; yet, there has not been a comprehensive, systematic and comparative evaluation of the rail transit experience of Turkish cities. It is not clear with what expectations these systems are built or whether these expectations are met. There seems to be an urgent need to study these rail investments, with a particular focus on their planning, investment objectives and outcomes.

This thesis analyzes the expectations from the rail transit systems in Turkey and answers the question whether these expectations are met. In order to understand the objectives under the planning and decision making processes in the implementation of Turkish rapid rail transport investments, a sample group was selected among the cities currently operating rail transit systems: İstanbul, Ankara, İzmir and Bursa. The study sets the objectives in planning and implementing rail transit systems drawn by the answers in the semi-structured interviews. It compares the expectations with the actual outcomes. As the primary indicators of performance, cost and ridership forecast and outcome data are also collected and considered in the comparison.

It is found that the main success in all case study cities was the increase in public transport usage after the opening of the rail transit systems. On the other hand, systems performed rather poor in terms of other expectations, such as attaining ridership forecasts, being built within budget, creating an integrated public transport system, traffic reduction, air pollution reduction, improvement of city image, etc. Hence there is a gap between expectations and outcomes.

Keywords: Rail transit systems in Turkey, Expectations, Ridership forecast, Cost forecast, Performance analysis

*Second part of this title is inspired by Mackett R L, Edwards M (1998) The impact of new urban public transport systems: will the expectations be met? Transportation Research A, volume 32, 231-245.

ÖZ

TÜRKİYE'DEKİ RAYLI SİSTEM YATIRIMLARININ ANALİZİ:

BEKLENTİLER KARŞILANDI MI?

Özgür, Özge

Yüksek Lisans, Şehir ve Bölge Planlama Bölümü, Kentsel Tasarım

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Raylı sistem yatırımları, bütün ulaşım modları içerisinde en yüksek yatırım maliyetine sahip olan yatırımlardır. Performanslarının beklentileri karşılıyor olması bu bakımdan çok önemlidir. Bu nedenle dünyada, raylı sistem yatırımlarının performanslarının incelenmesi önemli bir araştırma sahası haline gelmiştir.

Günümüzde, Türkiye'de yapılan raylı sistem yatırımı sayısı gittikçe artmaktadır. Bu yatırımların performanslarını değerlendiren çalışmalar ise bir o kadar kısıtlıdır. Türkiye'deki raylı sistem deneyimini inceleyen çalışmalar tek tek sistemler için yapılmakta olup, tüm sistemleri birbiriyle karşılaştırarak kapsamlı ve sistematik biçimde raylı sistem deneyimini bütün olarak inceleyen çalışmalar bulunmamaktadır. Bu yatırımların hangi beklentiler içerisinde planlandıkları ya da işletilmeye başlandıktan sonra beklentileri karşılayıp karşılamadıkları bilinmemektedir.Bu sebeple, raylı sistem yatırımlarının planlama aşamalarını, yatırım amaçlarını ve ortaya çıkan sonuçları araştıracak çalışmalara ivedilikle ihtiyaç vardır.

Bu çalışma, Türkiye'deki raylı sistem yatırımlarından beklenenleri ortaya koyarak bu beklentilerin karşılanıp karşılanmadığını araştırmaktadır. Bu beklentileri ortaya çıkarmak üzere İstanbul, Ankara, İzmir ve Bursa kentlerinde hali hazırda işletilen raylı sistem yatırımları incelenmiştir. Yapılan yarı yapılandırılmış görüşmelerle bu sistemler planlanırken ve uygulanırken öne sürülen hedefler belirlenmiş; bu hedefler, ortaya çıkan sonuçlarla karşılaştırılmıştır. Raylı sistem yatırımlarının temel performans göstergeleri olarak maliyet ve yolcu sayıları tahminleri ile gerçekleşen durum verileri de toplanmış, karşılaştırmalı bir analiz yapılmıştır.

Sonuç olarak, tüm sistemlerin ortak başarısının toplu taşın sistemindeki yolcu sayılarının artışına yaptıkları katkı olduğu gözlenmiştir. Bunun yanı sıra; yolcu sayısı tahminleri, maliyet tahminleri, entegre edilmiş toplu taşın sistemi, trafik sıkışıklığını azaltma, kente imaj kazandırma vb. konularındaki beklentileri karşılayamadıkları görülmüştür. Beklentiler ve ortaya çıkan sonuçlar arasında fark olduğu tespit edilmiştir.

Anahtar kelimeler: Türkiye'deki raylı sistem yatırımları, Yolcu tahminleri, Maliyet tahminleri, Performans analizi

To My Grandfathers

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CHAPTER 1

INTRODUCTION

Investments in rail transit systems are increasing throughout the world. In Turkey too, there has been many new urban rail transit projects. Seven cities in Turkey opened new rail transit systems since the 1990s, while various others are planning to build new systems.

Transport investments have long lasting effects on economical, social and physical life of cities, and this is particularly true for rail transit investments, which have fixed infrastructure resulting in a permanent change in urban areas. This fixed infrastructure also makes rail transit projects extremely expensive investments. Rapid rail transit systems require the highest amount of investment costs of all modes; and while light rail transit and street trams require lower costs they are still significantly more expensive than road-based transit systems. Considering the high cost involved in the development of these systems, it is particularly important that their performance justifies this high cost and that expectations from these investments are met. Therefore, in the world, it has become an increasingly important field of research to study the performance of these rail systems in order to assess whether expectations from these investments, such as high ridership, reduced traffic, improved air quality, and cost-efficiency in operation, are met. There has been a particular focus in the world literature on the accuracy of ridership and cost estimations for rail transit systems, and studies found that in many cases ridership was over-estimated while costs were under-estimated. In addition, studies looked at other expectations from these investments, and found that not all have been successful in helping increase ridership, reduce traffic congestion and air pollution.

In Turkey, such studies on the performance of rail transit investments in the country are extremely limited. There are researches on individual systems; however, there has not been a comprahansive and systematic evaluation of the rail transit experience of Turkish cities.

We do not know with what expectations these systems are built, and whether these expectations are met. Similarly it is not clear whether the estimations made during the planning of these systems turned out to be accurate. There seems to be an urgent need to study these rail investments, with a particular focus on their planning, investment objectives and outcomes.

This study aims to analyze planning and decision making for, and the performance of, rail transit systems in Turkey. Two main tasks are defined: first, providing a better understanding of the expectations planners have when developing these systems; and secondly assessing whether these expectations are met. It should be noted, however, that it is not possible to assess for each expectation, whether or not it is achieved since some expectations, such as land-use change and traffic reduction, require comprehensive researches to be conducted for each case. This study also did not cover the expectations of the rail transit users.

Therefore, the study focuses particularly on the ridership and cost estimates, while also providing information on the outcomes of other expectations based on the views of experts, planners, academics, etc, that were interviewed during the study.

Two main research questions are asked:

a. What are the main objectives of the rail transit investments in Turkey? In other words, what are the expectations from these systems?

b. Are these expectations met?

While revealing a set of expectations/objectives for investing in urban rail systems in Turkey, the study will also demonstrate the performance of current urban rail systems by revealing the extent that they meet the expectations.

In the study, rail transit systems in four cities: İstanbul, Ankara, İzmir and Bursa will be analyzed. According to the responses in the interviews, a number of objectives which are central to the decision making process will be identified. Ridership and cost forecasting data and actual outcomes will be collected from the responsible municipalities to assess the performance of the systems. The task may not be as straightforward for other possible expectations, such as land-use change, traffic reduction, etc. If such expectations existed for the case studies, it cannot be within the scope of this study to conduct comprehensive land use analysis and traffic counts for each city; furthermore an accurate analysis would not be possible without a before-and-after study; and not all cities have reliable and regular statistics to construct a “before investment” case. With or without analysis, cost-benefit analysis and multi criteria analysis are also used in evaluating transport investments;

however within the scope of the study these methods are not included. Therefore, **cost** and **ridership** data will be the major analysis in the study, while other impacts, or achievement of expectations, will be assessed by consulting planners, researchers, and academics involved in the planning or monitoring of these systems.

In the next chapter, a brief review of transit systems is given. After introducing the properties of bus transit systems and rail transit systems in general, expectations from new generation rail systems such as **image, land use, traffic reduction, ridership** and **cost,** are discussed briefly. The difference between expectations and outcomes are examined considering the studies made by Pickrell (1992), Kain (1988) and Gomez-Ibanez (1985). The political factors in the decision making process, which appear to significantly affect the performance of the systems, are discussed.

In the third chapter, political issues and expectations from rail transit investments in Turkey are analyzed. Need to assess the experience in Turkey regarding the expectations from, and outcomes of, rail transit investments are emphasized.

In the fourth chapter, the methodology used for assessing and evaluating the case studies is introduced. Research proposal is described and the aim of the study is clarified. Methods of data collection are given.

In the fifth chapter, the focus is on the planning, decision making and development of rail transit investments analyzed in the study. The planning background of each system is presented and the expectations from investing in these systems are illustrated based on the interviews made for the study.

The sixth chapter presents a comparative assessment of the rail systems in Turkey in terms of ridership including the forecasts and outcomes, creation of an integrated public transport system and ridership change on total public transportation, capital cost foracasts and outcomes. Contributions of the systems to city image, land-use development, traffic reduction and air quality improvement are also discussed briefly.

In the conclusion chapter, the research is summarized and its main findings are described. The comparison of estimations and expectations with the actual outcomes reveal important results about the performance of urban rail systems in Turkey, which are discussed in this final part of the study. The findings of the research provide a better understanding of the urban rail planning experience in Turkey and can help the planning of future investments.

CHAPTER 2

RAIL TRANSIT INVESTMENT IN THE WORLD: EXPECTATIONS AND OUTCOMES

2.1. A brief review of transit systems

1.1.1. Rapid Transit Systems

Rapid transit systems are the modes that are characterized by high running speed and less delays when compared to other modes. Rapid transit systems operate on exclusively controlled right-of-ways (Vuchic, 1975). A great majority of these systems use rail technology whereas special arranged buses can be also included under rapid transit systems (Grava, 2002). These two technologies, rail transit and rapid bus transit, are separately described in detail below.

1.1.2. Rail transit systems

Rail transit systems run on steel tracks. The specific characteristics of rail systems, such as external guidance, rail technology, electric propulsion, and right-of-way (R/W) separation, distinguish these modes from the other modes of transportation. By the help of the external vehicle guidance, rail systems require minimum R/W width and they have a better riding quality as compared to the nonguided modes.

This characteristic gives rail systems a strong identity and a great permanence. These factors are highly important in high passenger attraction and impact on urban development.

On the other hand, having these characteristics, rail investment costs get higher than highway modes because they are restricted on their guideway networks only (Vuchic, 1981).During the 19th century, railways were used to serve all the demand for mechanized transport. In the later centuries specialized railway systems were opened. London was the first city in the world to build a high speed rail transit line which was called the Metropolitan Line (today one of the many lines of the London Underground), opened in 1863, which connected two railway terminals.

The transfer of the short trips from rail systems to electric tramways under the municipal ownership were the consequence of the better accessibility offered by the electric tramway than railways whose route was located with the viewpoint of long distance trips. “It was the tramcar which gave the first opportunity to the majority of the population to make frequent use of mechanized transport to travel to work, at low fares.” (White, 1976, p. 72)

In the World War I the minor stations were closed in many cities. From the 1920s to World War II little growth took place. In some cities new systems were constructed such as those in Osaka, Moscow and Barcelona. After the 1960s a “boom” had taken place after the realization that the rail system can offer an attractive alternative to private car and buses on heavily congested roads (White, 1976).

Since World War II rail technology has become intensively modernized in several western European cities and Japan, transforming the old, noisy heavy rail transit systems into the modern, quiet and comfortable systems of today. Besides the technical progress in rail technology, some other factors have influenced the role of rail in the cities. Increasing auto ownership had a strong negative impact on the use of streetcar (SCR) but it resulted in the development of light rail transit (LRT) systems (Vuchic, 1981).

Vuchic (1981) argued that the increasing automobile ownership had a negative impact on the ridership of SCR (streetcar) mode, but this resulted in the development of the LRT (light rail transit) technology, increased the use of heavy rail transit and resulted in an increase in the construction of the commuter rail services. He further adds that “during the 25-year period from 1955 to 1980, the number of world cities with RRT (rapid rail transit) increased from 19 to 55; total length of RRT networks was increased during the period by approximately 80%”. In a more recent study, Babalik (2000) found that between 1970 and 2000, 61 new metros and 78 new light rail transit systems have opened. Developing countries continued on constructing metro systems in the 1980s and 1990s, whereas in Western Europe and North America, a shift towards investing on light rail transit systems occurred.

Vuchic (1981) argued that the increase in private car ownership causes chronic congestion in the cities, and that it is a fact that automobiles cannot satisfy the needs of cities' transportation needs due to physical, social, economic and environmental reasons. The only solution to solve congestion is therefore a system with adequate capacity and quality through an exclusive right-of-way. Although this separation could also be managed by separated bus lanes, Vuchic (1981) claimed that, the most effective solution is the construction of rapid rail systems.

1.1.2.1. Properties of rail transit systems

Vuchic (1981) classified rail transit systems into four modes, according to the main features that define transit modes, i.e. R/W (right-of-way) type, technology and operational/service characteristic: 1.Street cars, 2. Light rail transit, 3. Heavy rail transit and 4. Regional rail. The four rail transit modes are not distinctly separated from each other. The distinctions between SCR (street car) and LRT (light rail transit) systems and between RRT (rail rapid transit) and RGR (regional rail) are particularly complex whereas the sharpest difference is between LRT and RRT.

Grava (2002) defined the **street car** as "a transit service using rail cars singly or in short trains, powered by electricity supplied by overhead wire, operated usually on city streets in mixed traffic, with stations close together." Street cars generally consist of one, two and rarely three rail cars; and they generally operate on streets in mixed traffic. It is also possible to design these systems with limited separation from street traffic by preferential treatment or separate R/W (Vuchic, 1981).

Street car is named differently in different countries in the world. British calls streetcar as "tramway" and another name that refers to this technology is "trolley" (Grava, 2002).

Light rail transit is characterized as a metropolitan electric railway system that can operate single or short cars at ground level in streets, or in the tunnels where possible, on exclusive right-of-ways (Grava, 2002).

The ECMT (European Conference of Ministers of Transport Organization for Economic Co-operation and Development) defined light rail as:

"a rail-borne form of transportation which can be developed in stages from modern tramway to a rapid transit system operating its own right-of-way, underground, at ground level or elevated. Each stage of development can be the final stage, but it should also permit development to the next higher stage" (Hass-Klau et al., 2000, p.22).

Grava (2002) claimed that **heavy rail transit** systems are the most effective modes that can serve large urban agglomerations since they are capable of dealing with a high demand of public transportation. It can carry high volumes of people at the city scale. Heavy rail transit is powered by electricity from a third rail along its tracks, and it runs on exclusive right-of-ways. The heavy rail trains have a self-propelled high acceleration / deceleration characteristics and they carry people in a very fast and efficient way.

As ECMT (European Conference of Ministers of Transport Organization for Economic Co-operation and Development) defined heavy rail transit as:

"transit service using rail cars with movable capability, driven by electric power usually drawn from a third rail, configured for passenger traffic and usually operated on exclusive rights-of-way, service generally utilizes longer trains and station spacing rather than light rail" (Hass-Klau et al., 2000, p.22).

Heavy rail transit has also different names in different parts of the world as streetcar does. In England it is named as "tubes or underground"; in U.S. "subway" is the term used for heavy rail systems; and in Germany it is called "U-Bahn (short for *Untergrund Bahn)*". "Metro", particularly used in European countries, is derived from the original Metropolitan Line of London (1863) (Grava, 2002).

Grava (2002) claimed that the traditional rail mode is still the most effective way to move large volumes of people over many miles at reasonable speed. When these systems operate at the metropolitan scale, they are named as **commuter or regional rail** service. There may be some differences regarding this mode in different parts of the world. A small number of cities enjoy the presence of regional rail. In these cases, usually regional rail connects the outer city with the inner city (CBD) with few parts within the older parts of the city center. Further he defined the regional rail as:

"Rail passenger service operating at the metropolitan level, usually between the center and adjacent suburbs, using either locomotive-hauled or self-propelled railroad cars. Stations are relatively far apart, platforms may be high or low, and the right-of-way will be largely reserved and segregated, but possibly having some protected grade-crossings. Many provide peak period service only" (Grava, 2002, p. 807).

As Vuchic (1981) argued, rail transit system lines serve an understandable type of service with short stops in every hour of the day. With the convenient transfer stations, they comprise an integrated network with high level of service in the line. With the permanence of the transfer stations, the simplicity of the rail lines and the frequent and regular service of the rail transit systems, influence many investments and land-use decisions. In addition, White (1976) stated that, very high performance and level of service of rail transit modes and low unit operating costs are the results of an external guidance characteristic. He argues, however, that although the external guidance results in preferable characteristics, it requires higher investment costs than the other modes require. This, in return, increases the importance of the decision-making phase of new rail transit system projects.

The rail transit system route location in the urban areas is in accordance with the travel demand, the topographic and town planning requirements of the city. This also determines the rail technology that would be used in the corridor (Bursa Inner City and Near Surroundings Transportation Study and Mass Transportation Feasibility Study, 1992).

The cities startingwith a population size of 250,000 people and an overall density of 3,000 people per km^2 are accepted to be appropriate for LRT systems. As Grava (2002) pointed out these numbers are never usually used as the determining factor in deciding projects. These numbers are based on a reasonable understanding of urban situation. Large cities, above one million populations, should emphasize on putting heavy rail systems as their principal transportation mode (Grava, 2002). Vuchic (1981) stated that the “threshold” for all rail modes is getting lower, LRT for 200,000 to 300,000 population, but many cities having 500,000 to 2 million population utilize both LRT and metro systems (Amsterdam, Brussels, Cleveland, San Fransisco etc.)

As seen in Table 2.1, the characteristics of each rail system differ from each other according to different features. A streetcar has a length of 14 to 21 m and has 4 to 6 axles, with a capacity of 100 to 180 total passengers per car. As stated by Carmen Hass-Klau et al (2002), light rail requires least space in terms of the corridor widths. It has an operating speed between 12-20 km/hour because of the predominantly shared right-of-way. Articulated LRT systems range in length from 20 to 32 m and have 6 or 8 axle vehicles or multiple-unit trains which can accommodate 250 persons; 20 to 50% of them are seated. LRT vehicles have an operating speed of 20 to 40 km/hour. These modern LRT vehicles have high acceleration/deceleration capacities (1.0 to 2.0 m/sec^2, emergency braking 3.0 m/sec^2) (Vuchic,1981).

Table 2.1. Characteristics of rail transit systems

	Streetcar (tram)	Light rapid transit	Rail rapid transit (on surface)	Elevated rail rapid transit	Underground rail rapid transit	Regional rail
Vehicle (car) capacity	100-180	100-250	140-280	140-280	140-280	140-210
Vehicles per transit unit	1-3	1-4	4-10	4-10	4-10	4-10
Operating speed (km/hour)	12-20	20-40	25-60	25-60	25-60	40-70
Line capacity (passenger/hour/ direction)	4000-15,000	6000-20,000	10,000-40,000	10,000-40,000	10,000-40,000	8,000-35,000
Stop spacing (m)	250-500	350-800	500-2000	500-2000	500-2000	1200-4500
Seperation from car/pedestrian traffic (RoW)	None or partial	Complete	Complete	Complete	Complete	Complete
Maximum gradient % (slope)	12	15	8	8	9	4
Minimum horizontal curve radius (m)	15 possible 25-50 in practice	15 possible 25-50 in practice	25 possible 120-200 in practice	25 possible 120-200 in practice	25 possible 120-200 in practice	150 4000-7000 for high speed
Lane width (m)	3.00-3.50	3.40-3.75	3.70-4.30	3.70-4.30	3.70-4.30	4.00-4.75
Minimum width for the fixed corridor (m)	14(road) 3.50×4 lanes	7.5-10 (rail corridor)	8 (rail corridor)	8 (rail corridor)	- Not on surface	8 (rail corridor)

Source: Vuchic, 1981, “Urban public transportation”. Prentice-Hall

Other than its rapid acceleration/deceleration characteristic, LRT vehicles can be automatically or manually controlled under a variety of right-of-way conditions (fully grade separated, predominantly reserved, designated by pavement markings, or mixed traffic). Commuter (regional) rail has high average speed but low acceleration/deceleration rate than that of LRT systems and heavy rail systems and commuter rail systems (Grava, 2002).

A metropolitan area with a population of at least 1 million and a central city of 0.5 million that contains a central business district of 25 million ft (272 ha) was suggested as the minimum size for rapid transit in the early post-World War II period in studies in the United States. This observation strongly suggests that the determining factor is concentration of the urban fabric in nodes and corridors (Grava, 2002).

The situation is different in developing countries, and it has been suggested that a population of 5 million is the threshold size for rail transit, and that 700,000 or more person trips per day have to be generated in a corridor for the heavy rail rode to be feasible (Halcrow Fox and Associates, 1989 cited in Grava, 2002). On the other hand, with the introduction of Light Rail Transit technology, which also brought the street tramways back to the picture, these thresholds are significantly lowered: Many European cities operate successful LRT and tram systems in cities around, and even less than, half a million (Babalik, 2000).

As White (1976) stated, the close station spacing of **LRT systems** (350-800m) allows passengers to access the stations on foot and this attracts high proportion of passengers using public transportation systems. **Commuter rail (regional rail)** offers usually frequent services at regular intervals. Station spacing distance within inner city may be as much as metro systems but interval of 1,200-4,500 m is much commonly used. Grava (2002) claimed that since the stations are relatively far apart this affects the form of the city and since commuter rail is the principle means of the cities to develop historically, it is the mode that has the heaviest rolling stock and most expensive infrastructure.

LRT, metro systems and commuter (regional) rail systems operate on exclusive rights-of-way. In LRT systems the separation may be as little as 40% or as much as 90% of the total network length, but usually most critical sections of the systems are separated in central city or on congested arterials in practice which enhances the quality of service they offer in the city (Vuchic, 1981).

1.1.3.Bus Transit Systems

Bus transit modes have the ability to operate on virtually all streets. The investment costs are very low; however, they have limited capacity transit units. These three basic features, i.e. flexibility of route, low investment cost, and limited capacity, are the most important characteristics of highway transit modes (Vuchic, 1981).

There are approximately 8,000 to 10,000 communities and cities that provide bus transit services all over the world. Larger metropolitan cities generally have other modes too, such as rail transit; however, in every case the bus system is the primary public means of mobility (Grava, 2002).

As Grava (2002, p.304) defined:

"A ***bus***, as a vehicle, is a large over-the-street unit accommodating many riders, individually driven (controlled and steered), almost always utilizing a diesel engine and rubber tires (at least so far). When this type of vehicle is operated on a public right-of-way (street or highway) in mixed traffic, along a fixed route and on a set schedule, admitting all who wish to enter, but usually upon the payment of a fare, it is a public transportation mode or bus transit."

Buses are used for all types of services including short-haul to regional, local to express, all-day or peak hour and they can be used for irregular services. This wide use and short life of buses result in a great production of transit vehicles (Vuchic, 1981).

Buses carry considerable amount of passenger loads. They are economically beneficial. In order to run a bus there is no need for an advanced engineering or a special skill (Grava, 2002). On the other hand, Carmen Hass-Klau et al. (2000, p.16) argued that "the main disadvantages of relying on conventional buses are what are usually assumed to be advantages- its cheapness and flexibility." The authors argue that flexibility of buses, as opposed to the permanent nature of rail systems, results in the former to have limited impact on land-use and travel behavior.

The overall characteristics of bus systems and busway are seen in Table 2.2. In this study the emphasis will be on the rail system investments; therefore, only a summary is made for this mode.

Table 2.2. Characteristics of bus systems

	Regular Bus	Busway
Vehicle (car) capacity	40-120	40-120
Vehicles per transit unit	1	1
Operating speed (km/hour)	15-25	20-40
Line capacity (passenger/hour/direction)	1,500-5,000 (may carry up to 20,000 but with lower service quality)	2,500-7,000 (may carry up to 20,000 but with lower service quality)
Stop spacing (distance between stops)(m)	100-300	300-500
Seperation from car/pedestrian traffic (RoW)	None or partial	Complete
Maximum gradient % (slope)	10	10
Recommended width for the fixed corridor	- (Not fixed)	One or two road lanes
Land cost	Very low	Low
Construction cost	None	Low
Vehicle purchase costs	Low	low
System operating costs	Very low	Low
Maintenance costs	Very low	Low

Source: Vuchic, V. 1981, Urban Public Transportation. Prentice Hall

According to Grava (2002, p.383), **bus rapid transit** is:

“A systematically coordinated service, fully integrated with other modes in a community, that provides faster speeds, improved reliability, and increased convenience compared to conventional bus operations. Bus rapid transit under its current definition encompasses all those programs and actions that allow urban bus service to operate faster, but also (it might as well) includes those that offer better reliability, safety, and human amenities, such as good ventilation, comfortable seats, and secure waiting spaces.”

Grava (2002) argued that bus rapid transit is an advanced variant of bus systems. In the situations of accommodating high volumes of passengers, this mode should be considered in all bus operations. Carmen Hass-Klau et al. (2000) claimed that busways and guided busways might have the same symbolic meanings and qualities of light rail systems on a smaller scale. The existence of a permanent route again seems to be an important aspect. Additionally, these modes can run after leaving the track as conventional buses or feeder buses without a need to transfer to another bus service.

2.2. Expectations from New Generation Rail Transit Systems

2.2.1. Expectations

Rail transit systems are frequently compared with buses and other modes of transportation both in the literature and in the decision making process of rail transit investments. Before deciding on a rail transit investment or project, this “alternative analysis” plays a major role (Black, 1993, p.153).

It is stated by Grava (2002) that there is much acceptance from all the social groups in the society of LRT than of other transport modes in the city. LRT is regarded as “environmentally responsible”, “politically correct” and “socially relevant”. These characteristics become important when deciding whether to construct an LRT line in the city.

Black (1993) reviewed various arguments on LRT systems and summarized the pros of light rail as follows: “It is relatively quiet, thus environmentally unobtrusive; is electrically propelled, thus less dependent than buses on the availability of petrochemical fuels; and can operate effectively along available railroad rights-of-way and street medians, thus is far cheaper, less disruptive, and easier to build than heavy rail. LRT’s lack of exhaust fumes and comparatively slow speeds make it particularly compatible with pedestrian settings such as downtown malls” (Black, 1993, p.154).

It is seen that, the qualities of rail transit systems create expectations for the planners and decision makers. In the literature, authors generally highlight five main areas, on which rail transit investments may be expected to have a positive impact. These are reviewed below and comprise image expectations, land use expectations, traffic reduction expectations, ridership expectations and cost expectations.

2.2.1.1. Image expectations

Light rail transit is usually stated to have a positive image when compared to other type of modes, such as buses. Mackett and Edwards (1996, p.194) defined the image of a mode as "the difference between what a user or developer perceives the mode offers in terms of attributes such as speed, comfort and reliability, and what the mode actually provides in terms of these attributes. If the difference between the perception of the mode and its actual performance is positive, that is the mode is thought to provide more than it actually does, than the mode has a positive image; if the difference is negative, then the mode has a negative image." However, the authors also claimed that if identical service levels such as speed, capacity, frequency and reliability, are offered both for a bus transit and rail transit, then light rail would still be perceived to offer better service than bus system because of its general better image (Mackett and Edwards, 1996).

Vuchic (1981, p.470) claimed that rail transit systems become "landmark by itself and it gives the city a certain special identity and image". Most cities in the world such as Paris, London, New York, and Moscow are recognized with their rapid transit systems. Edwards and Mackett (1996b) gave the example of the city of Dallas having a light rail transit system in order to become a "world city" and a UK city whose leader from the City Council saw the metro as a way to become a major European city.

Grava (2002) emphasized on the relationship between the political power and the rail transport investments. He gives the example of the former Soviet Union in which the national resources were used to build metro for every city that reached a population of 1 million that in return caused an internal and external publicity. It is obvious that heavy rail transit is a massive investment and has "the force to define its own image and attractiveness", Grava (2002, p.570) concluded.

Richmond (1998, p.315) also stressed the importance of the image of rail transit in his article called "The Mythical Conception of Rail in Los Angeles" and concluded that "the train provides a solid basis for political support. Technologies with negative connotation cannot do that. Neither can complex, abstract ideas that would formulate the way transportation systems as a whole are organized. The problems of freeway solutions cannot be eliminated overnight; but a rail system, symbolic of free-flow, can indeed be installed. Rail is also something which can be promised and delivered within a predictable time-frame." Richmond also argued, however, that this positive image can often distort decision-making, resulting in a bias for rail alternatives even though non-rail solutions may be more cost-effective, as in the case of Los Angeles.

2.2.1.2. Land Use Expectations

Construction of a permanent transit facility such as a metro or LRT system is believed to encourage more intensive land use in its vicinity because it provides high capacity transit service along a fixed track in the corridor (Babalik, 2000). The benefits from a bus route are likely to be less than those of a rail transit system. Investors are in favor of implementing rail transit systems because the bus system routes could be changed or eliminated, whereas rail lines are permanent (Bursa Rapid Transit Feasibility Study, Toronto Transit Consultants Ltd, 1986).

As Vuchic (1981) argued rail transit lines and stations generate developments of land use, and in time with a good urban design and planning it can create its own attractive environment. Richmond (1998) pointed out that rail transit also has the ability to revitalize the city centers and reverse urban decentralization.

The key role of the stations and terminals should also be recognized. They are the contact points of rail transit systems with other modes such as walking, private cars and other transit services. Terminals affect passenger convenience, comfort, and safety. The interaction with its surrounding environment often requires investments (Vuchic, 1981).

Being a major point of access, the metro station attracts development and affects all the properties around it. Heavy rail (metro) systems carry more passengers than any other transport services in the city. It has the ability to influence the urban pattern and real-estate market investments. Generally commercial services choose the location near the metro stations because it generates advantages to the commercial service. Yet this development does not exist by itself, other planning and transportation policies should support a development near the stations (Grava, 2002). Babalik (2000, p.27) stated that "similarly in reinforcing declining city centers, a rail system is seen as an effective tool with both the accessibility it provides and the positive image it has".

It is provided in empirical analysis that light rail has had some positive effects on the LRT corridors as compared with the parallel bus corridors (Dueker and Bianco, 1999). However, there are limited numbers of successful examples of rail transit systems affecting urban development and land use of the cities. Some impact studies analyzed the factors and process behind the success (Babalik, 2000). Portland stands as an example of an effective land use and LRT project coordination. Many local planners have been interested in the concept of transit oriented development (TOD) that is: "the mixed use neighborhoods, between 20 and 160 acres in size, which are developed around a transit stop and core commercial area. The entire TOD site must be within an average one-fourth mile walking distance of a transit stop. Secondary Areas of lower density housing, schools, parks and commercial and employment uses surround TODs for up to one mile biking distance. TODs must either be located on a segment of the Trunk Line Network (either a light rail or Express bus line) or on a segment of the Feeder Bus Line Network within 10 minutes transit travel time from the Trunk Line Network" (cited in Glick, 1992, p.77).

In Portland region, planners achieved a consensus about the connection between land use and transportation. In order to achieve this goal "The Region 2040" plan was developed. Its aim was to reduce the travel of single-occupancy vehicles and to maintain a compact development (to reduce urban sprawl). This plan focused on light rail to provide development in mixed-use centers (Dueker and Bianco, 1999).

The light rail system in Portland, which is called the MAX LRT system, has stimulated major development in downtown and produced a vital and viable urban center. This strategy is the product of the public transport operator and the local planning authorities. The MAX system was constructed in order to stimulate transit related development in the corridors. Over one billion dollars worth of development has taken place in downtown Portland within ten years of operation near the MAX stations. It has brought historic renovation, commercial development and retail development in the downtown area (Cani, 1997).

Additionally, there have been transit oriented development approaches in other American cities, such as Sacramento and San Diego: the impact in Sacramento did not seem to be strong because of its low density characteristic. Urban sprawl is a dominant trend in the city. In Washington DC and Vancouver, there has been intensive development at station areas, as a result of both the rail systems and successful examples of transit oriented development planning approaches (Babalik, 2000).

2.2.1.3. Traffic reduction expectations

As car ownership, car usage and traffic congestion are rapidly increasing, investments in rail transit systems are seen as potential planning tools that can solve the congestion problem or at least prevent it from becoming worse. These systems can become attractive to car users when they provide improved accessibility to the CBD. Since the mid-1970s, there is a great interest in cheaper and quicker forms of mass rapid transit that might reduce the congestion on roads, including light rail, busways, guided busways that are segragated from the ordinary road system (Knowles, 1996). There is also an argument in the literature that rail options are more effective in attracting car owners to public transport, when compared to bus options. As Black (1993, p.152) argued "Buses have a bad image as they are considered slow, dirty, smelly, and uncomfortable".

It is argued in the literature that public transport, in general, has a poor image. Babalik (2000) pointed out that private car users would consider using light rail transit systems rather than using bus systems; because light rail systems have the ability to attract more people to public transport. This characteristic is defined by Simpson (1994) as follows: 'especially buses are widely regarded as being something to avoid by anyone who has a private car' (cited in Babalik, 2000, p.27).

There are a number of cities that preferred a rail alternative with a view to reduce or control congestion. Knowles (1996, p.2) stated that for the case of Manchester Metrolink, one of the main objectives was to "provide a better alternative to road travel in order to reduce congestion, travel time, accidents and air pollution". Since UK forecasts predict further national road traffic increase of between 83% and 142% by 2025, this objective appears to be important for other rail investments in Britain. Babalik (2000) stated that traffic reduction or congestion mitigation were amongst the main objectives for a number of North American rail systems, namely the Vancouver SkyTrain, St Louis Metrolink, Miami Metrorail and Sacramento Light Rail.

2.2.1.4. Transit ridership expectations

Ridership; that is the number of passengers carried (annually or daily), is generally considered as the indicative of a rail system's success. When systems are planned, they are expected to reach a certain level of ridership, which is used to justify the high-cost investment. Therefore, ridership is in fact a very important expectation from urban rail investment. All rail systems are built with the expectation that they will attract a certain number of passengers, which would generally be higher than what a bus line would attract.

Richmond (1998a, p.16) claimed that "the existence of riders on a new project does not necessarily mean that there are more passengers on public transport. To assess ridership effectively we need to understand the effects of the new project on the transit system as a whole." Similarly, Pickrell (1992) argued that a transit project's effect on overall ridership, that is in particular the number of new passengers in transit diverted from automobile users, is the primary determinant of a project's success in reducing air pollution and congestion.

The rail transit modes are generally argued to have a much stronger identity than highway transit modes. Their features such as exclusive right-of-ways particularly have huge impact on transit ridership and on the overall role of transit in the city (Vuchic, 1981). Richmond (1998) claimed that there are many reasons for proceeding with new rail projects. The potential of having high ridership is one of them. It relieves the congestion in the city and reduces the emissions given by the highway transit modes and enhances environment. In addition to that it serves to a wide range of passengers, from poor to higher income commuters. He explained this fact according to a standard view that the passengers are attracted by rail's "speed, comfort and middle-class image" and they prefer to use rail transit rather than bus systems. (Richmond, 1998, p.8)

Vuchic (1981) stated that rail transit modes have the highest overall performance of all modes, however they are limited in their network extensiveness because they have high investment cost. That is why rail modes are not efficiently utilized in low demand routes whereas they are usually optimal in high demand corridors. Richmond (1998) suggested that rail transit services should be restricted to high demand corridors since the investment costs of rail services are the highest of all. Grava (2002) argued the ideal situation for a LRT development would be a corridor of at least 10 km long with activities along the way and attractions at both ends such as a shopping center, medical complex, a university campus, an airport, a CBD, a recreation or a sports facility etc. He suggested that the corridor should be at a walking distance of 500 meters to the residential areas and it should be connected to the relatively distant residential districts with feeder systems. This pattern would not just increase the ridership but it would also help to maintain a balance of demand in both directions. Grava (2002) argued that heavy rail transit should have the ability to carry 30,000 and more passengers daily.

As Vuchic (1981, p.305) claimed "the point at which rail modes become superior depends, however, not only on the demand, but on the availability of partially or fully separated rights-of-way, requirements in terms of service quality and performance, characteristics of alternative means of travel, external effects, and numerous local conditions". Consequently performance changes of the bus systems become an important part of the story of the success of the rail systems (Richmond, 1998).

Planning, construction and operation of rail transit projects require higher expertise than bus systems, while the high performance and service quality needs considerable capital investment. The ability to operate large capacity units, high labor productivity and low operating costs per unit of time of rail systems make rail transit a feasible solution where high demand exists (Vuchic, 1981). If a rail system has a considerably high ridership, this is a proof that it is built on a high-demand corridor and that it is attracting passengers, thus fulfilling the expectations from the investment.

2.2.1.5. Cost Expectations

Infrastructure cost per kilometer is different in every mode depending on the conditions. Land costs, construction costs, vehicle purchase costs, system operating costs and maintenance costs increase the importance of a good planning system and evaluation of the projects. Grava (2002) emphasized the need to account for the operation costs and maintenance costs in every annual budget in addition to the costs discussed. The construction costs are differentiated according to the characteristic of the system's right-of-way, track, guideway and channel, stations, control systems, support facilities and rolling stock (Grava, 2002).

Richmond (1998) claimed that in deciding for new transit projects the significance of capital costs is forgotten. While some projects are selected because they are "low-cost" alternatives, after subsequent cost escalations the projects alter. It is sometimes the failure of the complexity of construction requirements and political needs, and sometimes external factors such as inflation. It is seen in Table 2.3 that the cost of rail transit systems are usually medium or high, that is because of its system operating costs, maintenance costs, construction cost and vehicle purchase costs.

Table 2.3. Costs of different rail transit systems

	Streetcar (tram)	**Light rail transit**	**Rail rapid transit (on surface)**	**Rail rapid transit elevated**	**Rail rapid transit underground**	**Regional (commuter) rail**
Land costs	Low	Medium	Medium	Medium	Low	Medium
Construction costs	Low	Medium	Medium	High	Very high	Medium-High
Vehicle purchase costs	Low-Medium	Medium	High	High	High	High
System operating costs	Low	Medium	Medium	High	High	Medium-High
Maintenance costs	Medium-High	Medium-High	High	High-Very high	High	High

Source: Vuchic, 1981, Urban public transportation. Prentice-Hall

Planners and engineers make a detailed research and data collection before predicting for a proposed system. This is partially because the investments are massive and partially because there are a variety of choices deciding on the features of a LRT system; that the system could be on an existing street or it may require tunnels. The difference in the cost depends mostly on the guideway that the system will be constructed on. Grava (2002) claimed that "a comparative analysis of the actual capital expenditures for Portland, Sacramento, San Jose, Pittsburgh and Los Angeles LRT (all opened before 1990) showed that a trackbed on a fill with retaining walls was 1.5 times more expensive than an at-grade construction, an elevated structure was almost 3 times more expensive, a cut with retaining walls was 5 times more expensive, and a subway was 10 times more expensive.

In order to implement a light rail transit system, there needs to be some legal arrangements, commitment on capital resources, right of way reservations, training of staff and a special technology. Being a massive investment a trial-and-error approach would not be appropriate. Therefore new urban transit projects depend on federal government funds in financing the projects in the United States. In deciding for a metro system more care should be given in the decision making process because the technical elements are complicated and this requires much more technical expertise. In addition to that metro construction would expend massive amounts of public resources and that should not be underestimated (Grava, 2002).

Grava (2002) stated that in the 1970s, for a LRT development, the capital costs were in a range between $ 3.5 million to $ 7 million per mile ($ 2 million to $ 4.5 million per kilometer). A single unit vehicle was expected to cost less than $ 100,000 and the advanced six-axle articulated LRVs were expected to cost no more than $ 500,000. In the mid-1980s with the availability of complete systems the actual costs increased. In recent years the costs have escalated for LRT.

Today it is difficult to construct a tram system less than $ 10 million per mile ($ 6 million per kilometer) (Grava, 2000). In some cases construction of LRT projects can approach the expense of a rapid transit line if tunnels and elevated sections are involved, which would be at least $ 100 million per mile ($ 62 million per kilometer). In the year of 2000 Metro averaged out the price of an LRV at $ 2.3 million each. As Grava (2002) concluded "this is about twice the cost of a heavy rail vehicle and approaches the level of a commuter rail electric locomotive. That is an amazing development and one not explained by inflation alone." The price of heavy rail vehicles continually escalates. General numbers are not reliable because in each implementation the number changes according to the situations. In 2001 the approximate prices for the vehicles were; for a passenger coach (not powered) as $1.3 million, for an electric multiple unit as $2.5 million (or more), for a diesel locomotive as $4 to $5 million and for an electric locomotive for $5 to 6 million (Grava, 2002).

Grava (2002) argued that this large range of costs brings us to the point that deciding on the projects should be for the most efficient mode that can satisfy the transportation needs of the community. In fact in many cases after careful ridership estimates and procedures of computerized simulation models to calculate the number of trip generations, trip distributions and trip attractions, LRT systems are more preferable. He claims that in the case of good usage rates and good management, operation and maintenance costs of trams are comparable with those of buses and under intensive ridership they can be lower per passenger carried. The standard average for LRT in 1993 operations were 44 cents per passenger per mile and the corresponding cost for single-occupancy passenger automobile was 58 cents (Grava, 2002).

It is important to analyze the previous research made on costs and ridership of rail systems in order to understand the emphasis that needs to be put on these two issues when analyzing rail transit systems. The following section focuses on this issue.

2.2.2.The gap between expectations and outcomes

One of the most important studies in the literature regarding the cost and ridership performance of rail transit systems is the study by Pickrell (1990). Don H. Pickrell (1990) evaluated ridership and cost forecasts of ten rail transit projects by comparing the forecasts with each project's actual costs and riderships in "Urban Rail Transit Projects: Forecast Versus Actual Ridership and Cost" (Table 2.4.). He found that ridership was consistently overestimated, while costs were underestimated. In the Washington and Atlanta Metro systems the actual annual operating expenses were approximately three times the forecast. Overestimations ranged between 188% for the Washington Metro to about 800% or more for the Detroit Downtown People Mover and the Miami Metro (Mackett, 1998).

Pickrell (1990) showed that in Portland, ridership was 54% below forecasts, capital outlay was 28% above, and operating costs were 45% above. In Sacramento, ridership was 71% below forecast, but the cost estimation was fairly good as capital outlay was only 17% over forecast, and operating costs were 10% below the estimate. In Buffalo, the actual ridership was 68% below the forecast, the capital outlay was 59% above the forecast and operating costs were 12% over the forecast.

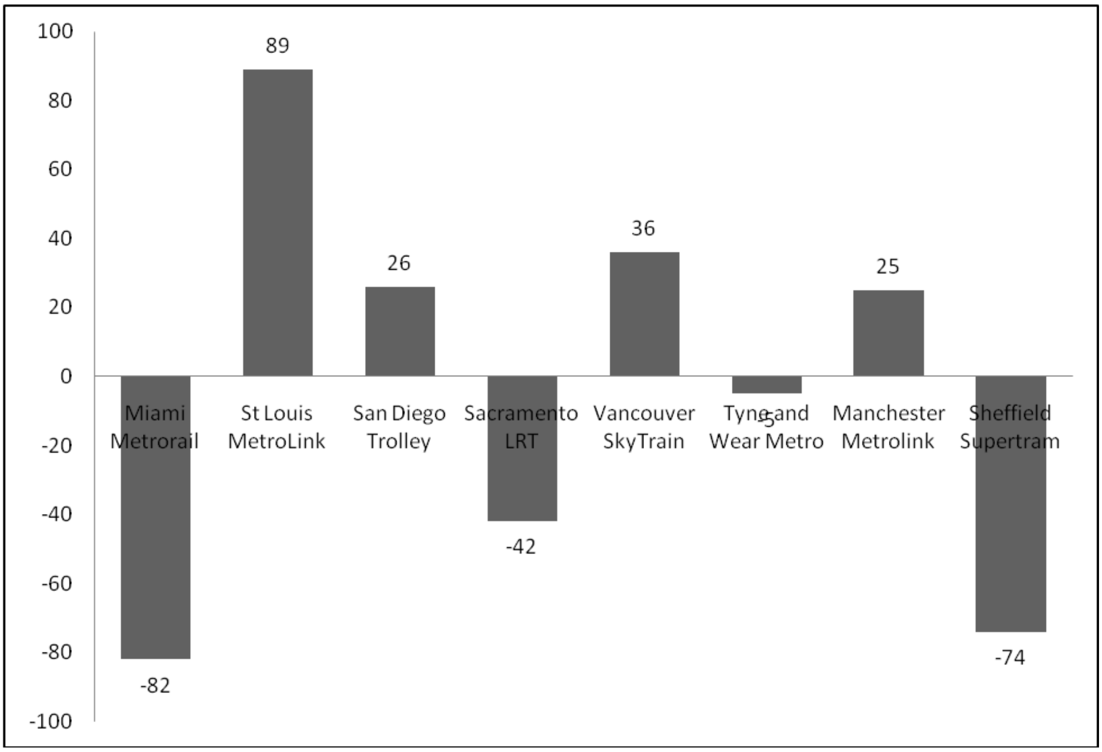
In Table 2.4., it is clearly seen that none of the US systems that Pickrell (1990) has examined have been forecasted accurately, that they could not reach the forecasted values. Only the Portland and Sacramento light rail systems have had increased in ridership. The other systems are still well below the ridership forecast (Mackett, 1998).

Table 2.4. Comparison of forecasts and actual ridership on new urban rail transit systems

	Washingto	Baltimore Metro	Miami Metro	Buffalo LR	Pittsburgh LR	Portland LR	Sacramento LR	Miami DPM	Detroit DPM	St Louis LR
Forecast										
Year	1977	1980	1985	1995	1985	1990	2000	1985	1985	1994
Ridership	569,6	103,0	239,9	92,0	90,5	42,5	50,0	41,0	67,7	17,0
Actual										
Year	1986	1987	1988	1989	1989	1989	1989	1988	1988	1994
Ridership	411,6	42,6	35,4	29,2	30,6	19,7	14,4	10,8	11,3	44,4
%difference	-28	-59	-85	-68	-66	-54	-71	-74	-83	+161
Year	1993	1991	1992	1995	1992	1995	1995	1992	1992	
Ridership	526,6	45,2	48,4	29,0	31,1	24,0	23,0	9,5	8,8	
%difference	-8	-56	-80	-68	-66	-43	-54	-77	-87	

Note: Ridership is in thousands of passengers on a weekday. The percentage differences are between the actual values and the forecast values. LR stands for light rail. DPM stands for downtown people-mover. Source: Mackett (1998)

Babalik (2000) analyzed 8 systems including 5 systems in North America and 3 in the UK. As seen in Figure 2.1, Babalik found out that for St Louis MetroLink ridership levels were higher than it was expected by 89%. Vancouver SkyTrain, San Diego Trolley and Manchester Metrolink ridership levels also exceeded the expected levels. Miami Metrorail, Sacramento LRT and Sheffield had failed, Tyne and Wear Metro was only slightly below comparing the actual and forecasted ridership differences.



Source: Babalik (2000).

Figure 2.1. Forecast and actual ridership differences in selected North American and British systems

Pickrell (1990) argued that the cause for the overestimated ridership is because of an overly optimistic assumption about the service that these new lines would provide, and in addition to that the feeder bus services on which these lines would rely on.

Pickrell (1992) claimed that it is difficult to measure the actual increase in ridership; because the fraction of new riders drawn from private automobiles is not considered by planners while preparing comprehensive forecasts (Pickrell, 1992, p160). Fouracre et al. (1990) argued that the actual ridership for metro was below the original forecast in most cities.

In his study estimates for only Manila and Tunis were approximately achieved. In other cities such as Calcutta, Porto Allegre, Rio de Janeiro, Santiago, Pusan and even Seoul, the ridership was below the target. He argues that the reasons why the forecasts are inaccurate may lie on 'over-optimism in the planning phase'. Because after the systems are opened integration has not been achieved, private vehicle users continue to use their own cars, the prediction of increase in population and economic wealth was inaccurate and in some cases the alignment of the metro was poorly selected and this caused a poor catchment (Fouracre et al., 1990, p10).

According to Pickrell (1992), demographic factors (downtown employment, population in corridors where lines are to be located and so on), the level of transit service lines, the fare system and basic category inputs in forecasting the ridership in the proposed rail line are critical (Pickrell, 1992, p161).

Pickrell (1990) concluded that giving the right decision is possible when the decision makers act on more accurate forecasts and costs, and it would be possible that after having done such an analysis the decision-makers would not select the projects reviewed in the report, at least in some cases.

In a study by Gomez-Ibanez (1985), the actual ridership and financial data were analyzed in the new lines in San Diego, Calgary and Edmonton. The new lines in these cities serve a metropolitan area with a population of about two million in San Diego, and 500,000 to 600,000 in Calgary and Edmonton. All three systems have a specified vehicle design that had been extensively tested and demonstrated on the streetcar systems in Europe. These systems were relatively inexpensive to construct, costing about $7 million to $20 million per mile when compared with the heavy rail systems costing $50 million to $100 million per mile. The Calgary line operates in a transit mall with buses in the downtown costing $146 million (in mid- 1970s Canadian dollars) to build. The San Diego system operates on a railroad right-of-way and in some parts for about 2.67 kilometers in a downtown street median cost for about $122 million to construct and equip (in 1980-1981 U.S. dollars) (Gomez-Ibanez, 1985, p.340).

In his study Gomez-Ibanez (1985) focused on the changes in ridership and costs. He argued that in all three cities proponents of LRT have oversold the systems. Gomez-Ibanez (1985, p.337) reminded that "Proponents argue not only that light rail is far less expensive to build than heavy rail, or subway systems but also that it costs no more to operate than conventional bus transit and offers much improved service". He concluded that in San Diego, Calgary and Edmonton, LRT cost more than the conventional bus service it replaced and it had a positive effect on transit ridership in two of three cities whereas the costs per added rider were high.

Gomez-Ibanez (1985) concluded in this study that in San Diego the Tijuana Trolley's cost exceeded that of the bus routes it replaced, but the ridership went up throughout the area. In Calgary ridership went up after the LRT line opened, but the transit ridership could not maintain the levels it had reached in the six previous years. The operating costs were high. It was different in Edmonton that the system gained more riders than the other two systems, whereas total cost per passenger went up sharply.

Gomez-Ibanez (1985, p.349) urged the other cities considering LRT to "be skeptical of claims that light rail will reduce transit costs, improve service quality, or increase ridership significantly." He further stated that it was obvious in all three cases that LRT systems required higher capital outlays than bus systems they replaced and the operational costs were also higher. These additional operating expenses arose from the higher maintenance cost for vehicles, track, power and the signal systems and the feeder bus services.

In his study, Gomez-Ibanez (1985) concluded that the service improvements on the bus systems may be a better way to add ridership in a more cost-effective way. The analysis of small ridership gains showed that LRT would be a choice for promoting downtown development in rapidly growing metropolitan areas but not in declining ones.

Kain (1988) criticized building light rail lines in low density Sunbelt cities like Los Angeles and Dallas. He claimed that both in Dallas and Los Angeles the decisions to build LRT systems was an outcome of a more emotional and psychological attachment to rail rather than an outcome of a cost-effective analysis and/or another method of forecasting. The decisions were made without any consideration of any other alternative such as a bus rapid transit system which would be more suitable. The proposed ridership forecasts were far too high and it is understood that the advocates of rail systems have shown a tendency to overestimate the ridership forecasts.

Kain (1988) claimed that, "I continue to be puzzled by the persistent popularity of Light Rail Transit. LRT seems to me to be nothing more than a slow and expensive bus that cannot pass and is unable to operate on the city streets". He further argued that bus rapid transit has technological advantages over heavy rail and LRT systems and bus systems perform better than rail systems in most situations particularly in LA, Dallas and other Sunbelt cities that the destinations and origins are dispersed. The small unit size of bus vehicles, frequently cited as a disadvantage by advocates of rail transit, allows more direct and frequent service and lower trip times (Kain, 1988).

2.2.3. Reasons for the gap

The estimates of the projects are dependent on the accuracy of traffic demand forecasts (Pickrell, 1990, Richmond, 1998). Although the planners and the decision makers have the ability to reduce the errors of the forecasting processes, the outcome may not be as it is estimated for various kinds of reasons. The errors could have arisen from the structure of the forecasting model or “misinterpretation-or possibly misrepresentation- of the output” (Pickrell, 1992). Other reason could be the errors in the financial planning process. Underestimating the construction, scheduling, project management and forecasting the price inflation, demographic factors, employment, the level of transit services, feeder bus services, fare system, may, in return, result in overestimated projects (Pickrell, 1992). Sometimes it is because no empirical data is provided regarding to rail versus bus systems; such as riding comfort, attraction of real estate development near LRT stations and route understandability (Henry, 1989).

It is complicated to quantify the secondary and indirect effects in the decision making process of rail transit investments. It is also the result of the difficulty in cost-benefit analysis. Not only the unequal circumstances of rail and bus systems but the inflation also plays a significant role in the inaccurate forecasts. The complexities of construction requirements and political needs that have emerged in the process of the project implementation changes the circumstances, increases the cost and it opens a way for the failures. It is sometimes a total change of the project from the initial planning to the date of opening. It is generally the money spent after the project opening in order to improve the system (Richmond, 1998).

Carmen Hass-Klau et al. (2000) claimed that there has been a discussion about “rail factor” in the United States that under equal conditions politicians tend to choose rail transit, not the bus systems. However it is not easy to analyze whether the bus system or the rail system would be suitable unless the conditions are equal; thus to give a final conclusion is not quite possible. Besides the operational and technical aspects, the complementary measures that are “all those measures which are not connected directly to the operation of light rail”, such as restraint policies, ticketing and support measures, marketing e.g. play a key role in the degree of the success of the rail transit systems (Hass-Klau, Crampton, 1998, p. 67).

Babalik (2000) argued that the problem was not just the overestimation of success, but it could be resulted from lack of coordination between urban planning and transport planning process. In the study, it was concluded that the most effective factors were the supporting policies that were implemented to enhance the success of rail transit systems. Babalik (2000) divided the supporting factors into two: transport planning policies and urban planning policies.

> “Transport planning policies are policies that could be implemented by the transport planning agency at the planning stage of the system. Urban planning policies, on the other hand, contain policies, actions, and projects that are most likely to be implemented by municipalities, or metropolitan planning governments. These policies can take place during the planning and construction of systems, or after the opening of the systems. Both sets of policies are generally implemented to support and enhance the success of systems; however, some of these policies have been observed to have another function, which is enhancing policy coordination between transport and urban planning” (Babalik, 2000, p.38).

With another point of view Mackett (1998) divided the reasons why the forecasts are wrong into two groups. In the first group, he stated that the problems arise from internality of the modeling process. These reasons included the usage of wrong inputs (such as population, employment, GDP and so on), model misspecification, usage of models for unsuitable purposes, insufficient disaggregation and missing of variables. In the second group, there were the external reasons to the modeling process such as the desire to achieve a specific result (such as obtaining funding), political pressure and technical incompetence. (Mackett, 1998)

Temyson has suggested that ridership forecasting should take into account the “inherent passenger appeal” of LRT, “the wider aisles”, smoother movement, absence of odor, and engine noise, all weather reliability, fixed route which people can relate (Henry, 1989). It was argued that these characteristics create an inclination for planners and politicians to choose LRT systems.

Richmond (1998, p.27) pointed out the need of a “wider systems perspective in evaluation and by deduction in planning- than is offered by raw project ridership data, disappointing though it may itself be in most cases”. He argued that the overall system gains in ridership are generally low and the highways continue to be congested anyway. In some cases it would be better to implement bus service improvements and fare incentives to increase ridership, not constructing new, high-cost rail systems (Richmond, 1998).

Grava (2002) claimed that a good planning process is a process which concentrates on ridership estimates. This would be a result of comprehensive restructuring of the feeder systems in broader corridors. It is also important to show that no other mode is compatible with the mode that is constructed. Secondly, the financial analysis would have to be expected to show not the theoretical but the reality of capabilities and expectations and these should be documented over a time period. In some respects private participation might play a major role in the design, building, operation and management arrangements (Grava, 2002).

As Kain (1998) argued in his article named "Choosing the Wrong Technology: Or How to Spend Billions and Reduce Transit Use" policymakers in transit planning and investment should seriously examine more cost-effectiveness in their analysis. Otherwise these investments would be wasteful and inappropriate rail systems in some cases. Flyvbjerg et al. (2005) concluded in their study that "it is highly risky to rely on travel demand forecasts to plan and implement large transportation infrastructure investments. Rail passenger forecasts are overestimated in 9 out of 10 cases, with an average overestimation above 100%. Today, the benefit risks generated by inaccurate travel demand forecasts are widely ignored or underestimated in planning, just as cost risks are neglected"(Flyvbjerg, Holm, Buhl, 2005).

2.2.4. Political factors in decision making as a factor affecting the performance of the systems

Flyvbjerg et al. (2005) speculated that transit ridership is overestimated in comparison to road traffic where there is a strong political power or ideological desire to reduce congestion and protect the environment. Another issue is the funding that is more typically pronounced for rail than road-based transit projects, which creates a shift towards rail transit investments with overestimated benefits and underestimated costs. In some cases politicians use the forecasts to show voters that they have the power to solve the problems and that this will be done or is being done in a small period of time (Flyvbjerg et al., 2005).

As Black (1993) stated, rail transit systems has been oversold in many cases and some people are fascinated with rail while forgetting about the desire to make public services cost-effective. The cost of the projects is really important because money spent on transit cannot be used for another worthwhile public activity. It is obvious that there is so much political interference in deciding the technology, whereas it should be more of a comprehensive study.

Pickrell (1990) examined the Sacramento light rail transit and concluded that the choice of light rail is not an outcome of a comprehensive study but rather it reflected the local concerns of the politicians. He states that ‘overstated assumptions and irregular manipulations of data’ led to the choice of light rail.

Richmond (1998) made a case study of the decision making process of the Long Beach Blue Line in Los Angeles. He interviewed the officials involved in the process and the people using the system. He argued (1998, p.298) that;

“The Long Beach light rail service was forecasted to carry 54,700 weekday daily passengers in the year 2000 (SCAG, 1984). This was scaled back to 35,000 weekday daily passengers by the end of the first year of operation. During July 1991, one year after opening the Long Beach Blue Line it was actually carrying 27,500 weekday daily passengers. By comparison, pre-existing local Long Beach Los Angeles bus line 60 was carrying 31,801 daily weekday passengers at the time Blue Line service opened, while other-parallel- bus services also carried substantial loads.”

The California Department of Transportation (Caltrans) estimated in 1981 that the Long Beach light rail line would cost $ 146. 6 million to build; however it was $ 887 million in the opening day in 1990. According to an unpublished estimate from the Southern California Rapid Transit District (RTD), in order to provide bus service and the operating facilities to provide a bus service equivalent to the Long Beach LRT line would cost $168 million. (Richmond, 1998)

Richmond (1998) argued that such decision was given according to the symbolic meaning and image of “the compelling myth of the rail to solve transportation problems of Los Angeles.” The train was seen as speedy and powerful. In the Los Angeles case the decision was not made by an analytical reason but made in a symbolic world and with the metaphor of a powerful toll; that is the train. Richmond (1998) explained this behavior in a good example:

“The problems of freeway congestion cannot be eliminated overnight; but a rail system, symbolic of free flow, can indeed be installed. Rail is also something which can be promised and delivered within a predictable time-frame.”

In this study Richmond (1998) showed why the decision makers do not act according to a comprehensive study but rather behave in a way in which the vivid images, meaningful symbols and powerful metaphors guide them. Academic and economic analysis has a limited role to play in that kind of a world where politics has the power to solve it.

2.3. Summary

Rail transit investments are constructed with high expectations. While attaining a reasonably high ridership is often considered as a primary objective, there are other important expectations from new rail transit investments, such as an improvement in image, effect on urban development, and reduction in congestion. In addition, attaining the rail system within the forecasted cost appears to be an important planning objective.

In spite of these expectations, studies on urban rail systems show that the actual outcomes can be disappointing. Both in the planning processes and in the implementation and operation processes, a gap between these expectations and outcomes often appears and deviations occur. The previous research show that this gap can be due to over optimistic expectations regarding the performance and positive impacts of rail transit systems, or because of the lack of complimentary or supportive policies that can increase the ridership. There is also broad agreement in the literature that political reasons and politicians' inclination towards rail alternatives are the reasons for this gap between expectations and outcomes, since political bias results in unrealistic expectations.

In Turkey too, the past decades saw many investments in rail transit systems. On the other hand, there are no comprehensive studies that provide information on what the planners' expectations were in building these systems and whether or not these expectations were met. However, the experience in Turkey shows that there may be similar issues of political support and inevitably political bias in building these systems. The next chapter, therefore, looks into similar political issues and expectations in rail transit investments in Turkey, and shows that there is need to assess the experience in Turkey regarding the expectations from, and outcomes of, rail transit investments.

CHAPTER 3

RAIL INVESTMENTS IN TURKEY

3.1. The decision making system in Turkey regarding rail transit

In Turkey the municipalities, project consultants, Railways, Ports and Airports Construction General Management (DLH), Prime Ministry State Planning Organization (DPT) and the National Treasury play the key role in the approval of the rail transit system projects. The most important factor in decision making process should be the financial, technical and economical factors, however it appears that political and commercial factors have a direct effect on the decision making process in Turkey (Öncü, 2007).

The central government institution responsible for urban rail projects is DLH (Railways, Ports and Airports Construction General Management). In the mid-1980s, there was an interest in many cities in Turkey to construct rail transit systems and therefore the central government brought about the requirement for transport studies to be made a condition to evaluate the funding of these investments and approve the projects. Regarding the law of The Ministry of Transportation 3348, DLH has the authority to approve the rail transit investment projects and documents of both public and private sectors. Since 1985, in nearly twenty cities in Turkey, urban transport studies have been approved by DLH (Özalp, 2007).

As seen in Table 3.1 in İstanbul, Ankara, Bursa and İzmir, more than one study has been made for rail systems in different years since 1985. The failure of proceeding to the goals is the main reason to update or revise these studies. Another reason is that, after each election every new local politician asked for new studies in order to introduce these investments as their own projects (Özalp, 2007).

Table 3.1. Urban rail transit investment studies in case study cities

City	Study	Year
Ankara	Ankara Transportation Study (Ankara Kenti Ulaşım Etüdü)	1972
	Ankara Feasiblity Study of Rail Transit Investment (Ankara Raylı Toplu Taşıma Sistemi Fizibilite Etüdü)	1983
	Ankara Urban Transportation Study (Ankara Kentsel Ulaşım Çalışması)	1986
	Ankara Transportation Master Plan (Ankara Ulaşım Ana Planı)	1994
İstanbul	Feasibility Study for İstanbul Metro	1970
	İstanbul Metro Feasibility Study	1978
	İstanbul Urban Transportation plan	1983
	Pre-feasibility study for İstanbul fast tramway project	1984
	Feasibility studies and Preliminary Project for Bosphorus Rail Transit Tunnel and İstanbul Metro	1987
	İstanbul Greater City Transportation Master Plan	1988
	New Metro Network Proposals for İstanbul	1988
	Strategic network plan for Europe side rail transit system	1996
	İstanbul Transportation Master Plan	1997
İzmir	İzmir Transportation Study	1974
	Public Transport System Optimization Study	1980
	Transportation Master Plan	1992
	Transportation Master Plan Update Study	1997
	Urban Transport and Rail System Investment project Feasibility Report	1998
	İzmir Commuter Rail System Development Project	2001

Table 3.1.(continued)

Bursa	Bursa Rapid Transit Feasibility Study	1986
	Inner-City and Near-Surroundings Transportation Study and MassTransportation Feasibility Study	1992
	Bursaray Study	1995
	Bursa Urban Development Project Urban Transport Improvements Study	1997
	Bursa Light Rail System Optimization Study	1997
	Bursaray 1. Aşama Güzergah İnceleme Değerlendirme ve Fizibilite Etüdü	1999
	Bursaray HRS Sistem Planı ve Modellemesi	2000-2001
	Bursa Traffic Study and Alternative projects	2007

Source: Özalp (2007).

Although DLH is the main government body that deals with the approval of urban rail projects, The State Planning Organization (DPT) under the Prime Ministry has long been carrying out its responsibility of setting out the main policies and principles for urban transport to be adopted by local authorities. Every five years, since the early 1960s, DPT has produced five year development plans; and after the mid-2000s these are defined for seven year plan periods. The development plans cover a variety of sectors, and set out the main policies, objectives and investment priorities of each sector. However, the plans generally remain as recommendations since they are not binding and not seen as strict guidelines for local authorities. As a result, the expectations of the politicians play a key role in deciding for the projects and these projects have been created by a group of "non-technical local management decision groups" (Öncü, 2007, p.73). An unfortunate outcome of this is that road investments became important in many cities in spite of the DPT development plans' emphasis on public transport and possible rail investments (Öncü, 2007).

Although the effect of the DPT development plans has been somewhat limited in actual urban transport decisions and investments, it is nevertheless important to review what these plans proposed for urban transport:

The first five years plan (1963-1967) referred to general transportation objectives of the country. It involved strategies to improve highway transportation policies, and only a few statements about national railway projects. It suggested that maintenance costs, as well as operating cost should be considered before constructing a system (DPT, 1963).

The second plan (1968-1972) also emphasized the national transportation issues of the country. The tendency to construct new road investments is the main issue of this plan period. Rail transportation issues remained limited. It is mentioned that the lack of coordination between the parts of the Turkish Republic Rail Roads (TCDD) paved the way for the failures in operation of the systems. In the second plan period, it was expected to have an increase of rail transport by approximately about 4,1%. The objective was to increase the capacity of the vehicles, to produce their own vehicles and to improve comfort in the service (DPT, 1967).

The third year plan (1973-1977) did not introduce any policy proposals for urban transportation either: road development projects were the main area of investment (DPT, 1973).

In the fourth development plan (1979-1983), priority was given to the major cities in implementing rail transit investments; Istanbul and Ankara light rail or underground metro systems were to be started to be constructed. The principles in the plan were not considered because of the lack of coordination among the institutions and limited funding (DPT, 1979).

The fifth five year plan (1985-1989) covers important policies for urban transportation. It is stated that priority will be given to low-cost measures; accessibility will be improved and effective usage of existing infrastructure and vehicles will be prioritized. This plan stresses the need for the integration of urban development plans with urban transportation plans.

In the sixth five year development plan (1990-1994), lack of standardization in urban transport projects, problems in creating financial resources and inefficiencies in the operation of the transportation systems are the main issues. The need for integration of urban transportation plans with urban development plans are again emphasized in this plan (DPT, 1991).

The seventh five year plan (1996-2000) states that the infrastructure and operation of rail transit systems are way behind the new technologies and management methodologies, and that this causes problems in meeting the demands. It is said that the standardization in urban rail transit systems, authority and responsibilities of the systems and integration with other modes in the city are not clearly mentioned in transport study reports or plans, and that this causes the systems to be inefficient (DPT, 1995).

In the eighth development plan (2001-2005) the standards of the rail transit system projects were determined. It is stated that the cities over 1.000.000 population with high travel demand corridors, can implement rail transit projects. The main goal of the plan was to determine the responsibilities of different decision making authorities and the standards of technical measures (DPT, 2000). As Özalp (2007) argued, in the eighth development plan, it is the first time that concrete criteria were determined, however there have also been cases during that plan period where these criteria were not addressed (Kayseri is one such example, where an LRT system was constructed although the city has a population much lower than one million) (Özalp, 2007).

In the ninth and the most recent development plan (2007-2013), it is stated that:

"Rail transit system projects will be planned in corridors where alternative transit modes are insufficient and where the travel demand during the peak hour in the year, when the system is projected to operate, is expected to be at a minimum level of 15,000 passenger/hour in a single direction" (DPT, 2007).

Öncü (2007) argued that this statement narrows the feasibility of the rail transit investments and these thresholds go beyond the performances of the systems operating in the big cities in Turkey. Nevertheless, it appears that this most recent plan introduced these thresholds in order to address the increasing tendency in many cities to build a rail transit system, regardless of whether such a major investment can be justified or not. This tendency, in other words, the increasing popularity of rail transit in decision making for urban transport in Turkey is further elaborated in the following section.

3.2. Increasing popularity of rail transit in urban transport decisions in Turkey

The review of national development plans prepared by DPT, as presented in the previous section, shows that rail transit is becoming an important issue on the country's agenda. Major metropolitan cities, such as İstanbul, Ankara, Bursa and İzmir, carried out various transport studies and invested in rail transit systems. Many other cities in Turkey also seem to be keen to develop such rail transit systems.

While such investment in rail systems may be justifiable in a number of cities in Turkey, there is also growing concern that in a majority of cities, plans to build rail transit do not rely on realistic predictions and technically sound studies. Öncü (2007), for example, argued that in many cases, the technical properties of the systems, threats and benefits of the projects and the costs are not evaluated, and that the "dream of having rail transit systems in the cities" initiates the project implementation process. Özalp (2007) also claimed that in many cases the decision to build a rail system was already taken by politicians, without considering the land use plans, population size, topography, travel demand and so on.

In an interview with Erhan Öncü (Ulaşım Art Ltd Şti, 18.03.2009), the example of Gaziantep was illustrated. Öncü stated that a plan carried out by the Ulaşım Art Ltd. proposed a metrobus system for the city. The Greater Municipality decided to construct a rail transit system instead of a metrobus system. The rail system was projected to carry 17.000 passenger/hour and it would cost approximately 170 million dollars. DPT refused to allocate funding for this investment; and the Mayor allocated the municipality's own resources to the project. During this process, further studies at the municipality also resulted in changes in the routes of the rail transit system and the plan was revised.

In the records of Grand National Assembly (TBMM) of Turkey dated 10 July 2003, it is stated that in a period of local elections, the Ankara mayor of the period; Melih Gökçek, started some new "unplanned" investments and that the national resources were wasted as a result of this. During Gökçek's first period as the mayor of Ankara after his being elected in 1994, it was announced that the Kızılay-Çayyolu Metro Line, which was proposed as the second line in the approved urban transport plan of Ankara, was cancelled. Instead, the Eskişehir Road, the road corridor along this line was widened and the Akay junction constructed in order to carry the demand of the corridor into the city centre. The widening of Eskişehir Road cost about 16 million dollars. Before finishing the road construction, the municipality proposed to extend the light rail system from AŞTİ to Çayyolu along the Eskişehir Road. After the criticisms on this investment, that it would not be feasible to have the capacity of Ankaray, a light rail system, in that corridor, the Municipality changed the decision on constructing the system and metro project between Kızılay and Çayyolu remained a major issue on the agenda: Currently the tunnel construction is completed; however, there is no progress regarding the rest of the construction; it is unclear when the line will be opened to service.

Constructing rail transit investments need a comprehensive data collection and analysis in the decision making process. Haluk Gerçek (2007) pointed out the fact that the decisions on transportation systems and urban land use principles are made almost with no technical research and that on the contrary the city authorities make decisions with an approach that Gerçek summarized as "we know what is best for the city". Most of the decisions taken are not based on any plans or consistent transportation policies. After the rail system projects are completed, the sections that have been constructed separately present severe difficulties in terms of integration. Gerçek stated that because of this problem, two different stations were built in the same location in İstanbul, instead of a single transfer station. Similarly, a rail system projected to be an at-grade tramway can easily be changed due to the lack of vehicles. Gerçek (2007) also criticizes the Metrobus system that was constructed between Avcılar and Topkapı, since there were no implementation plan and projects for this system.

Gerçek (2007) also noted that the mayor of Greater İstanbul Municipality stated in a public meeting that politically, sometimes, decisions are given without considering the technical side of the projects. The Mayor further added that it is not an obligation to ask for the approval of the planning authority in order to implement the projects.

Because of having these failures, integration problems occur, the total cost of transportation projects increase and the system cannot serve the city's expectations adequately. These investments should not be constructed without having land-use studies, feasibility analysis and so on.

In a Panel called "Efficiency in Transportation and Rail Transit in Urban Transport", Aziz Duran-The Sakarya Greater Municipality Mayor- stated that the "1 million population standard for having a rail transit system in the cities" in Turkey should be argued. He claimed that a study that would increase the quality of life and that would ease public transportation is not an unnecessary study. There should not be a need for great populations. He concluded that it should not be a solution for small towns; but if the city reached a point that road transportation is the major problem, the city should have a rail transit system for the solution (Duran, 2008)

From another TBMM record dated 15 December 1996, İsmail İlhan Sungur (RP) argued that in almost all cities in Turkey there should be rail transit systems. This is a very striking statement, showing the increasing political support in Turkey for rail transit investments. Sungur recommended having a rail transit system in Trabzon, for which the feasibility studies had been prepared, and he suggested that Ministry of Transport should start accepting the bids for the project in 1997.

3.3. Urban rail systems in Turkish cities

The reasons for implementing a rapid transit system vary from city to city. Some cities construct rapid transit lines to address major transportation capacity deficiencies while others wish to defer the need for expensive and disruptive roadway expansions. In addition, improved quality and reliability of service, quality of life and the achievement of strategic land use objectives are all legitimate reasons for implementing a rapid transit system. Although it is possible that a rail transit system can provide all such benefits, or expectations, there is also the possibility that decisions for investing in rail system are highly influenced and shaped by political reasons. Systems that are built predominantly for political reasons, due to the inclination of the city authority to introduce a rail system to the city, may fail to fulfill expectations, such as ridership, traffic reduction, etc.

As presented in the previous sections, in Turkey, too, political decisions have an effect on rail transit investments and there are discussions whether these investments were justified in the first place. It is not within the scope of this study to show whether these systems were built with sound justifications; however, it is intended to provide a better understanding regarding the expectations from these systems and whether they have succeeded in fulfilling these expectations. It is clear that the tendency in investing in rail transit systems in Turkey is likely to continue: while many systems have opened within the past few years, there are many others that are being planned or constructed. It is therefore important to have a better understanding of why and with what expectations these systems were planned, and what outcomes were attained.

Seven cities in Turkey opened new rail transit systems since the 1990s, while various others are planning to build new systems (Table 3.2.) In İstanbul, there are three systems operating. İstanbul Advanced Light Rail Transit system (or “Light Metro”) between Aksaray-Airport, İstanbul Metro between Taksim and 4th Levent and the tramway system between Zeytinburnu-Kabataş. In addition, there is the Taksim Funicular System, a short connection between the tram and the metro; and there is the historical tram in İstiklal Street. The latter two systems are not within the scope of the study, however, due to their limited size and capacity. In Ankara, there are rail transit systems on two corridors; Ankaray Light Rail Transit System between AŞTİ and Dikimevi and Ankara Metro between Kızılay and Batıkent. In İzmir, Üçyol-Bornova line is currently the only line in operation.

Table 3.2. Rail transit systems in Turkey

City	Type of system	The length of the system (km)	Opening year	Status
Adana	Heavy rail	13,5		In construction
Antalya	Heritage Tramway Light rail	5,1	1999 2009	In operation Construction continues
Ankara	1 line heavy rail metro 1 line light rail	14,6 8,527	1997 1996	In operation, work in progress on extensions.
Bursa	Light rail	21,893	2001	In operation
Istanbul	Heavy rail Light metro tramways	8,5 19,95 13,2+0,5124	2000 1989 2006	In operation
Eskisehir	2 lines light rail (tramway)	14,5	2004	In operation
Izmir	Light rail	11,5	2000	In operation
Konya	Light rail (tramway)	18	1992	In operation
Kayseri	Light rail (tramway)	17,5		In construction
Samsun	Tramway	17,5		Contract awarded in July 2008

In Bursa, a 12 km long light rail transit system, Bursaray, operates. Konya Tramway has been operating since 1992 and has a network length of 18 km and it has 20 stations. In Antalya short tramway line was opened in 1999 with a network length of 5,1 km. Eskişehir Tramway has 26 stations and the length of the system is 14,5 km. In Adana 65% of the system construction is completed. Adana light rail system will have 13 stations and it will be 13,5 km long. The construction of Kayseri light rail transit system project started in 2006 and when it is finished it will have a network length of 17,5 km and it will have 31 stations.

There are researches considering rail transport planning issues in Turkey. In a thesis considering urban transport modes and choice of public transport; urban transport systems were analyzed, categorized and compared to each other and in a selected corridor in İstanbul, a comparison is made according to costs of bus and metro systems (Yılmaz, M., 1987).

In another thesis about urban rail systems; importance of rail transit in public transport was examined, Ankara Metro and Ankaray systems were compared to different rail systems in different countries, performances and planning process of the systems were evaluated (Türkmen, M., 2001).

In the scope of a thesis prepared for Kütahya, the transport structure of the city was analyzed and a tramway system was proposed. The feasibility of the project was researched by analyzing travel demand, cost and physical conditions (Özatağ, A.S., 1995).

In a study by Özalp (2007), urban transport planning background was analyzed. Planning process and transport policies were examined, classifications were made. General idea about the history of transport planning was introduced.

In another thesis on metro station design listed some criteria on how a metro station can be made. The study recommended the design criteria under three headings: According to Design Process, According to Design Criteria and According to Operational Process. It was concluded that the design of metro stations has an important role that there should be a sincere consciousness. Another finding of the thesis was the relation between the design of the metro stations and the formation of urban identity. (Güneş, S., 2007)

As discussed above, the studies evaluate transport policies, analyze system performances, propose new systems or compare two different systems, recommend ststaion design for the systems and so on. However, these studies do not draw an overall picture of the experience of rail transit investments in Turkey. Considering that there are limited studies analyzing the planning, decision making, expectations, and outcomes or performance regarding the urban rail systems in Turkey, this study, therefore, has two main research questions:

a. What are the main objectives of the rail transit investments in Turkey? In other words, what are the expectations from these systems?

b. Are these expectations met?

The following chapter describes the methodology of the study, including the aim and objectives, method of analysis, data collection, and case study selection.

CHAPTER 4

METHODOLOGY

4.1. Aims and objectives

Rail transit systems require the highest amount of investment costs of all modes. Considering the high cost involved in the development of these systems, it is particularly important that their performance justifies this high cost and that expectations from these investments are met. Therefore, in the world, it has become an increasingly important field of research to study the performance of these rail systems in order to assess whether expectations from these investments, such as high ridership, reduced traffic, improved air quality, and cost-efficiency in operation, are met. It has been shown in the previous chapters that in the world there has been increasing concern regarding the accuracy of ridership and cost estimations for rail transit systems, and that many studies found that ridership was over-estimated while costs under-estimated. In addition, studies found that other expectations from these investments were not all fulfilled either, and that not all have been successful in helping increase ridership, reduce traffic congestion and air pollution.

In Turkey, such studies on rail transit investments in the country have been limited. There are researches on individual systems; however, there have not been a comprehensive and systematic evaluation of the rail transit experience of Turkish cities.

The study has two main research questions:

a. What are the main objectives of the rail transit investments in Turkey? In other words, what are the expectations from these systems?

b. Are these expectations met?

Consequently the main analysis is carried out in two sections:

a. The analysis of the planning background of rail transit systems in Turkey, with the objective of finding out what planners expected from these investments.

b. The performance analysis of the rail transit systems in Turkey

Therefore, the research, on which this thesis is based, aims to conduct a comparative analysis of different rail transit systems in Turkey in order to bring out the planning history behind and to assess their performance. This study first analyzes the expectations behind the rail transit systems in Turkish cities. Especially the decision making process, targets and estimates during the planning of these systems will be studied. Secondly these will be compared with the actual outcomes, i.e. the performance of the systems. Results of this research will lead us to observe the differences between expectations or forecasts in planning and actual results, which then can help the planning of future investments.

4.2. Case study selection

4.2.1. Selection criteria

In order to understand the objectives under the planning and decision making processes in the implementation of Turkish rapid rail transport investments, a sample group was selected among the cities currently operating rail transit systems.

Two criteria have been effective in case study selection:

1) Rail technology: It was decided to study heavier technology, hence higher capacity and higher cost rail systems. The literature review had shown that the failure to reach the high ridership capacity in spite of the high costs involved was the main problem with the current rail transit systems. Therefore, heavy rail systems (metro systems) and segregated light rail transit systems were selected, while street tramways were eliminated. As a result, four cities that are currently operating rapid rail transit systems were chosen to be studied: Ankara, İstanbul, İzmir and Bursa.

2) Availability of data: During the interviews and data collection for Istanbul systems, detailed data were also obtained for the Zeytinburnu-Kabataş tram system. Because of this available data, this tram system was included in spite of the initial intention of

excluding trams. However, due to time limitations, other tram systems, namely the Eskişehir tram and Konya tram, were not included. Although the Zeytinburnu-Kabataş tram is different in technology, cost, capacity etc. in comparison to the main case studies, its inclusion in the study was considered a positive aspect that can help to broaden the research and provide comparisons.

4.2.2.Information on cases

As shown in Table 4.1, there are two full-metro systems in the case studies: Istanbul Taksim-4th Levent metro and Ankara metro. There are three light metro or advanced LRT systems: Ankaray, Izmir metro and Aksaray-Havalimanı light metro. These systems are using LRT cars and they have LRT capacity; however, they take their power from a third rail like metro systems, and therefore they are fully-segregated. Such technologies are often discussed as pre-metro: they currently provide LRT capacity but they can be easily upgraded to a metro.

Bursaray is a LRT system. It is also fully segregated and separated from other traffic however; it takes its power from aerial lines rather than a third rail. Therefore its segregation is not a technological necessity but a measure to increase the speed and service quality. Bursaray is a more typical example of LRT technology.

As mentioned before, Zeytinburnu-Kabataş Tramway is a streetcar or tram system. It takes its power from aerial lines or overhead wires, and it partically runs in mixed traffic. The route is mostly segregated, i.e. other vehicles cannot use the corridor, but at intersections the system is designed with at-grade crossings.

It can be seen that in İstanbul, three rail transit systems are to be studied: Aksaray-Airport Light Metro, İstanbul Metro and Zeytinburnu-Kabataş Tramway. There are also ongoing rail transit investments but they are not studied here. In Ankara, there are two systems; Ankaray and the Ankara Metro. In Bursa, Bursaray have been operating since 2002 and the İzmir Metro started operating in August 2000.

Table 4.1. Systems used in the study

City	Name of system	Opening year	Type of system	Level of integration	Length of system (km)	Number of stations
Ankara	Ankaray	1996	Advanced LRT	Fully segregated	8.527	11
	Ankara Metro	1997	Metro	Fully segregated	14.6	12
Bursa	BursaRay	2001	LRT	Fully segregated	21.893	23
İzmir	İzmir Metro	2000	Advanced LRT	Fully segregated	11.50	10
İstanbul	M1 Aksaray-Airport	1989	Advanced LRT or “Light metro”	Fully segregated	19.95	18
	M2 Taksim – 4th Levent	2000	Metro	Fully segregated	8.5	6
	T1 Zeytinburnu-Kabataş	1992	Tramway	Partially/at grade crossing	13.2	24

Taksim-4Th Levent Metro is a fully segregated metro line having a total length of 8,5 km. Aksaray-Airport light metro line is also fully segregated from other traffic without level crossings and runs underground between Aksaray-Ulubatli Topkapi (3.1 km), Bakirköy - Bahçelievler (1.8 km) and Airport (0.3 km). With a network length of 13.2 km, Zeytinburnu-Kabataş is a partially segregated tramway system as described above.

Ankaray is an advanced LRT, or a light metro running between Dikimevi and AŞTİ. 6.6 km of the system is underground and Emek station is above ground, but fully segregated. Ankara Metro is also fully segregated. The line has 12 stations and it has a network length of 14.6

km (6.5 km of underground, 4.5 km on surface, 3.7 km of elevated railway). The line runs between Kızılay and Batıkent.

İzmir Metro line runs underground through the city center for 4.4 km between Üçyol and Basmane. It is elevated between Hilal and Halkapınar for 2.3 km and at grade (but fully segregated) between Stadyum and Bornova for 4.8 km.

Bursaray is a fully segregated LRT system having 23 stations with a network length of 21.893 km.

4.3. Method of Analysis

The study is expected to contribute to our understanding of the planning and performance of urban rail systems, and will have two major outcomes:

- Research is expected to reveal a set of objectives/expectations for investing in urban rail systems in Turkey.
- Research will demonstrate the performance of current urban rail systems in Turkey by revealing the extent that they meet the expectations.

According to the responses in the interviews, a number of objectives which are central to the decision making process will be identified. Analysis of objectives for investing in urban rail systems is important because these objectives reveal expectations of planners and policymakers from these investments. An accurate assessment of the urban rail systems can be made only when these objectives and expectations are fully understood.

Currently in Turkey, in spite of over 10 years of experience in urban rail investments, there is no comprehensive research and reliable information on what the planners expected from these investments, and to what extent the expectations have been met.

While it is straightforward to assess the performance of systems in certain expectations, such as ridership and cost because these require only forecasting data and actual outcomes; the task may not be as straightforward for other possible expectations, such as land-use change, traffic reduction, etc. If such expectations existed for the case studies, it cannot be within the scope of this study to conduct comprehensive land use analysis and traffic counts for each city; furthermore an accurate analysis would not be possible without a before-and-after study; and not all cities have reliable and regular statistics to construct a “before investment” case. Therefore, cost and ridership data will be the major analysis in the study, while other impacts, or achievement of expectations, will be assessed by consulting planners, researchers, and academics involved in the planning or monitoring of these systems.

4.4. Method of data collection

Information on the planning of the systems was obtained through semi-structured interviews that focus on the factors taken into account in deciding on the mode, and on the background and objectives of building the system. The interview questions were formulated as follows:

1. What are the reasons for constructing the system? Can you state the main objectives of the investment? (After an initial list was obtained from the interviewee, other possible list of objectives were also asked in Question 2 below)
2. Which of the expectations below were considered while constructing the system (and if they were), to what extent have they been achieved?
    a. Reducing traffic congestion
    b. Improving the image of the city
    c. Increasing the usage of public transport (increasing total passengers using public transport systems)
    d. Urban transformation/regeneration
    e. Decreasing air pollution
    f. Encouraging urban development
    g. Increasing the viability of the city center
    h. Decreasing the operating cost in public transportation, increasing efficiency
    i. Other
3. Which methods were used in the decision making process and in forecasting?
4. What are the criteria used for choosing the rail transit technology in the city?
5. What are the criteria used for choosing the route of the rail transit system?

In February, a study trip to Istanbul was made. Interviews were made with the officers in the İstanbul Greater Municipality Department of Transportation Planning, the academics of İstanbul Technical University Department of Civil Engineering, Department of City and Regional Planning and Mimar Sinan University Department of City and Regional Planning, employees of the İstanbul Ulaşım A.Ş. and employees of the İstanbul Metropolitan Planning.

In March and April, Ankara case was analyzed. Interviews were made with officers in the EGO Coordination between Transport and Planning Center, the EGO Department of Rail Transit System and the EGO Department of Management.

In April a study trip to Bursa was organized. In Bursa, interviews were made with the officers in the Bursa Greater Municipality Coordination between Transport and Planning Center and Burulaş. For the last case study, in June a study trip to İzmir was made. Interviews were made with İzmir Greater Municipality officers and academics in Dokuz Eylül University City and Regional Planning Department.

Where possible, technical reports were obtained from the municipalities, organizations and academicians to supplement the answers given in the semi-structured interviews.

CHAPTER 5

EXPECTATIONS FROM RAIL INVESTMENTS IN TURKEY: İSTANBUL, ANKARA, İZMİR AND BURSA

The reasons for implementing a rapid transit system vary from city to city. Some cities construct rapid transit lines to address major transportation capacity deficiencies, while others wish to defer the need for expensive and disruptive roadway expansions. In addition, improved quality and reliability of service, improved quality of life, reduced traffic congestion and the achievement of strategic land use objectives are all legitimate reasons for implementing a rapid transit system.

This chapter provides a review of the four major rail transit investments in Turkey, with a view to present the planning background and decision making of these systems, and the expectations that planners had in investing in these systems. The information presented in the following sections are predominantly based on interviews made with the planners and experts that were involved in the planning of the chosen rail transit systems.

In the scope of this study, the rail systems in İstanbul, Ankara, İzmir and Bursa are examined. Some preliminary information about the systems is given in Table 5.1.

Table 5.1. The rail transit systems used in the Study

	İZMİR İzmir Metro	**ANKARA Ankaray**	**ANKARA Metro**	**İSTANBUL Aksaray-Airport Light Metro**	**ISTANBUL TRAMWAY Zeytinburnu-Kabataş**	**ISTANBUL TRAMWAY Zeytinburnu-Bağcılar**	**İSTANBUL Taksim-4th Levent Metro**	**BURSAB Bursaray**
Management	İzmir Metro AŞ	EGO	EGO	İstanbul Ulaşım AŞ	İstanbul Ulaşım A.Ş.	İstanbul Ulaşım A.Ş.	İstanbul Ulaşım AŞ	Burulaş
Opening year	2000	1996	1997	1989	Sirkeci-Aksaray part: 1992 Aksaray-Topkapı part:1992 Topkapı-Zeytinburnu part: 1994 Sirkeci-Eminönü part: 1996 Eminönü-Fındıklı part: 2005 Fındıklı-Kabataş part: 2006	2006	2000	2002
Length of the system (km)	11.5	8.527	14.6	19.95	13.2	0.5124	8.5	21.893
Number of stations	10	11	12	18	24	9	6	23
Number of vehicles	45	33	108	78	52	14	32	48
Mean time headway	5 min	4.2 min	3.25 min	3-5 min	3 min	5 min	4.3 min	4-8 min
Passengers per day	75,000	125,000	160,000	240,000	N.A.	40,000	140,000	127,000
2007 ridership	28,548,741	44,646,512	64,237,405	54,423,063	51,867,061	8,506,932	37,266,774	

Source: İstanbul Ulaşım A.Ş, İzmir Ulaşım A.Ş, EGO, Burulaş

The following sections focus on the planning, decision making and development of these systems. The planning background of each system is presented; and expectations from investing in these systems are illustrated based on the interviews made for this study.

5.1. İstanbul

5.1.1. Decision making process

The urban transportation plans for İstanbul started dating back to the Ottoman Period. Until today, many transportation studies and urban planning studies were prepared (Özalp, 2007)

- Feasibility Study for İstanbul Metro (1970)
- İstanbul Urban Development Project Traffic Engineering and Control study (1975)
- İstanbul Metro Feasiblity Study (1978)
- İstanbul Urban Transportation plan (1982)
- Pre-feasibility Study for İstanbul Fast Tramway Project (1984)
- Feasibility Studies and Avant Project for Bosphorus Rail Transit Tunnel and İstanbul Metro (1985-1987)
- İstanbul Greater City Transportation Master Plan (1988)
- New Metro Network Proposals for İstanbul (1988)
- Strategical Network Plan for Europe Side Rail Transit System (1996)
- İstanbul Transportation Master Plan (1997)
- İstanbul Urgent Action Plan for Transportation (1998)

Feasibility Study for İstanbul Metro (1970) analyzed the feasibility of a metro system in İstanbul and it was prepared by the İETT (İstanbul Electric, Tramway and Tunnel Administration) and the Soviet Vsesojuneje Exporto-Importnoje (Technostroyexport) firm in 1970. In the study, a rail system composed of two lines and having a total length of 23 km was proposed. The construction was planned gradually and the first phase of the project; Topkapı-Yenikapı-Taksim-Zincirlikuyu line's (partially the same route that Istanbul Metro and Zeytinburnu-Kabataş tramway are passing today) management plan and technical properties were determined.

İstanbul Urban Development Project Traffic Engineering and Control study (1975) was prepared by experts of local institutions and a foreign consulting firm in 1973. A transportation plan was proposed.

İstanbul Metro Feasibility Study (1978) was prepared to evaluate the line proposal of Yenikapı-Taksim-Levent metro project. A system of 12 km, underground metro, passing through Yenikapı, Haliç, Taksim and Levent, was proposed.

İstanbul Urban Transportation plan (1982) was composed of three studies; signalization of junctions, study of parking areas and general transportation study. It was prepared by İstanbul Technical University in collaboration with the municipality. The study analyzed the transportation characteristics of the city, estimated the future demands and suggested proposals for the city.

Pre-feasibility Study for İstanbul Fast Tramway Project (1984) analyzed the feasibility of a tramway project on Aksaray-Halkalı-Ataköy route. This study was carried out particularly because the Mayor of that period was keen on having a tram line in the mentioned corridor.

Feasibility Studies and Preliminary Project for Bosphorus Rail Transit Tunnel and İstanbul Metro (1985-1987) was not a comprehensive plan in the scope of a transportation master plan. In this study a computer modeling system, TRANPLAN, was used to develop transportation alternatives for the year 2005. The plan developed a proposal of a metro system between 4th Levent and Topkapı and Bosphorus Rail Transit tunnel projects.

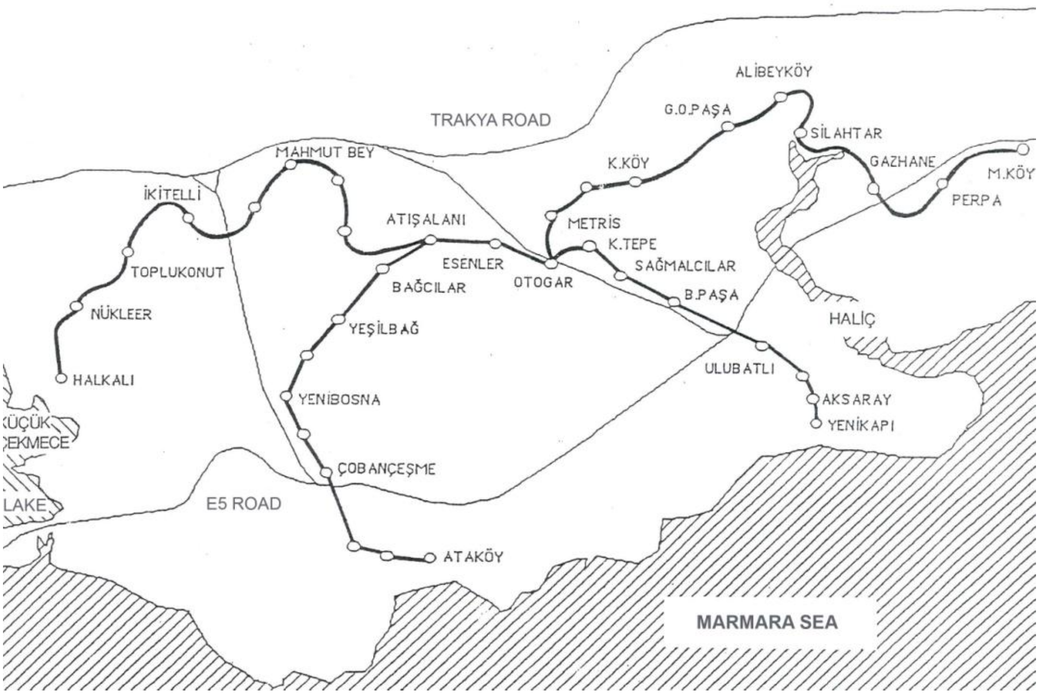
İstanbul Greater City Transportation Master Plan (1988) was prepared by Temel Mühendislik A.Ş. and Halcrow Fox to facilitate the decision making of transportation projects and to evaluate the project proposals systematically. The target year was chosen as 2005 and with the help of a transportation model, some strategic transportation system alternatives were developed and a road transportation system and a public transportation system network was prepared according to the target year's population estimation of 10 millions.

In 1988, **"İstanbul'da Yeni Metro Güzergahı Önerileri (New Metro Network Proposals for İstanbul)"** was prepared by Boğaziçi University. The aim of the project was to analyze the demand of the corridor for a metro investment and to make estimations for the year 2005.

This system would be an extension of Yenikapı-Ataköy route from Abidei Hürriyet to Halkalı. This new route would be a transfer point with the Yenikapı-Ataköy route.

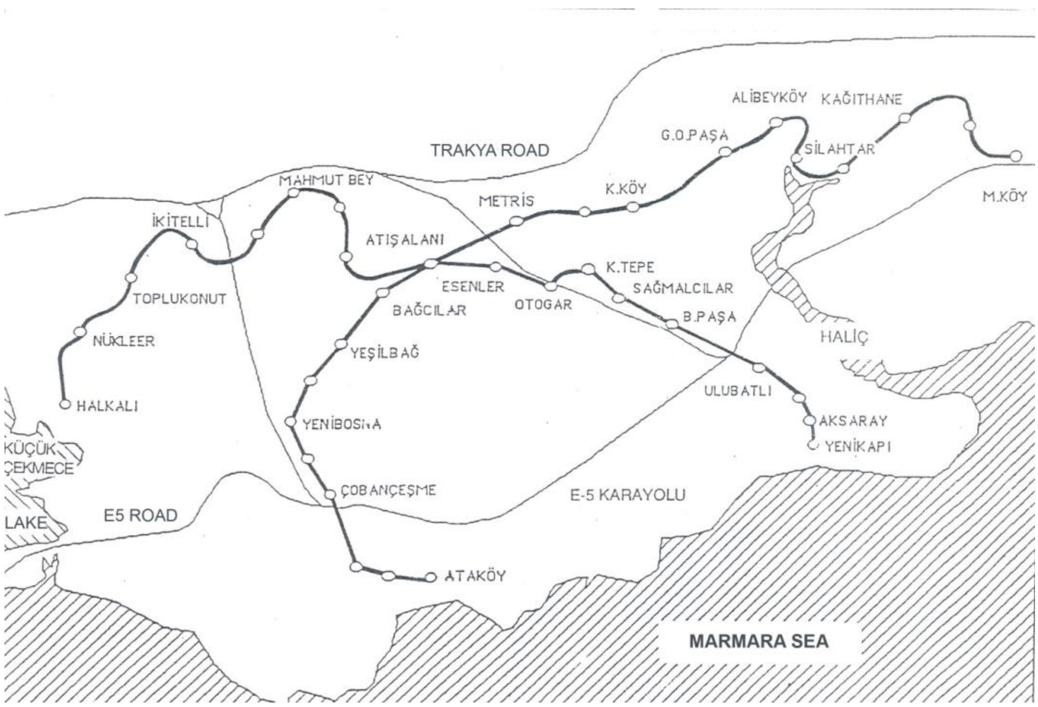
Assignment and simulation models were used in this plan. According to the results; it was estimated that 50-60% of total journeys to and from the Otogar would use the metro system. For the year 2005, ridership estimation for Otogar was 100,000 journey/day.

As in Figures 5.1.,5.2. and 5.3., different route scenarios were determined. The number of passengers carried between Aksaray and Topkapı would be high and Topkapı would be an intersection point of all modes. In this sense, Topkapı would become a transfer center. The high demand corridor of Bağcılar and Esenler would be carried with a metro system supported with other modes in order to carry the capacity of the corridor. Mecidiyeköy-Halkalı route was seen as a necessary route because this would be a high demand corridor and another alternative for this route could be the extension of the route to Levent.



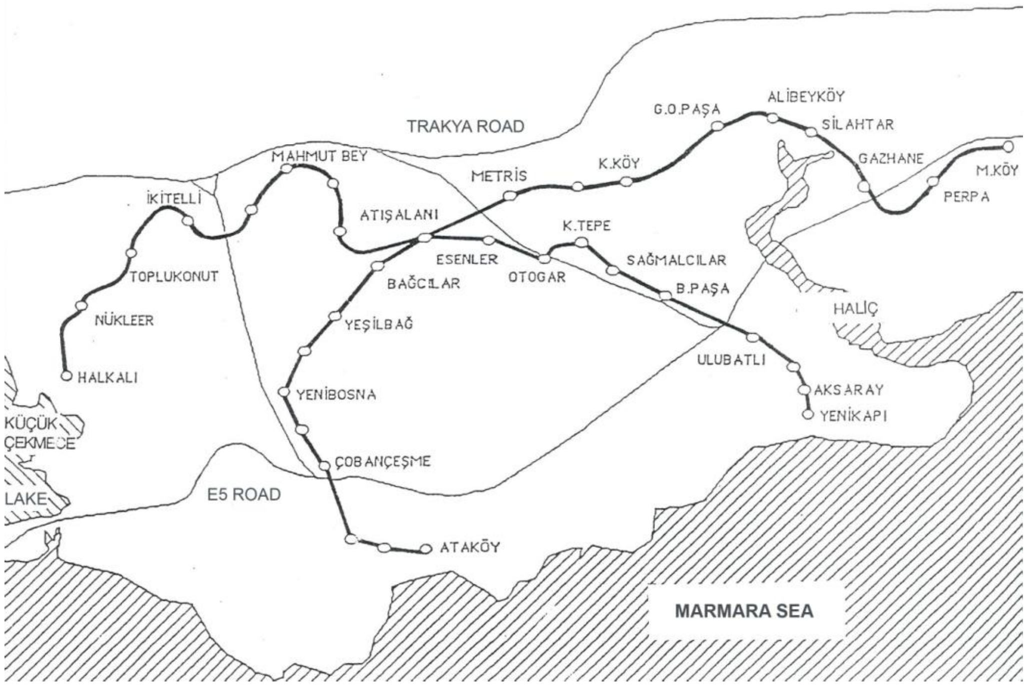
Source: New Metro Network Proposals for İstanbul, 1988

Figure 5.1. Route alternative 4



Source: New Metro Network Proposals for İstanbul, 1988

Figure 5.2. Route alternative 6



Source: New Metro Network Proposals for İstanbul, 1988

Figure 5.3. Route alternative 11

Another transport plan for İstanbul was prepared in 1997 by İstanbul Technical University and Greater İstanbul Municipality. **“The Transportation Master Plan (1997)”** put forward land use and urban transportation objectives and policies for the year 2010. In the plan, the aim was to find out the effects of new transportation investments on urban transportation system of the city and to expose the demand corridors.

This study evaluated and investigated all modes of transportation in the İstanbul metropolitan area. 9 transportation system proposals were tested by using a model considering two different urban development scenarios for İstanbul (one was the development plan proposal and the other was existing development trend) and finally the plan proposed 274 km rail transit network for the city.

The model was used to investigate the effects of urban land use changes on transportation system. The proposals 1, 3 and 4 were accepted as the primary choices and they were compared with the proposal 9. In this comparison; travel demand, maximum cross section traffic, passengers per kilometer, passenger-hours, passenger kilometers, modal split and impact on road network were used as standards.

Proposal 1 was the situation in which there would be no further addition to the ongoing transportation system investments. There was only the Taksim-4th Levent metro system of 7.1 km long as a new investment. The total length of the rail system was to be 97 km (suburban rail system, metro system and present tramway lines)

Proposal 3 comprised a widespread rail system network in the two sides of the city. Ayazağa-Topkapı metro was to be extended through Topkapı to Bağcılar. In order to overcome high journey demands between İkitelli and Aksaray, Bağcılar-İkitelli route was projected as a metro system. In the west side of the city: Vezneciler-S. Çiftliği, Otogar-Şişli, Halkalı-İkitelli and the in the east side of the city: Harem-Kartal and Üsküdar-Ümraniye-Dudullu light metro systems were proposed. In addition to that, Atatürk Airport rapid rail transit system was connected to the light metro systems. In this proposal total rail network was to be 213 km.

Proposal 4 introduced three suburban rail systems in addition to those in Proposal 3, and these systems were to be integrated with a Bosphorus tube rail system between Söğütlüçeşme and Yenikapı. The total rail transit network was to be 226 km.

Proposal 9 included all the rail transit systems and new road investments that were proposed in previous proposals. The light metro between Harem and Kartal was connected to the new airport in Kurtköy and the light metro between Üsküdar-Ümraniye-Dudullu was connected to Ümraniye-Kozyatağı line and Harem-Kartal. The total system length was to be 270 km. A

Bosphorus tube rail system and a third bridge (road+railway) were also in the scope of this proposal.

Table 5.2. The Rail Transit Investments Proposed for the year 2010 for İstanbul

	Metro	**Light metro/Tramway**
1st Group	Taksim-Yenikapı metro(5 km) 3rd suburban rail system (66.4 km) Bosphorus Rail Tube (13 km) Yenibosna-Atatürk Airport (2.8 km)	Otogar-Bağcılar-İkitelli OSB light metro (10.1 km) Aksaray-Yenikapı light metro (0.6 km) Kadıköy-Bostancı Tramway (7 km)
2nd Group	Yenikapı-Topkapı-Bağcılar metro(10.3 km) Bağcılar-İkitelli metro(10 km) Menekşe-Beylikdüzü metro(13.6 km) 4th Levent-Ayazağa metro (3.4 km)	Harem-Kartal light metro (21.1 km) Üsküdar-Ümraniye light metro (9.1 km)
3rd Group		Otogar-Şişli light metro (20.8 km) İkitelli OSB-Olimpiyat Köyü light metro (7 km) İkitelli-Halkalı light metro (7 km) Kartal-Kurtköy light metro (11.7 km) Ümraniye-Kozyatağı light metro (5.4 km)

Source: İstanbul Transportation Master Plan, 1997

The priorities of these systems were determined using these criteria:

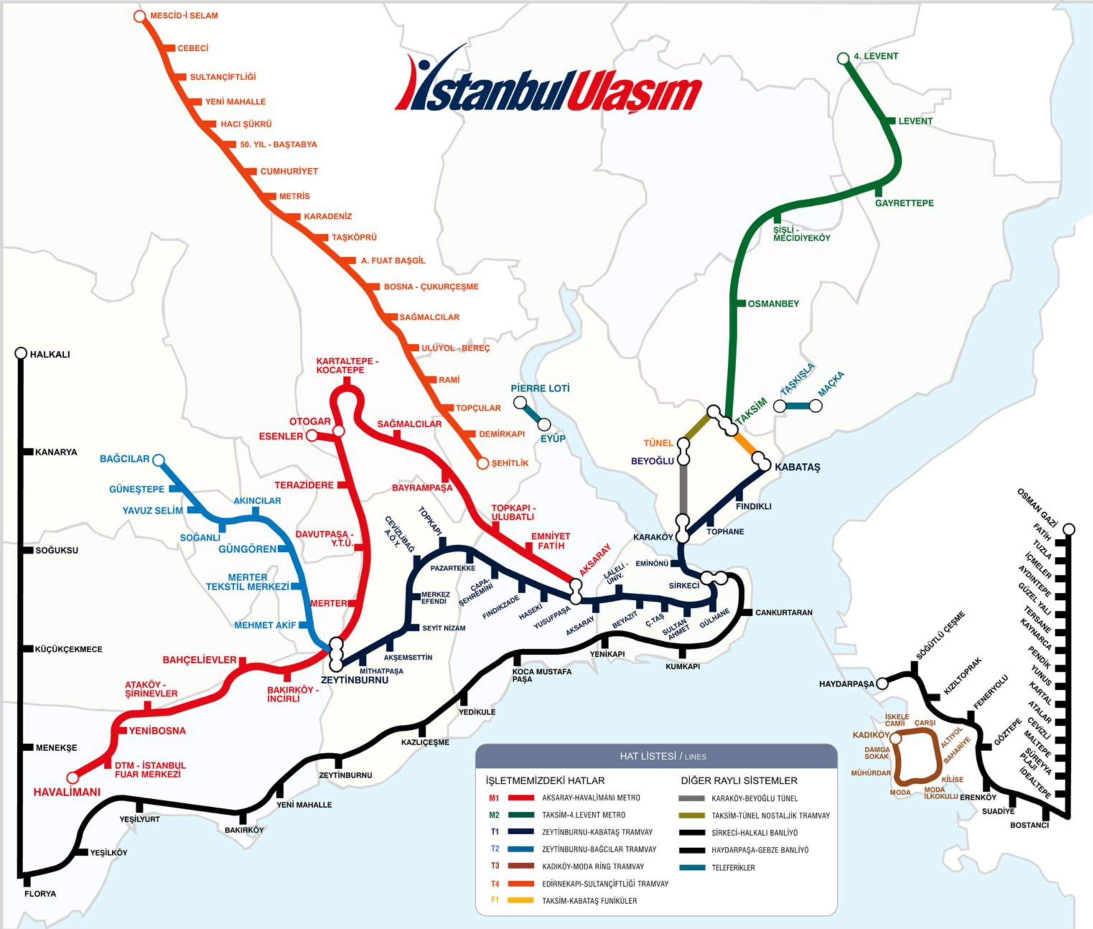
- Daily journey demands
- Average journey demands/km
- Maximum cross section traffic of morning peak hours
- Ranking possibilities of the new systems

In an interview with Prof. Dr. Haluk Gerçek (İTÜ, 17.02.2009), he stated that there are different elements in decision making process of the transportation investments in İstanbul. While plans are being prepared, there are always political pressures imposed by local or central authorities, and these affect the projects. He added that in some studies it was possible that costs are underestimated and ridership overestimated in feasibility reports. In addition, the planning process is said to be a participatory one in which the chambers of architects and city planners are involved, whereas this is not always the case. This is highly recognizable from the lawsuits against the transportation investments. Prof.Dr. Tülay Kılınçaslan (İTÜ, 19.02.2009) claimed that, advisors from other countries came to İstanbul, such as Vuchic, and they had a significant influence on the preparation of the projects too.

5.1.2. The systems currently operating in İstanbul

In the section 5.1.1, the plans prepared for İstanbul have been discussed. Until today five of the systems have been constructed: İstanbul Metro, Aksaray-Airport Light Metro, Zeytinburnu-Kabataş tramway and Zeytinburnu-Bağcılar extension to the tramway.

There are ongoing investments too: İstanbul Metro extension (4th Levent-Ayazağa), Kadıköy-Kartal Metro, Taksim-Yenikapı Metro and Haliç Metro Bridge. (İBB internet site)



Source: İstanbul Ulaşım A.Ş. Management Report, 2008

Figure 5.4. İstanbul rail transit network

In this section the rail transit systems that are operating will be analyzed (Table 5.3.)

Aksaray-Airport Metro

The first stage of the system was the Aksaray-Otogar route. In the 18th of December, 1989 Esenler station, in the 31st of January, 1994 Otogar and then the second stage that is the Terazidere, Davutpaşa, Merter, Zeytinburnu and Bakırköy stations were opened and increased the potential of the system. In the 13th of December, 2002 last two stations; World Trade Center and the Airport were added (İstanbul Ulaşım A.Ş.) By integrating the system with the Atatürk Airport, daily 35,000 to 55,000 passengers could be connected directly to the city from the airport. The capacity of the system is 36,000 passengers/ direction. The Aksaray-Airport light metro system carries 240,000 passengers daily.

Table 5.3. System characteristics

The system	**Opening year**	**Actual ridership of passengers pass/hour/direction**	**The length of the system (km)**	**Number of stations**	**Number of vehicles**
Aksaray Airport Metro	1989	9,704	19.95	18	78
Zeytinburnu-Kabataş Tramway	Sirkeci-Aksaray part: 1992 Aksaray-Topkapı part:1992 Topkapı-Zeytinburnu part: 1994 Sirkeci-Eminönü part: 1996 Eminönü-Fındıklı part: 2005 Fındıklı-Kabataş part: 2006	5,528	13.2	24	52
İstanbul Metro	2000	9,331	8.5	6	32

Note: Characteristics were retrieved from http://ibb.gov.tr/tr-TR/SubSites/raylisistemler.

Zeytinburnu-Kabataş Tramway

The Sirkeci-Aksaray-Topkapı part of the system was opened in 1992, Topkapı-Zeytinburnu part was opened in March 1994 and Sirkeci-Eminönü part was opened in April 1996. The system was extended to Kabataş in January 2005 and the integration between Taksim-Kabataş Funicular system and sea transportation systems was achieved. (İstanbul Ulaşım A.Ş.)

Zeytinburnu (Güngören)-Bağcılar Tramway

The aim of the system was to extend Zeytinburnu –Kabataş Tramway to Güngören-Bağcılar direction. It was opened in 2005 at it started operating in 2006.

İstanbul Metro

The construction of the system began in 1992 and it started to operate in 2000. The main objectives for building the system were to solve the traffic problem in the city and to give İstanbul a modern city image (İstanbul Greater municipality website).

This line was intended to serve the North-South Transportation Line in İstanbul. This project was prepared by the Ministry Of Transportation between 1985-1987 in an integrated way with the Tube tunnel project for the Strait as it was mentioned in the section 5.1.1. Firstly it was planned to construct Metro between Topkapı and Levent, however after 1990 the number of residences, industrial and trade centres increased drastically in 4th Levent and Maslak. Therefore the line was decided to take place between Taksim and 4th Levent.

Meanwhile, in Ayazağa too multi-floor business and trade centres increased, some in an unplanned manner. In addition, there are İstanbul Technical University, Işık University and Ataturk Auto Industry in this area. In fact, the idea of extending the Metro beyond Maslak has been rejected since this "could negatively affect natural and urban assets that should be protected in the north part of Istanbul and could violate principles of master plan development" as stated by Monuments Board. However, after 1998, metro project between 4th Levent and Ayazağa started to be planned. The length of the route between 4th Levent and Ayazağa is 3125 meters and there are two stations one of which is the Industry Station in Levent Auto Industry and the other is Ayazağa Station in the intersection of İstinye route and Sariyer route in Maslak. The construction of an additional metro station and a transfer center which would foster the integration with other public transportation vehicles have been considered according to the needs of the aforementioned area. The cost of the system was 602 million dollars. (İstanbul Greater municipality website)

There are differences between the planned systems and the implemented systems. These differences are in the route of the systems, in the technology of the systems, and in the priorities constructing the stages of the systems. In the interviews, the reasons of the changes were asked. Mustafa Metin Yazar (İstanbul Ulaşım A.Ş, 18.02.2009) stated two reasons as; the change in the land use pattern and the pressure by the politicians. He gave the example of the demands of district municipalities to have the rail transit routes in their territories and to have a station. These demands affected the system. Prof.Dr. Tülay Kılınçaslan (İTÜ, 19.02.2009) emphasized the power of land owners in İkitelli, and she stated that the route change is a decision given on behalf of the land owners. Gerçek (İTÜ, 17.02.2009) argued that sometimes the change is because of the change in the land use patterns; sometimes it is hard to find an area to construct the station and the route selection changes.

In the implementation stage of the investments some changes occur. Gerçek (İTÜ, 17.02.2009) stated that in 1997 Transportation Master Plan a rail system of 210 km network was projected in İstanbul. In this plan the preferential routes were selected. Gerçek (İTÜ, 17.02.2009) stated that the routes which were selected in the 1997 Transportation Master Plan were the demand corridors and for İstanbul, it could be said that, the plan and the implemented rail transit investments are convenient in these corridors. Murteza (İstanbul Greater Municipality Department of Transport Planning, 20.02.2009) supported this argument; however, he stated that Aksaray-Airport and Zeytinburnu-Sirkeci routes were accepted despite the fact that these corridors were not suggested in the plan. Yazar (İstanbul Ulaşım A.Ş., 18.02.2009) stated that from the year 2000 the Transportation Master Plans were coordinated with the Urban Development Plans, which provides accurate estimations and helps to ensure the objectives of the investments.

For the changes that occurred during implementation, Prof. Gerçek gave the example of Harem-Kartal route change (although a new system not analysed here). The system started from Kadıköy rather than Harem. Yazar (İstanbul Ulaşım A.Ş., 18.02.2009) argued that this was compatible to the plan although not originally designed. The İstanbul Metro which ends with Maslak station in the plan was also changed and extended to Darüşşafaka. These decisions were taken by the municipality in an ad-hoc manner; they are not the outcomes of the plan.

Aksaray Light Metro was planned to have a route which ends in Bağcılar when Dalan was the mayor of İstanbul. After the local elections, Sözen came into power and he gave his support for a route which ends in Otogar-Yenibosna. However the first proposal was designed to meet the travel demand between Aksaray-Airport and Aksaray-Bağcılar; so this new implementation was inaccurate when demand lines are considered. It appears that this change was due to political reasons. It is also possible that this might be because the construction cost was lower in the implemented route (Mustafa Metin Yazar, İstanbul Ulaşım A.Ş., 18.02.2009). Nevertheless, Mustafa Murteza (İstanbul Greater Municipality Department of Transport Planning, 20.02.2009) states that this implementation is an "unplanned route". In the first study (1985) ridership estimation for the year 2005 was 300,000 passenger/day for Aksaray-Bağcılar system. It was stressed in the interviews that if this route was constructed this number would be consistent. Today although the system is built as a light metro, the Aksaray-Otogar part of Aksaray-Airport light metro system is operating overcapacity (Mustafa Metin Yazar, İstanbul Ulaşım A.Ş., 18.02.2009). It is claimed that heavy metro would have been more appropriate in that corridor.

Another "unplanned route" is the connection of 4th Levent and Ayazağa as mentioned above. Normally, in the plan the last station is the Maslak station. However, in order to make use of the already existing tunnel (by only extending it a little further) and to increase popularity by voters, this route was extended to Ayazağa. Being an "unplanned route", it has deficiencies in the number of vehicles that in return makes it an inefficient route. There is a dependence on foreign companies for vehicles. This route needs 200 vehicles, however the companies could provide 4 vehicles in each month. So the system serves in every 20 minutes to overcome this problem. (Mustafa Murteza, İstanbul Greater Municipality Department of Transport Planning, 20.02.2009)

In the period of Gürtuna, the mayor demanded a study for a tramway system to be constructed. Consequently, Kabataş-Sirkeci tramway route and Vezneciler-S.Çiftliği route was constructed. However it is stated these routes also operate inefficiently. (Mustafa Murteza, İstanbul Büyükşehir Belediyesi Ulaşım Planlama Müdürlüğü, 20.02.2009)

In the interviews the reasons of inaccurate estimations (if there were any for the relevant cases) were asked. Prof.Dr. Haluk Gerçek (İTÜ, 17.02.2009) claimed that the population increases continuously in İstanbul, so it changes the data used in the models. He argued that the mistakes are because of the data, not the model itself. Mustafa Murteza (İstanbul Greater Municipality Department of Transport Planning, 20.02.2009) supports this argument and stated that these mistakes usually happen in the implementation stage of the process.

5.1.3.Expectations from the rail transit investments

Rail transit investments are massive in all respects. They require extremely high costs of construction; but they are also believed to have a wide variety of strong impacts, on public transport, car traffic, urban land-use and environment. It was one of the objectives of this study to find out whether the planners had an awareness of all these possible potential impacts and benefits of rail transit systems. The expectations from the rail investments were asked in the interviews with planners and experts involved in the decision making process of these investments.

Table 5.4. Expectations from the rail transit investments in İstanbul

	İstanbul	**Explanation**
Reducing traffic congestion	+	It could be seen as a goal however there are no supportive policies.
City image	-	**None of the interviewees emphasized this**
Increasing total passengers in public transportation systems	-	**None of the interviewees emphasized this**
Urban transformation/regeneration	+	İkitelli-Başakşehir
Decreasing air pollution	-	**None of the interviewees emphasized this**
Encouraging urban development	+	Example of İkitelli
Increasing the viability of the city center	-	**None of the interviewees emphasized this**
Decreasing the operating cost in public transportation, increasing efficiency	-	**None of the interviewees emphasized this**
Other	+	Economical, fast and safe transportation for people Creation of a better integrated system with the addition of rail transit

There are some objectives of each municipality, city or organization to invest in a project. The objectives of İstanbul were asked and Gercek (İTÜ,17.02.2009) (who has been involved in the transportation plans of the city in the late 1990s) argued that reducing traffic congestion could be seen as a goal of the rail transit investments, however the policies implemented in the city were not suitable for such a goal. Provision of more parking areas in the city centres and construction of new multilevel junctions to improve vehicle flow and vehicle speeds are clear examples that there are no such policies in the city. Reducing traffic congestion, as an objective, was also asked to Mustafa Murteza, and he claimed that this objective was not a primary one in investing rail transit investments in İstanbul; because he stated that car ownership would not decrease even if new rail systems are constructed. It is accepted in transport planning literature that when urban rail investments are supported with complementary policies of car restriction, such as reduced car parks, increased parking pricing, and other financial measures including congestion charging, they can help reduce traffic congestion and that this can be a major benefit/expectation from investing in these systems. However, it appears that this potential benefit was not recognized in the Istanbul case.

In the 1997 Transportation Master Plan, objectives for the investment were presented. The plan suggested that the service quality and capacity of public transportation systems would be increased, and that the rail system would provide an economical, fast and safe transportation for people. The plan suggested that the transportation network should be composed of high capacity rail transit systems and all the modes should be integrated with each other.

In the 1997 Transportation Master Plan İstanbul Metro –"the most important system of İstanbul" as quoted by Mustafa Murteza (2009) - was planned to pass through Yenikapı, İncirli, Kirazlı, Başakşehir and industrial areas with supportive routes. However, this route was passing through empty areas, so it was decided to change the route and it was planned to go from southern parts. (Mustafa Murteza, İstanbul Greater Municipality Department of Transport Planning, 20.02.2009) Similarly, in order to pass through high demand corridors the Bakırköy-Beylikdüzü route was also changed. (Mustafa Murteza, İstanbul Greater Municipality Department of Transport Planning, 20.02.2009). These examples show that creating new development in under-developed areas was not an important objective or expectation for these rail systems; attaining a high ridership level by using high-demand alignments was considered more important by planners.

There are investments to encourage urban development, to create transfer centers and to increase integration, which is the case in Bakırköy. (Mustafa Murteza, İstanbul Greater

Municipality Department of Transport Planning, 20.02.2009) Yazar (İstanbul Ulaşım A.Ş., 18.02.2009) gave the example of İkitelli, that in order to encourage urban development the metro passes through İkitelli. Therefore, encouraging urban development can be considered as one of the objectives of the metro system.

Sometimes the circumstances affecting the planning process change according to the dynamics of the city. Yazar (İstanbul Ulaşım A.Ş., 18.02.2009) stated that İstanbul Metro is compatible with the plan. The Olympic Village was not a case in the 1997 Transportation Master Plan. New development areas, such as İkitelli-Başakşehir, were not included in the plan. In order to change the land use pattern in İkitelli, the route of the system and the technology was changed from a light rail system to a heavy rail metro system. But, today the plan is to construct a system composed of both a light metro and a heavy metro system.

5.2. Ankara

5.2.1. Decision making process

In the 1970s, Ankara was facing problems in the urban transportation system. The public transport system could not meet the mobility demands. Many studies were prepared with a view to improve the public transport system. Most of the studies were assessment reports and/or recommendations of some institutions and experts. After the 1970s, the studies became more comprehensive and were based on urban development plans. (Özalp, 2007)

- Ankara Transportation Study (Ankara Kenti Ulaşım Etüdü) (1970-1972)
- Ankara Urban Rail Transit Project (Ankara Kentiçi Raylı Toplu Taşın projesi) (1978-1980)
- Ankara Feasibility Study of Rail Transit Investment (Ankara Raylı Toplu Taşıma Sistemi Fizibilite Etüdü) (1980-1984)
- Ankara Urban Transportation Study (Ankara Kentsel Ulaşım Çalışması) (1985-1986)
- Ankara Transportation Master Plan (Ankara Ulaşım Ana Planı) (1992-1994)
- Ankara Traffic and Transportation Improvement Study (1998)

Ankara Transportation Study (1972) was prepared by Ankara greater Municipality EGO General Management and a French firm SOFRETU to defend the need for a metro system for Ankara. The proposal system was composed of two lines intersecting at Kızılay about 14 km long and it was an underground system. The first stage of the Project was the line between Dışkapı-Kavaklıdere (7 km) and the second stage was the line between Dikimevi-Beşevler (7 km). The system was rejected by State Planning Organization (SPO) on the grounds that it proposed a system dependant on French technology, that the design standards were not adequate and that the financial support was not clear. (Özalp, 2007)

Ankara Urban Rail Transit Project (1980) was carried out by an organization of urban transportation planners in EGO General Management and a consulting firm; Yapı Merkezi. The data for population, land use, topography and number of passengers carried by the transportation systems were collected. The present transportation system and demand of journeys were found after the data collection. With the help of a mathematical model, projections for the year 1990 were made. A network of 25 km and 90% at ground rail transit system was recommended. The study consisted of only one corridor in the city. In this sense experts did not find it realistic and they claimed that it would be a system used overcapacity and that it was an expensive proposal. Construction of the system started in 1980 without having an approval. It was stopped by the government in a short period of time. (Özalp, M., 2007)

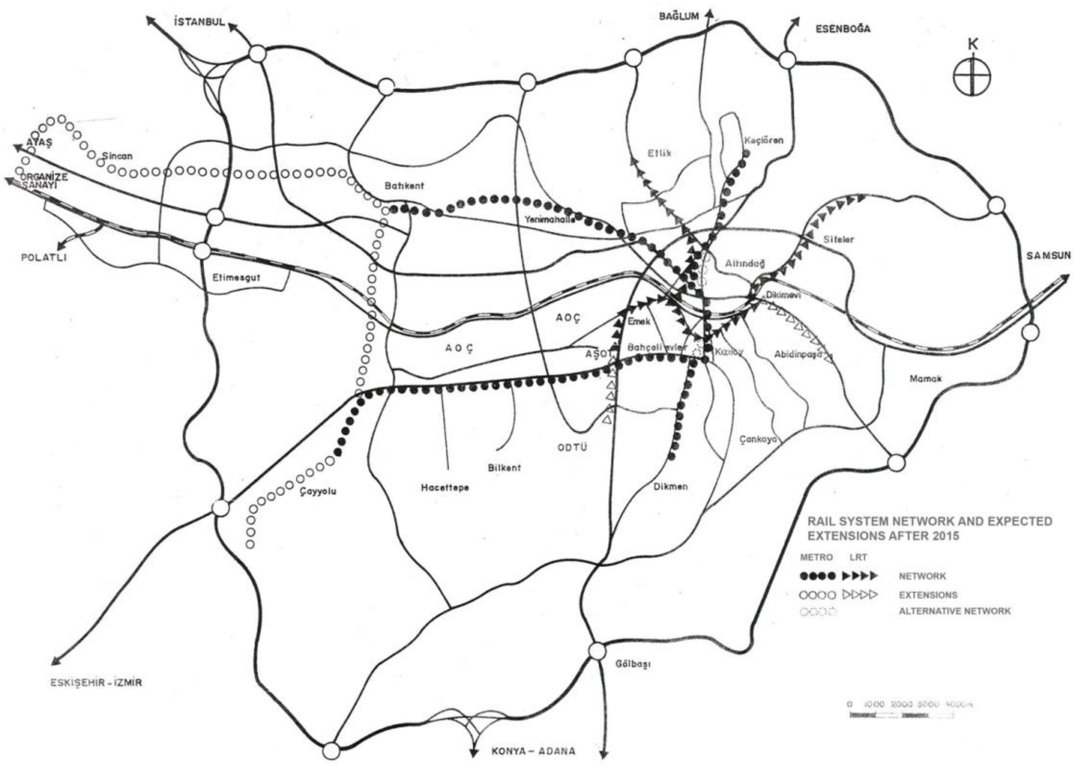
Ankara Feasibility Study of Rail Transit Investment (1983) suggested the project of Kavaklıdere-Dışkapı line. It was prepared by the Municipality, the Ministry of Public Works and Settlement and a consulting firm; Transurb Consult. The study was financed with the United Nations Development Programme. In 1984, the Ministry of Public Works and Settlement rejected the project because it used the data from the 1979 study and it did not lean on a comprehensive land use and transportation plan. (Özalp, 2007)

Ankara Urban Transportation Study (1985) is composed of four different studies: Transportation Study, Transportation Master Plan, Feasibility Study for Rail Transit Investment and Documents, Description of the System, Bid Documents and First Draft.

The study determined the main public transportation corridors and recommended a rail transit system of 55 km long and a busway system. Ankara Urban Transportation Study is an integrated approach of urban transportation and urban development. The urban development plan proposed that Ankara would have a decentralized development along two corridors supported by metro systems (Babalık, 1996). The transportation study adopted these development pattern proposals as the basis of the rail investment plan.

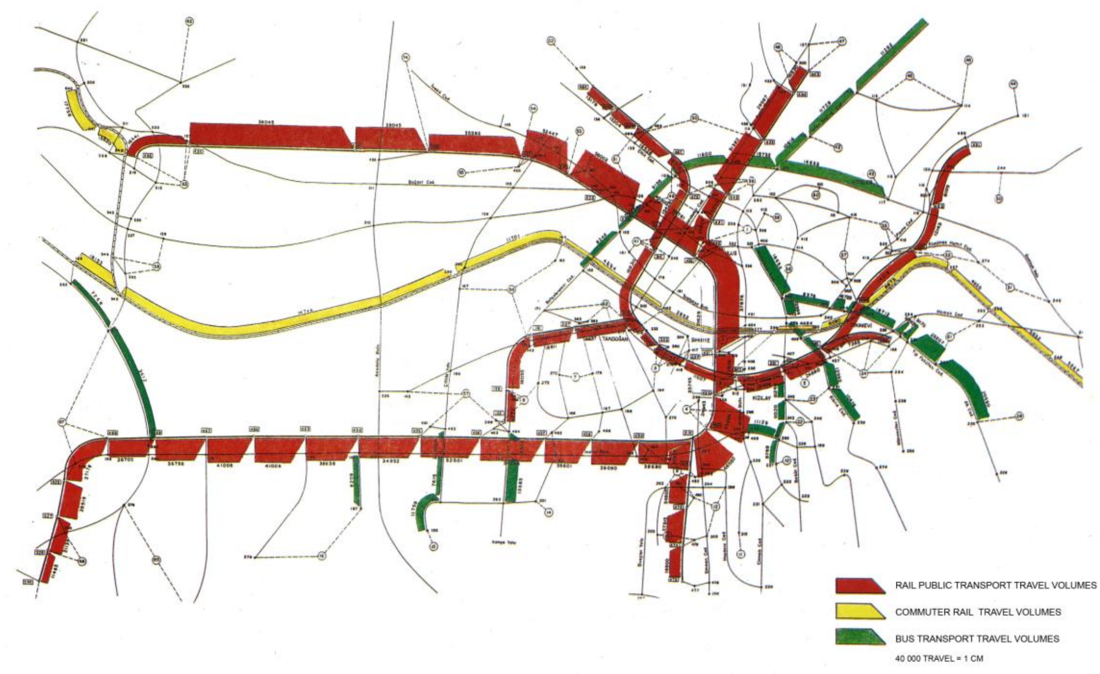
This study is a comprehensive and long-term study. On the other hand, the transportation study did not become a legally approved transport plan. Nevertheless, the construction of the rail system started. (Çubuk and Türkmen, 2003)

Ankara Transportation Master Plan (1994) was prepared by EGO General Management and consulting firms. In fact the plan adopted the main policies and principles of the previous transportation study; however, data were updated and some changes occurred in plan proposals. Rail system network, rail and bus transport travel volumes were determined as shown in Figures 5.5. and 5.6.



Source: Ankara Transportation Master Plan, 1994

Figure 5.5. Rail system network and expected extension after 2015



Source: Ankara Transportation Master Plan, 1994

Figure 5.6. The travel demand corridors

IBIMOD modeling programme developed by a Canadian IBI Group was used to determine the demand corridors using the variables, such as land use, socio-economical structure of the city, population, employment and so on. The decisions made in the previous studies about the preferential rail transit lines were verified, policies of management of systems and integration were developed. The plan was divided in four phases:

- First phase:1995

  The construction of Kızılay-Batıkent line has been started and the line was estimated to be finished in 1997. Ankaray (Dikimevi-AŞTİ) would be opened in 1996.

- Second phase:2005

  The Çayyolu-Kızılay metro line would be finished in 2000. Keçiören-Ulus line was expected to be constructed by 2005.

- Third phase: 2015

  In the end of 2015, all the rail transit investments would be constructed.

- Fourth phase: after 2015

  The extensions of the rail systems-if needed- would be constructed.

The plan was accepted in 1994 by Ankara Greater Municipality and approved by Ankara Transportation Coordination Center (UKOME). (Özalp, 2007)

The aim of **Ankara Traffic and Transportation Improvement Study (1998)** was to guide the institutions responsible of the operation of rail transit systems by developing policies and to improve the public transportation systems in Ankara. It was completed in 1998 by a consortium of Parsons Brinckerhoff Ltd, Ulaşım Art Ltd and Yüksel Proje A.Ş. (Özalp, 2007).

The transportation master plans and studies were not fully implemented and one of the priority lines could not be constructed in Ankara. Metro 2 (Çayyolu Line) was first announced to be postponed and then dropped from the plans in the early 2000s, although it was later started to be constructed. More than six years after the construction started, the system is still not open and construction continues. Keçiören Line also started to be constructed; however, that line is not completed either. Etlik Line appears to have been postponed since there are no current plans to start construction. On the other hand a new line, which was not in the transport plan, started to be constructed as the extension of the first line of the Batıkent Metro. This line connects Batıkent to Sincan, and there are arguments that the decision for introducing this line was a mistake, both because the line capacity for such a long route would be insufficient, and because the line parallels the commuter railroad which could have been improved instead of this new investment.

It is concluded from the plans that the current rail transit systems in Ankara are based on the 1986 transportation study and the 1994 transport plan, as described above. In 1979, a metro Project connecting Ulus (the historical center of Ankara) with Kızılay (the new central business district) has been prepared. The construction of the system had started in 1980 but disrupted and stopped in the same year. In the second phase it was proposed to connect the western settlements with the two centers and in the latter phases the new development areas suggested were connected to the city centers.

During the administration of the liberal party by Altınsoy, an underground metro project started to be discussed in 1984. With foreign consultancy on the preparation of a rail transit system it was decided to construct a light rail transit system which would be a developed form of the previous urban rail study of late 1970s. Additionally it emphasized accessibility of western settlements to the city.

In the first proposal of the metro system (1980s), it was decided to construct through Built-Operate-Transfer system. However; some problems occurred in the implementation of BOT system and the construction of the metro had to be delayed. After the Karayalçın came to power in Greater Municipality of Ankara in 1989, foreign aid was supplied to construct the system. Karayalçın, the mayor of the period, suggested a new light rail line in the project. With this addition, the proposal was composed of two systems; an underground metro connecting the old and new central business districts of Ankara with North-western settlements; and the light rail system, predominantly underground, connecting the new central business district with the east and west (inner city) settlements. (Babalık, 1996)

5.2.2.The systems currently operating in Ankara

In Table 5.5., the properties of the systems operating in Ankara are given.

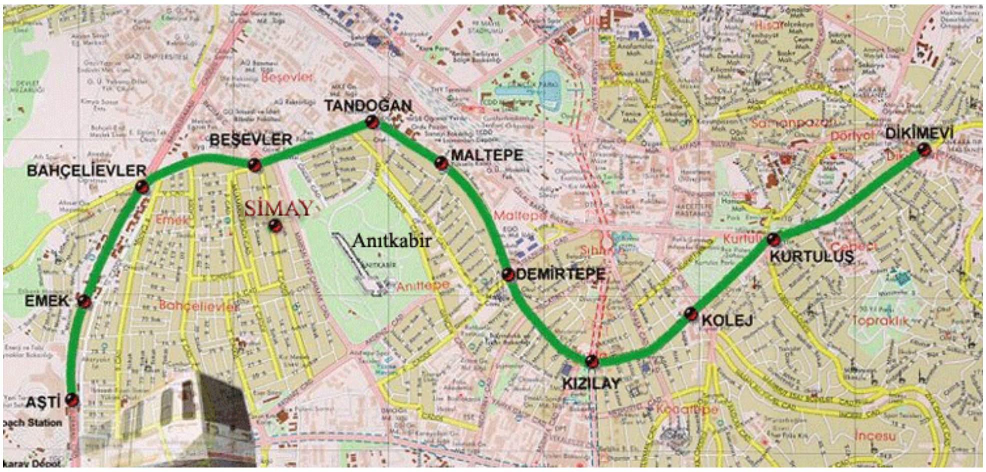
Table 5.5. System characteristics

The system	Opening year	Vehicle Capacity (passenger)	The length of the system (km)	Number of stations	Number of vehicles
Ankaray	1996	308 (60 seated)	14.6 km	12	33
Metro	1997	275(64 seated)	8.527 km	11	108

Source: Ankara Greater Municipality website

Ankaray

The system was constructed to meet the demand of public transportation services and to connect the city center to AŞTİ (Ankara Intercity Bus Terminal). The route of Ankaray starts from Terminal to Beşevler, Tandoğan, Maltepe, Kızılay and Dikimevi. In this corridor there was a busway operating between Dikimevi-Beşevler and the system was carrying 8000-9000 passengers/hour/direction (Türkmen, 2001).



Source: http://web.ego.gov.tr/parts/egoankarayhizmetleri.asp

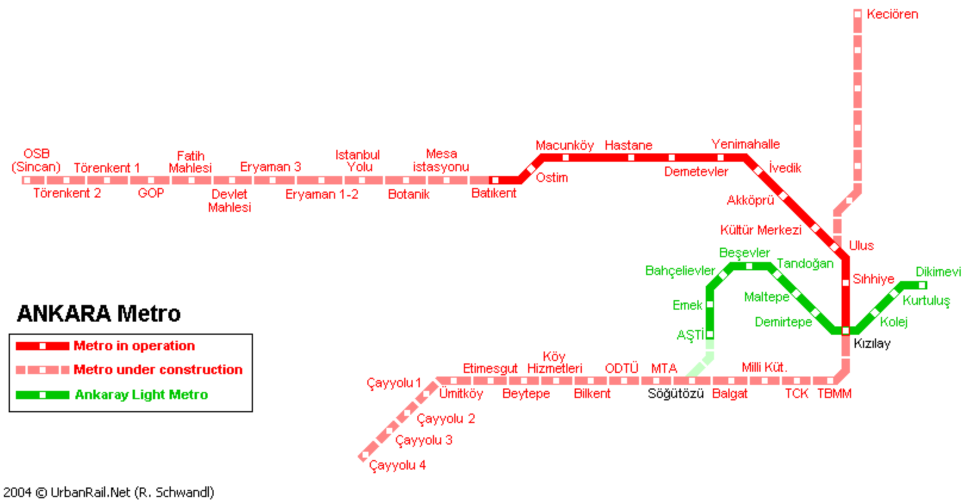
Figure 5.7. Ankaray line

In the Transportation Master Plan (1994) Ankaray is projected to have a network length of 22 km in 2015. It would have 3 different lines; Dikimevi - AŞTİ, Kurtuluş – Siteler and Maltepe - Etlik. (Çubuk and Türkmen, 2003) Today, only the first line is operating.

Metro

The Ankara Metro was opened in late 1997. The system operates between Kızılay and Batıkent. It is connecting the city center to the new residential and industrial developments that were proposed in the urban development plan under the decentralization strategy.

In the Transportation Master Plan (1994) it is stated that the system would have a total length of 44.5 km in the year 2015 and it would be composed of four different lines as: Kızılay - Batıkent, Kızılay - Çayyolu, Ulus – Keçiören and TBMM - Dikmen.



Source: www.urbanrail.net/as/anka/ankara.htm

Figure 5.8. Ankara Metro line

The stations in Kızılay, İskitler, Atatürk Culture Center (AKM) and Balgat would be designed to be transfer centers from Ankara Metro to Ankaray rail transit system. The Kızılay – Batıkent line would be extended to Eryaman and Sincan if the rapid rail system is impossible or inefficient. (Çubuk, Türkmen, 2003)

Today, the system M1 starts from Kızılay to Ulus, Yenimahalle, Demetevler, Ostim and Batıkent having a total network length of 14.6 km and it has 12 stations. There are ongoing investments in Ankara; Kızılay-Çayyolu (M2), Batıkent-Sincan (M3) and Tandoğan-Keçiören (M4). (EGO website)

M2 (Kızılay-Çayyolu-2): The construction of Çayyolu Metro started in 2002 and it was estimated that the line would be openned in 2004. However, today, the construction has not been finished and electromagnetic works has not started yet.

M3 (Batıkent-Sincan/Törekent): The third stage of Ankara Metro is an extension of Metro 1 that connects Metro 1 to Organized Industrial Zone with a network length of 15.4 km. The construction started in 2001; however vehicle purchasing and electromagnetic works has not started yet.

M4 (Tandoğan-Keçiören): This metro line would have 9 stations and it would have a network length of 9.2 km. The line would create transfer stations at Tandoğan station with

Ankaray and at AKM station with The Ankara Metro. The construction started in 2003 and it still continues (Öncü, M.A, 2009).

Although the second, third and fourth stages of Ankara Metro have not been finished yet, in the newspapers, there have been news about the system that it would be finished earlier in the Çayyolu corridor to bring service for the residents in the New Year (Figure 5.10.).

Yılbaşında devrede

ÜMİTKÖY-KIZILAY 21 DAKİKAYA İNECEK

Yapımı devam eden Çayyolu metrosunun bitim tarihi 4 ay öncesine çekildi. Çayyolu ve Ümitköy'de oturanlar yılbaşında metro ile yolculuk yapabilecek

Uğur BECERİKLİ

ÇAYYOLU'NA metro müjdesi. Çayyolu Metrosu 1. Etap inşaatının planlanandan daha hızlı ilerlediği öğrenildi. Nisan 2004'te tamamlanması hedeflenen metro, çalışmaların hız kazanması nedeniyle yıl sonunda bitecek. Çayyolu'na uzanacak 2. Etabın işnaatı da yılbaşından hemen sonra gündeme gelecek. Metro ağının genişletilmesi için Büyükşehir Belediyesi tarafından başlatılan çalışmalar sonuç vermeye başladı. Çayyolu Metrosu 1. Etap inşaatı hızla ilerliyor. Metro, Ankaray AŞTİ son durağa yapılan bir bağlantı ile Armada karşısından başlayıp, Ümitköy'e kadar devam edecek şekilde inşa ediliyor. Metroyu Ümitköy'den Çayyolu'na uzatacak 2. etap daha sonra yapılacak. Hattın Armada-Kızılay arasında İnönü Bulvarı'nın altında seyredecek şekilde uzatılmasının da planlandığı bildirildi.

ENGELLER KALKTI

Çayyolu Metrosu inşaatının önündeki engeller kaldırıldı. Metronun güzergahı ile ilgili sorun da aşıldı. Daha önce Atatürk Orman Çiftliği (AOÇ) arazisi içerisinde kalan bölümler, arazi dışına taşındı. Bunu sağlamak için orman arazisi dışından geçen yollar seçildi. Metro, Söğütözü'nde Eskişehir Yolu'nun altından geçecek ve yola paralel giderek Ümitköy'e ulaşacak. MTA ve ODTÜ duraklarında çalışmalar başladı. Armada durağında ise çalışmalar uzun süre önce başlatılmıştı. Toplam on beş ayrı noktada metro ile ilgili çalışmalar sürüyor.

Üstü açık olarak planlanan metro projesi, Büyükşehir Belediyesi'nin talebiyle değiştirildi ve yeraltına indirildi. Metro, tamamen yer altından geçecek ve üstü yeşil alan olarak düzenlenecek.

YENİ HATLAR YAKINDA

Metro konusunda bir müjdeli haber de Keçiören ve Çankaya'da oturanlara geldi. Büyükşehir Belediyesi Çayyolu Metrosu'nun tamamlanmasının hemen ardından Çankaya ve Keçiören Metroları'nı da ihaleye açmaya hazırlanıyor. Kızılay-Çankaya ve Keçiören-Ulus arasında yolcu taşıyacak metro hatları, Çayyolu Metrosu'nun ardından yapılmaya başlanacak. 100. Yıl Çiğdem Mahallesi'nde oturanlar ise ANKARAY'ın yeni hattıyla ulaşımda rahatlık yaşayacaklar.

Metronun inşaatı yerli bir firma tarafından yürütülüyor ancak elektronik aksam ve vagonlar yurtdışından ithal edilecek. Dünyada metro vagonlarının lisansını elinde bulunduran birkaç firma var. Büyükşehir Belediyesi önümüzdeki günlerde elektronik aksamı için ihaleye çıkmaya hazırlanıyor.

SORUNSUZ ULAŞIM

Ankara Metrosu inşaatı hızlı bir şekilde devam ediyor. Başta ODTÜ'lü öğrenciler olmak üzere, bölgedeki diğer üniversite öğrencileri de okula metro ile gitme şansı bulacak. Sorunsuz ulaşımdan kamu kurumlarının çalışanları da yararlanacak.

Çayyolu metrosu başlangıçta 74 milyon dolara malolacak şekilde planlanmıştı. Ancak güzergah uzatıldı ve 9 kilometreye çıktı. Bunun da maliyeti 96 milyon dolara çıkardığı öğrenildi. 9 km'lik yol üzerinde 7 ayrı istasyon yapılıyor. Metro ile Ümitköy-Kızılay arası 21 dakikada katedilecek. Nisan 2004'te teslim için AKTÜRK İnşaat ile anlaşan Büyükşehir Belediyesi, çalışmaların hızlı gitmesi nedeniyle yıl sonunda metroyu tamamlanmış olarak devralacak.

News about Çayyolu Metro that was planned to be opened in 2004, 28 March 2003 Sabah Ankara

Source: Öncü,M.A, 2009

Figure 5.10. News about Çayyolu Metro

5.2.3.Expectations from the rail transit investments

In the Ankara Urban Transportation Study (1985), the reasons in deciding on rail transit investments are listed as, providing improved accessibility to the city center, integration with the development plan and the low cost of management and construction.

In the Ankara Transportation Master Plan (1994), the main criteria for choosing the rail transit network were determined as the capacity, suitability with the urban development strategy, accessibility to the CBDs (central business district), flexibility, costs and environmental impacts. In addition, to reduce the traffic in the city center and to relieve the city center traffic congestion were also relevant objectives or expectations (Türkmen, 2001)

Table 5.6. Expectations from the rail transit investments in Ankara

	Ankara	**Explanation**
Reducing traffic congestion	+	For Ankaray, it was aimed to decrease traffic congestion between Dikimevi and Tandoğan and it was expected not to have bus public transport systems operating in this corridor; it appears that by eliminating buses (and without much concern about private car traffic) congestion as expected to be reduced.
City image	+	Some interviewees argued that it was an objective, some of them argued the opposite.
Increasing total passengers in public transportation systems	+	For this objective in the plans park-and-ride areas were designed; however this was not overlapping with the transportation plan of the municipality.
Urban transformation/regeneration	-	**None of the interviewees emphasized this**
Decreasing air pollution	+	It is an indirect objective
Encouraging urban development	+	Batıkent corridor, Sincan,Keçiören,Çayyolu
Increasing the viability of the city center	-	**None of the interviewees emphasized this**
Decreasing the operating cost in public transportation, increasing efficiency	-	**None of the interviewees emphasized this**
Other		In the Batıkent corridor integration between bus systems and rail transit system is successfully implemented.

Erhan Öncü (Ulaşım Art Ltd Şti, 18.03.2009) stated in the interview that reducing traffic congestion, improving the image of the city and encouraging urban development were the objectives of constructing the rail transit systems in Ankara. It cannot be said that the Batıkent corridor urban development is a result of a rail transit investment; however, the metro system, which was based on the urban development plan, may have reinforced the residential development that already started to take place in the Batıkent area. As Çakan (Ulaşım Art Ltd Şti, 18.03.2009) also stated, the metro did not create the development, but supported it. The decision of constructing a rail transit system appeared after analyzing the corridor's potential. There were suggestions of building busway on the Batıkent corridor; however an underground metro system was accepted. (Çakan, Ulaşım Art Ltd Şti, 18.03.2009) Ayşe Gül Gürel (EGO Rail Systems Department of Management Manager, 01.04.09) claimed that the proposals for Sincan, Keçiören and Çayyolu metro projects were aimed to encourage urban development in these areas. This might be the case for Sincan and Çayyolu, where further development may take place; however, Keçiören corridor is already a developed high density urban area.

For Ankaray light rail system, Çakan (Ulaşım Art Ltd Şti, 18.03.2009) argued that the main objective for constructing the system was to reduce the traffic congestion between Kızılay and Demirtepe route. The former busway system was at ground level in the Kızılay junction and it caused traffic congestion in the area. Ertan SARIGÖL (EGO Rail Systems Department of Metro Construction Manager, 01.04.09) stated that the decision of an underground light rail transit technology was a result of objectives to decrease congestion on the corridor. It is important to note that the reduction of traffic was estimated to be achieved by the elimination of bus public transport and car restriction policies and implementations, although discussed to a certain extent in the 1986 and 1994 transport study and plan, were not considered.

In the decision making process of Ankaray, environmental impacts and management costs were also taken into account. In addition, improving the city image was one of the expectations. Ayşe Gül Gürel (EGO Rail Systems Department of Management Manager, 01.04.09) gave the example of the way the passengers use the Ankara Metro, Ankaray, and the Ayaş-Kayaş commuter rail transit system. Because of the high quality and the image of Ankaray and Ankara Metro, they use these systems carefully and they do not damage the vehicles as they do in the Ayaş-Kayaş commuter rail transit system. Ertan Sarıgöl (EGO Rail Systems Department of Metro Construction Manager, 01.04.09) argued that the aim of improving the city image and modernizing the city by investing on a rail transit system were delayed because the local authorities did not have the courage and financial means to construct these massive investments. Their budgets were limited. He stated that in Ankara, the municipality managed this with its own resources and it contributed to the image of the city.

The expectation of increasing total passengers in public transportation systems was asked to Çakan. He stated that in the 1980s 80% of the citizens, which is a very high proportion, were using public transportation systems in the city; so he concluded that it was not an expectation from the rail transit investments. However, in most cities in the world, including those in Turkey, public transport modes' share is decreasing, and therefore preventing such a decrease could have been considered as one of the potential benefits of rail investments.

Fuat Vural (EGO Transport Planning and Coordination Center, 31.03.2009) stated in the interview that the main criterion in deciding the routes of the systems in Ankara was travel demand in the corridors. It was decided to construct a light rail transit system if the demand was between 15.000 -20.000 passengers, and a heavy rail transit system if the demand was between 20.000-25.000 passengers. On the other hand, it is clear that the Batıkent corridor was chosen to be the first phase because this was the corridor for future urban development. In that sense, for the first metro line in Ankara, urban development was a significant expectation. After AŞTİ was founded the Ankaray system was started to be constructed and it opened before the metro system. For the Ankara Metro, the capacity of the system and the need to carry more passengers to the outskirts of the city were effective in the decision of the rail transit technology (EGO Rail Systems Department of Metro Construction Manager, 01.04.09). It can be concluded that although urban development impacts were important, the Ankara Metro's primary objective was to attain and sustain a high ridership level. As for Ankaray, traffic reduction in the central corridor that this system is located on was an important objective.

5.3. İzmir

5.3.1. Decision making process

The third most populated city in Turkey, İzmir, has started transport planning studies in 1974 with a study by Jamieson Mackay and Partners consulting firm: İzmir Transport Study. After this study, in 1976, another study focusing on the transport structure of the central business district (CBD) was prepared. In 1980, 1992 and 1997 further studies concerning public transportation systems, rail transit systems and a transportation master plan have been made by the Municipality and consulting firms. In the 2000s a study to improve the commuter rail system was prepared. (Özalp, M.2007)

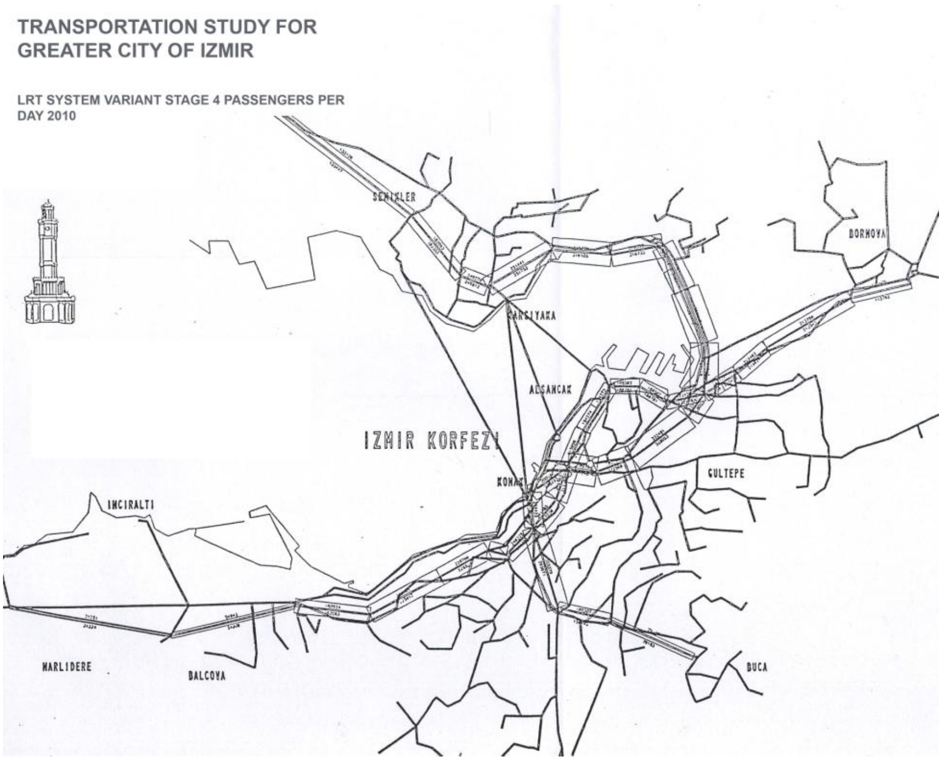
The studies for İzmir from the 1970s are as follows:

- İzmir Transportation Study (1974)
- Public Transport System Optimization Study (1980)
- İzmir Transportation Master Plan (1992)
- İzmir Transportation Master Plan Update Study (1997)
- Urban Transport and Rail System Investment Project Feasibility Report (1998)
- İzmir Commuter Rail System Development Project (2001)
- İzmir Transport Study Revision (2007)
- İzmir Transport Master Plan Conclusion Report Summary (2009)

İzmir Transportation Study (1974) was prepared by Jamieson Mackay and Partners and Economic Consultants Ltd with İzmir Metropolitan Planning Department to solve the traffic problems in the city centre and to take short-term measures. The study had two main parts: traffic engineering and control, and master plan analysis.

Public Transport System Optimization Study (1980) was prepared by the consulting firm Shankland Cox Partnership and Rennie Park Associates and İzmir Metropolitan Master Plan Department. The study aimed to analyze the public transport system of İzmir and to offer solutions to improve the transportation system in short and long-terms.

In 1992, the decision was made to prepare a more comprehensive transportation study determining the present conditions and to produce solutions for the target year 2010. For this reason, Italien Transystem and İzmir Greater Municipality made an agreement. Heusch/Boesefeldt (Germany) started preparing **İzmir Transportation Master Plan (1992)** in 1990. The travel demand corridors were determined (Figure 5.10.)



Source: Public Transport System Optimization Study, 1980

Figure 5.10. Travel demand corridors for the year 2010

In the study, two different scenarios were developed about the public transport systems in the target year:

<u>Scenario A:</u> The core of the public transport system would be the bus systems. However the bus systems would be optimized and adapted to the future demands.

<u>Scenario B:</u> The core of the public transport system would be a high capacity rail transit system connecting the main areas of the city and integrating with the other modes (dolmuş, bus, etc.).

It is stated in the study that, Scenario B is more goal-oriented; that is to create a transportation system with a variety of different public transport technologies, helping to provide more options in public transport.

The rail transit system that was suggested in the plan was a metro system. The system was expected to carry more than 300,000 passengers/day. The buses and minibuses would be feeder services for this system. It was proposed to have two lines. The aim was to connect all the main points of the city to the central business district. The system was offered to be a substitute for Alsancak-Buca, Basmane-Bornova and Basmane-Çiğli commuter rail systems.

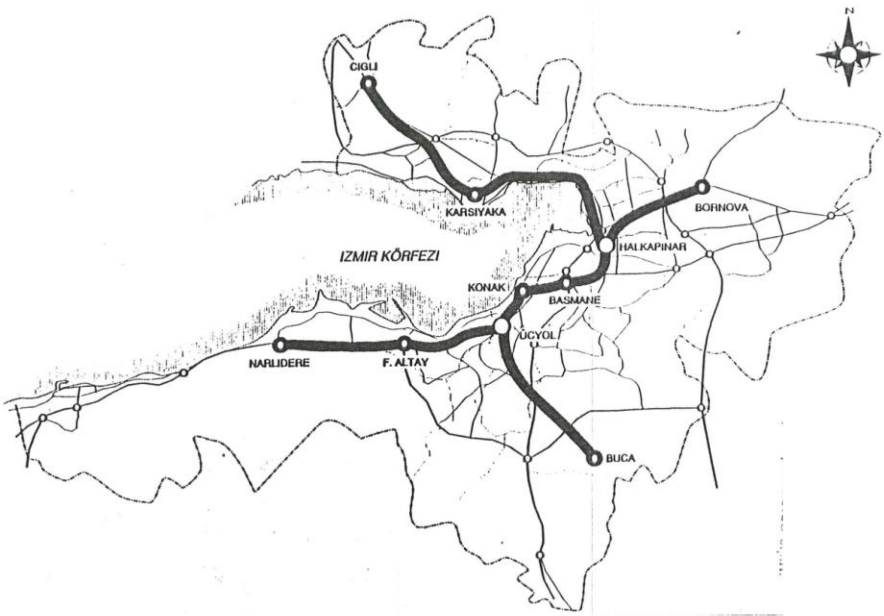
Line I: Network length of 23 km, following Narlıdere-F.Altay-Bayramyeri-Alsancak-Halkapınar-Bornova route.

Line II: Network length of 27 km, following Buca-Bayramyeri-Konak-Basmane-halkapınar-Karşıyaka-Çiğli-Egekent route.

The rail transit network would also include the Alsancak- Adnan Menderes Airport commuter rail system.

In the study, some alternatives were given. It is stated that the Line I would be inadequate to carry the passengers between Halkapınar and Bornova high density areas. To increase the popularity of the system and to avoid the long walking distances, a route passing from the north of İzmir-Ankara Road would be an alternative.

Another alternative LRT network (Figure 5.11.) was composed of two lines intersecting in Bayramyeri, Gaziosmanpaşa and Mersinli stations. Between Üçyol and Halkapınar there would be only one LRT connection. In the north, Karşıyaka/Çiğli, in the east Bornova, in the south Buca and in the west F.Altay/Narlıdere outer connections were the same with the previous alternative.



Source: Public Transport System Optimization Study, 1980

Figure 5.11. Proposed rail transit system network

The system was planned in four stages (Figure 5.12. and 5.13.):

<u>1.Stage:</u> The highest traffic volumes were expected between Üçyol-Basmane.

F.Altay-Basmane: 9.2 km, 10 stations

<u>2. Stage:</u>

Basmane-Karşıyaka: 10.5 km, 9 stations

<u>3. Stage:</u>

Halkapınar-Bornova: 5.8 km, 5 stations

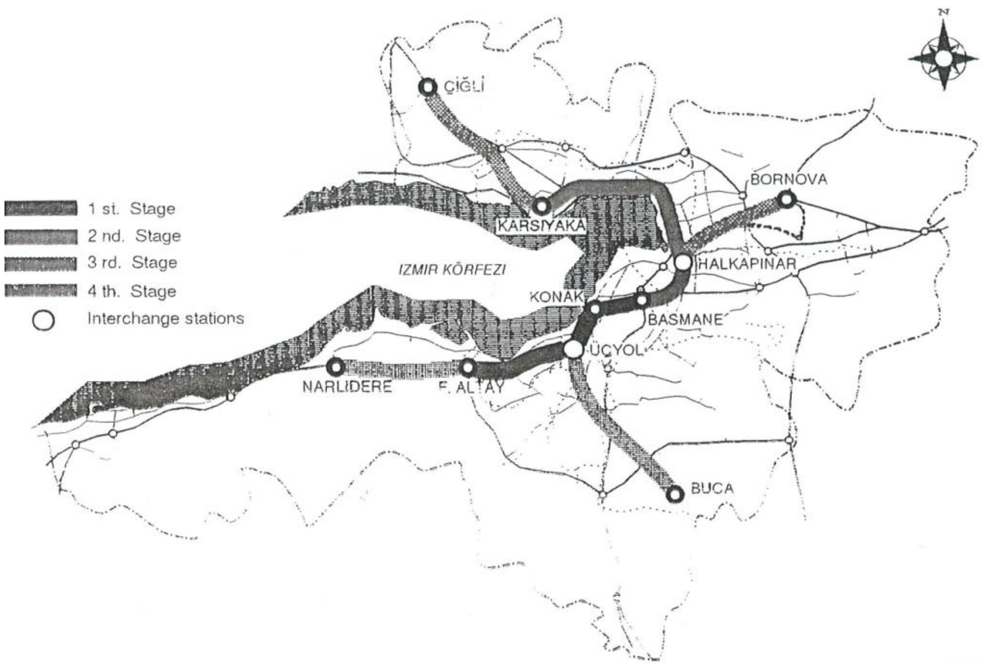
Karşıyaka-Çiğli: 8 km, 8 stations

<u>4. Stage:</u>

F.Altay-Narlıdere: 3.6 km, 3 stations

Üçyol-Buca: 6 km, 4 stations

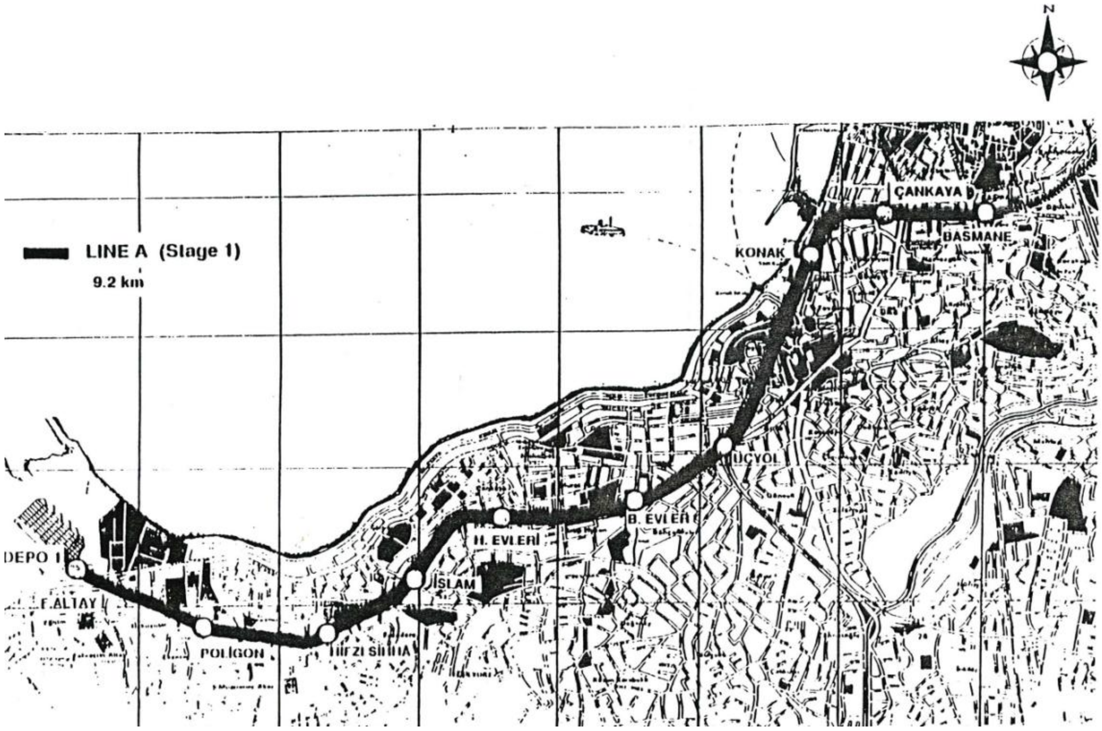
TOTAL: 43.1 km, 39 stations



Source: Public Transport System Optimization Study, 1980

Figure 5.12. Stages of rail transit system network

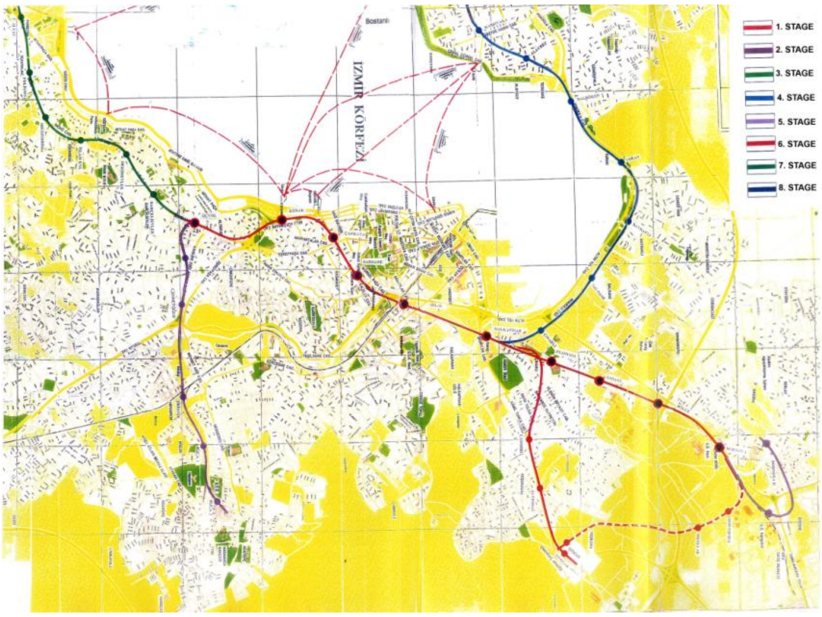
The ridership estimations were given in the plan. It was estimated that between Üçyol and Konak daily ridership would be 300,000. For one direction in the peak hours it would be 30,000 passengers/hour.



Source: Public Transport System Optimization Study, 1980

Figure 5.13. Proposed stage 1

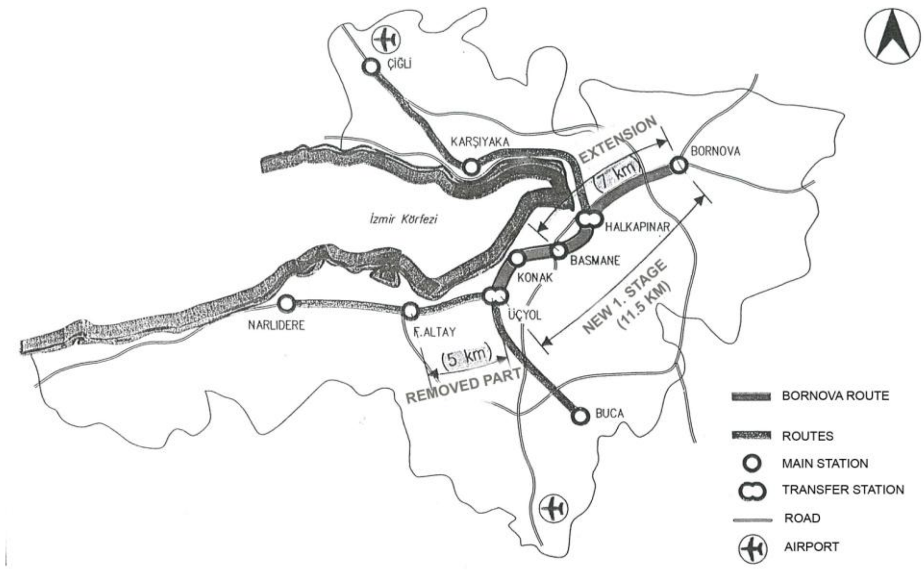
In the Transportation Master Plan (1992), the new data were not gathered and the previous data was not updated and this brought about the need to update the study. **İzmir Transportation Master Plan Update Study (1997)** is a revision of the 1992 Transportation Master Plan and it was prepared by Boğaziçi University Structure Technology Implementation and Research Centre. In the study, estimations and projections were made not using a transportation model, new lines were added to the system and a financial analysis was provided.



Source: İzmir Transportation Master Plan Update Study, 1997

Figure 5.14. Proposed rail transit system network

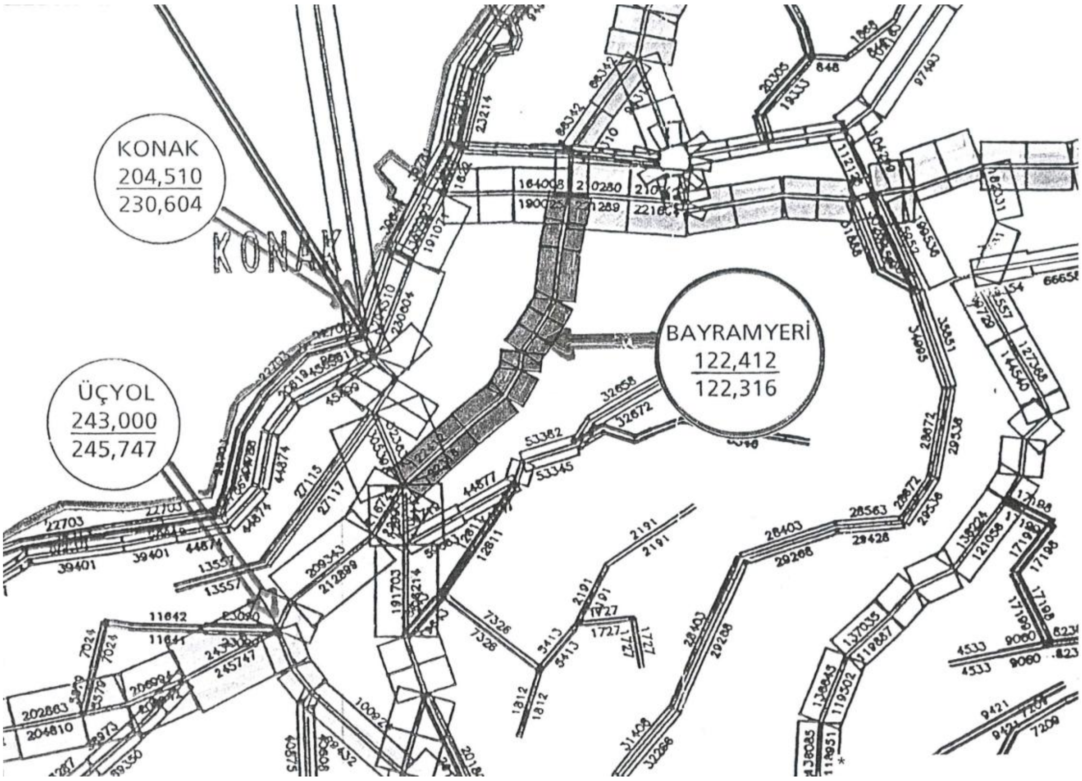
The rail transit system network was 43.1 km long in the previous study and it was planned in four stages. In this study, Halkapınar-Yeni Otogar route was added to the system (Figure 5.15.).



Source: İzmir Transportation Master Plan Update Study, 1997

Figure 5.15. Changes in the rail transit network

The passenger estimations for the corridors were given (Figure 5.16.). In the corridor of Üçyol-Bornova, it was estimated that in the target year 2010, the ridership would increase to a potential of 1.600.000 passengers/day.

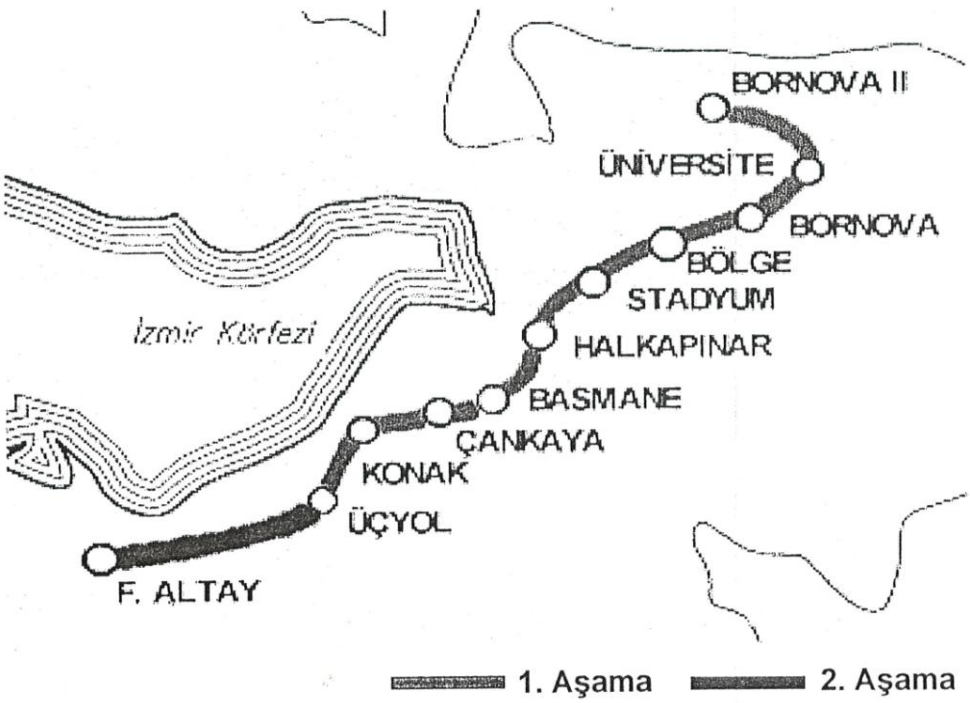


Source: İzmir Transportation Master Plan Update Study, 1997

Figure 5.16. Passenger estimations

TCDD (Turkish Republic State Railways) agreed to allocate the commuter rail route from Basmane-Bornova to the Municipality and this gave the Municipality a chance to construct the main line in this corridor. It is stated in the plan that this route had the highest demand. The first priority was given to F.Altay-Üçyol-Konak-Basmane line that has a total length of 9.5 km. After the agreement with TCDD (Turkish Republic State Railways) the line was extended and it was shifted to Üçyol-Konak-Basmane-Bornova with an additional 2 km long section. However, it is stated that it would meet the high travel demand in the corridor if the line is extended to F.Altay.

In **Urban Transport and Rail System Investment Project Feasibility Report (1998),** technical aspects of the proposed rail transit system was given. The plan determined Üçyol-Bornova route as the first stage. It was stated that this part of the system was the most problematic part according to its ground studies and the cost of the system would be even higher in the later stages. The first stage would be composed of two parts; Bornova Hospital-Bornova Centre and Üçyol-F.Altay (Figure 5.17.).



Source: Urban Transport and Rail System Investment Project Feasibility Report, 1998

Figure 5.17. Stages of İzmir Metro

İzmir Commuter Rail System Development Project (2001) was prepared by Yapı Teknik Ltd, Su Yapı Mühendislik ve Müşavirlik A.Ş. and Mott MacDonald and aimed at improving the commuter rail system which passed through the developing residential areas and central business districts in the northwest and south parts of the city, and had a low level of service quality, inefficient management and a modal share of 1% in total public transport journeys. It was planned to transform the commuter rail system into a comfortable, high capacity and fast rail service. The study did not cover all the urban area and remained as a corridor study.

İzmir Transport Study Revision (2007) was an interim report of İzmir Transportation Master Plan. The Master plan is a regional plan; however İzmir transport Study revision only covers the center of the city and analysis the surveys and the traffic counts. It includes the suggestions for future transportation network.

İzmir Transportation Master Plan Conclusion Report Summary (2009) was prepared to provide integration between the transport plans and the development plan of the city. The plan dealt with the transportation and traffic problems of the city. Detailed land use and traffic studies were prepared and alternative solutions were given.

In the interviews, the history behind the current system was asked and each interviewer told different stories according to their participation in the implementation and construction of the system.

Yıldırım Oral (DEÜ, ŞBP, 05.06.2009) argued that the system operating today was not proposed in 1973 in the development plan. Instead, the commuter rail line was expected to be the spine of the city. In the north-south direction there would be the commuter rail line, and in the bay there would be ferries and the bus systems. Turkish State Railways Project was planned; İzmir-Ankara commuter rail line was going to be the main corridor; however, today the first stage of the İzmir Metro partially uses this line. As a result, the opportunity to develop a long-distance high-speed rail system was lost. Halkapınar area was proposed to be the center of the city, not Konak. A linear city was suggested. Oral argued that in 1992, it was decided to construct a rail transit system and that is why a study was made to test whether it was feasible, although the decision for the technology was already made. He also claimed that, the route of the metro system would not be from Üçyol-Bornova, if the development plan was considered. The changes caused increases in the total cost of the system.

In İzmir Metro A.Ş., it was stated that with the changes in the administration in the city, some changes occurred in the route of the system. It was stated that the shifting of the first station from Üçkuyular to Üçyol and the shifting of the final station from Basmane to Bornova negatively affected the system, particularly because Üçkuyular was a high-demand area which should have been penetrated by the metro.

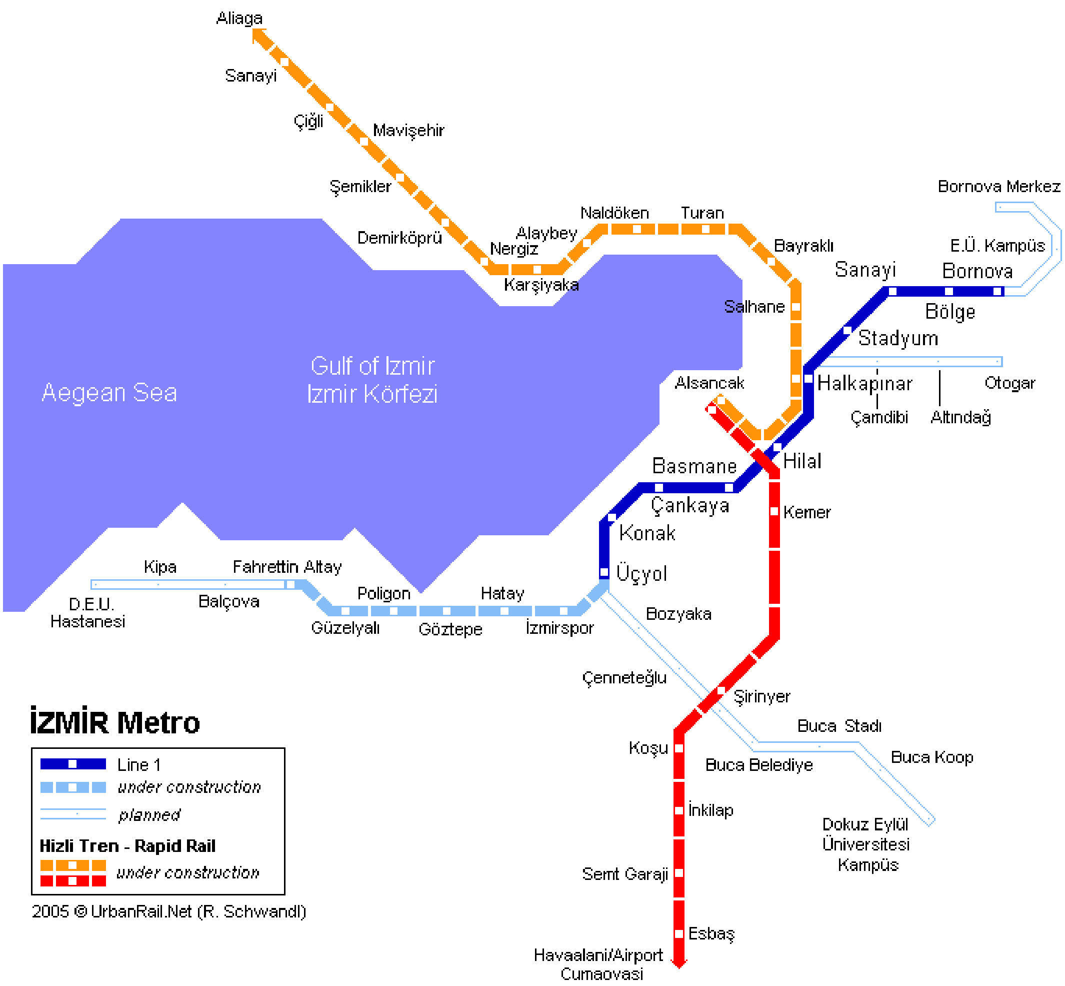
Tacettin Kınay (15.04.2009- Bursa Greater Municipality Manager of Department of Transport) argued that the route choice of İzmir was in fact the result of Turkish State Railways rail route's being transferred to the Municipality. When the line from Basmane-Bornova was given from Turkish State Railways to İzmir Greater Municipality, it was decided to construct the system in that corridor. Oral supported this view (Dokuz Eylül

University Department of City and Regional Planning, 05.06.2009) and added that it is the main reason why the system was constructed. Kınay further added that to increase the ridership of the corridor now it is extended to the residential areas in Bornova.

In the interviews with the technical experts, it was stated that Buca was the first stage according to the mathematical model; because there was high demand from the residential areas and the university. However; the plan (1992) approved Üçyol-Bornova as the first line and the line passed through Konak as the traditional centre.

5.3.2. The systems currently operating in İzmir

İzmir Metro



Source: http://www.urbanrail.net/as/izmi/izmir-map.gif

Figure 5.18. İzmir Metro line

In the first studies for İzmir Metro in 1989, Heusch und Bosefeldt (Germany) counted traffic in the main corridors in the city for two years and prepared the Transportation Master Plan, which proposed 50 km of metro network for the target year 2010. The system was planned to reach four main points of the city; Bornova, Buca, Narlıdere, Çiğli. The priority was given to the highest density part of the system. After some changes were made in the route in 1994, the contract was signed in 1995. The metro system started operating in 2000. (İzmir Metro A.Ş. Faaliyet Raporu, 2007)

Table 5.7. System characteristics

The system	**Opening year**	**Capacity of the system passenger/hour/direction**	**The length of the system (km)**	**Number of stations**	**Number of vehicles**
İzmir Metro	2000	45000	11,5	10	45

Source: İzmir Metro A.Ş.

1. Stage: Üçyol-Bornova

2. Stage: Üçyol-Fahrettin Altay

3. Stage: Bornova Merkez-Bus station

4. Stage: Fahrettin Altay- Balçova D.E.Ü. Hospital

5. Stage: Üçyol-D.E.Ü Campus

The first stage of the system is 11.5 km. The route starts at Üçyol and continues to Bornova passing through Konak, Basmane and the abandoned rail route. There are 10 stations in İzmir Metro system.

5.3.3.Expectations from the rail transit investments

Table 5.8. Expectations from the rail transit investments in İzmir

	İzmir	**Explanation**
Reducing traffic congestion	+	Konak square
City image	+	The system was expected to enhance image
Increasing total passengers in public transportation systems	-	**Mentioned in 1997 revision plan** **None of the interviewees emphasized this**
Urban transformation/regeneration	-	**None of the interviewees emphasized this**
Decreasing air pollution	-	**None of the interviewees emphasized this**
Encouraging urban development	-	**None of the interviewees emphasized this**
Increasing the viability of the city center	-	**None of the interviewees emphasized this**
Decreasing the operating cost in public transportation, increasing efficiency	+	Increased the efficiency in public transport, though it was not one of the expectations.
Other		Better integration of modes

In İzmir Transportation Master Plan (1992), it is stated that increasing economical efficiency, reducing traffic accidents, increasing road safety, increasing passenger comfort and safety are the main objectives of the rail transit system. In the revision plan (1997), integration and attracting more people to public transport were added to the objectives.

It is stated in the website of İzmir Greater Municipality that, it is their main objective to create an economical, comfortable, environmentally-friendly and high quality transportation structure. With these qualities İzmir Metro increased cultural and social activities taking place in the city by hosting exhibitions, concerts, conferences and so on. (İzmir Metro A.Ş. handbook, 2009)

In the interviews, the technical experts and advisors in the Municipality and İzmir Metro A.Ş. claimed that an improvement in the city image and a reduction in traffic congestion were expected after the system started operating. The chaos of the buses in the Konak area was removed and Konak square became a pedestrian area. The traffic congestion in the Fevzi Paşa Boulevard was reduced. It affected the other modes by introducing more passengers to the public transport system. As an example it was stated that sea transportation ridership rose up to 60.000 passengers/day.

However; urban transformation/regeneration, decreasing air pollution, encouraging urban development and increasing the viability of the city center were not expressed by any of the planners and experts as the expectations from the Izmir Metro. Some interviewees argued that it might be the consequences of the metro system that Bornova area and Hilal-Sanayi area started to develop but there is no technical basis for these arguments.

There is one unexpected development that had a positive effect on the metro system: the integration project. When the rail transit project was planned, the Urban Transportation Plan did not cover a transport integration project. In the 2000s a study was started to introduce route, fare and ticket integration in Izmir's public transport systems, including buses, metro and ferries. Although not planned together, the implementation of these two projects overlapped, affecting each other in a positive way. (Interview with Yıldırım Oral, Dokuz Eylül University Department of City and Regional Planning, 05.06.2009)

5.4. Bursa

5.4.1. Decision making process

Over the past decades, Bursa has experienced rapid population growth and increase in employment in the industrial areas of the city. Therefore, the city's need for a rapid transit system increased. Although the first study was made in 1986, it was after 1990 that transport planning studies escalated. As a result, in Bursa, nine rail transportation studies have been made since 1986 (Bursa Greater Municipality). These studies are:

- Bursa Rapid Transit Feasibility Study (1986)
- Bursa Transportation Master Plan (1987)

- Inner-City and Near-Surroundings Transportation Study and Mass Transportation Feasibility Study (1992)
- Bursa Urban Development Project Urban Transport Improvements Study (1997)
- Bursa Light Rail System Optimization Study (1997)
- Bursaray LRT System Plan and Transport Planning Programme (2001)
- Bursa Traffic Study and Alternative projects (2007)

Bursa Rapid Transit Feasibility Study (1986) was prepared to determine the alignment for a transit line to serve the organized industrial area, Uludag University and Kestel. The study analyzed the travel demand in the corridor, and developed proposals for the technology and integration with other modes of transportation. Before this study, there has not been any feasibility analysis for such a system.

In the choice of the technology, buses and light rail vehicles were compared. It was observed that the standard sized vehicles would not provide sufficient capacity to meet travel demands. The space that standard buses require would be wider; in addition, light rail transit seemed to be the only technology capable of meeting demands of the forecasted year 1992 and beyond. The light rail transit system was proposed to operate in at-grade with exclusive right-of-way operation and all intersection crossings in mixed traffic with appropriate signaling. Feeder buses would provide the collection and distribution function to the LRT system.

Three alternative light rail transit alignments were considered for implementation: the South side, North side, and median of the Ankara and Mudanya Highways.

Six alternative options were determined in the plan. For the preliminary evaluation four loop options and two options that do not require a loop routing were identified (Figure 5.19.).

Option 1- Line Haul: via Ulu Street and terminating at the inter-city bus garage (no downtown loop)

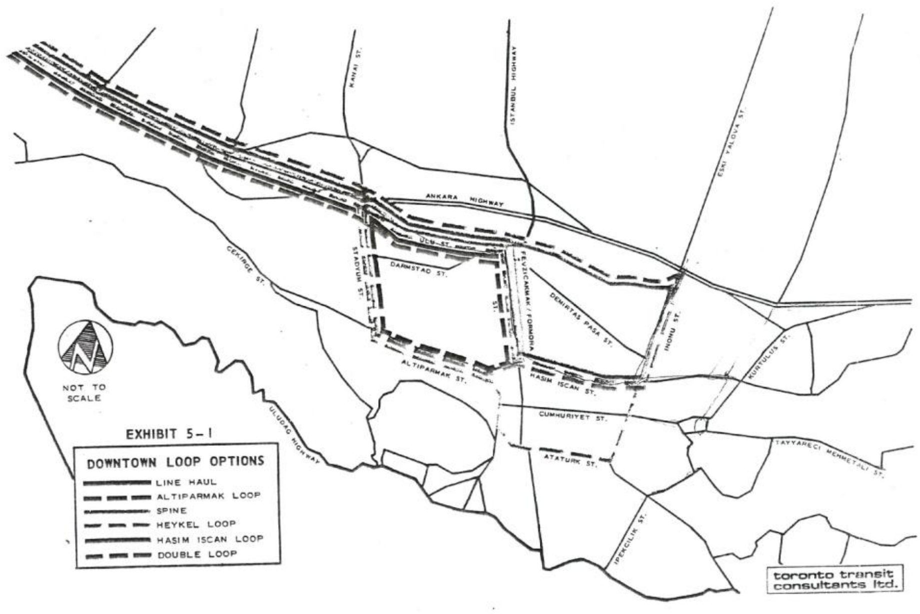
Option 2- Altıparmak Loop: via Stadium, Altıparmak, Fevzicakmak/Formora and Ulu Streets.

Option 3- Spine: via Ulu and Fevzicakmak/Formora Streets and terminating at Sehrekustu (no downtown loop)

Option 4- Heykel Loop: via Stadyum, Altıparmak, Ataturk, Inonu, Hasim-Iscan, Fevzicakmak/Formora and Ulu Streets.

Option 5- Hasim-Iscan Loop: via Fevzicakmak/Formora, Hasim-Iscan, Inonu and Ulu Streets.

Option 6- Double Loop: via Stadium, Altıparmak, Hasim-Iscan, Inonu and Ulu Streets.



Source: Bursa Rapid Transit Feasibility Study, 1986

Figure 5.19. Loop options

In conclusion an alignment on the South side of the Mudanya and Izmir Highways was preferred. It was assumed that with a low forecast the peak hour ridership estimates (1992) would be 5,100 passengers per hour between Merinos Junction and the Izmir/Mudanya Highway Junction and 6,300 passengers per hour between the Izmir/Mudanya Highway Junction and the organized industrial area. With a high forecast the peak hour ridership estimates (1992) would be 6,257 passengers between Merinos Junction and the Izmır/Mudanya Highway Junction and 6,956 passengers per hour between the Izmir/Mudanya Highway Junction and the organized industrial area.

Bursa Transportation Master Plan (1987) was prepared to solve the urban transportation problems in the long-term by Middle East Technical University (METU) and Bursa Greater Municipality. In the study, estimations for the target year 2005 were made, problems were analyzed and solutions were offered. Traffic regulation strategies, structural suggestions such as multi-story car parks, multi-level junctions and bus stations and a busway in the high public transport demand corridor were proposed. In that corridor it was stated that a rail transit system would be appropriate to meet the demand of the corridor and a 11,5 km long LRT system was suggested.

In "**Inner-City and Near-Surroundings Transportation Study and Mass Transportation Feasibility Study (1992)"** planning alternatives of "Zero" planning case (The routes of public transport remains the same, only the service frequency would be improved.), "Bus" Planning Case (The bus network would be developed in separate bus lanes with routes reorganized if necessary) and "Light Rail" Planning case (A light rail transit system to serve the main traffic axes and the inner city, and where possible operates underground) was compared.

After evaluating the alternatives it was found that a light rail transit system would be a solution to carry the maximum number of passengers with public transport services. It would also decrease the number of private cars coming to the city center, providing a reduction in traffic as well as a reduction in noise. The system would be extended without any difficulties in the future and it would be easier to construct the system in stages.

The following routes were selected:

Line A: Industrial Zone West, Mudanya Street- Ankara Street-Kestel

Line B: University-Izmir Road- Stadium Street- Altıparmak St-Ataturk St-Gokdere Boulvard- Ankara St-Kestel

Line C: Yaloca St-Fevzicakmak St- Hasim Iscan St- Mehmet Ali St

Line D: Industrial Zone West- Mudanya St- Stadyum St- Altıparmak St- Hasim Iscan St-Mehmet Ali St

The criteria affecting the choice of routes were the ability to serve urban areas with high residential and employment densities, adaptation of the routes in terms of natural ground profiles and space, the travel demands, approximately 500 m wide passenger catchment area and the ability to be integrated into urban development in the future development stages.

The proposed network length was 52 km of double track installations. Because of its high investment costs, the investment was assumed to be finished over a period of at least ten to fifteen years. The construction stages were defined as follows:

First stage: Industrial Zone West- Mudanya St- Ankara St- Kestel (length approx. 24 km)

Sub-stage 1.1: Industrial Zone West-Mudanya St-Bus Terminal (length approx. 12 km)

Sub-stage 1.2: Bus Terminal- Ankara St (length approx.4.5 km)

Sub-stage 1.3: Ankara St-Kestel (length approx.7.5 km)

Second stage: University- Mudanya St- and Fevzi Cakmak St-Hasim Iscan St-Mehmet Ali St. (length approx.17.5 km)

Third stage: Yaloca St- Bus Terminal (length approx.6 km)

Fourth stage: Stadium St- Altıparmak St- Ataturk St- Gokdere Boulvard (length approx.4.5 km)

Bursa Urban Development Project Urban Transport Improvements Study (1997) defined general strategies supporting the new proposed light rail transit system as protection of the line, ticket integration, feeder services and the policies that should be implemented to other modes of transportation. In order to ensure success, the study recommended an integrated public transport system.

"Bursa Light Rail System Optimization Study – First Stage Works (1997)" was prepared by the joint venture of OBERMEYER Planen+Beraten of Munich, Rail Consult and OPTIM of Turkey to determine principles of the first construction stage of the light rail transit system in Bursa. This study built up the main criteria for the current rail system network in the city.

The light rail system line was determined considering the traffic demand, topography, historical and natural values of the city. The main principles of the line alignment were approximately the same in the previous study "Inner-City and Near-Surroundings Transportation Study and Mass Transportation Feasibility Study (1992)".

LRT line was suggested to serve urban areas with high residential development and employment densities. The routes would be located over ground not affecting the existing traffic and where possible it would be underground. It was recommended that the line should be in the passenger catchment area of 300-500 m. The routes were also planned to serve the future phases of urban development.

The light rail transit network would be as follows:

Route A: The West of Organized Industry Region- Mudanya Street- Ankara Street-Kestel

Route B: Gorukle Uludag University Campus- İzmir Road- Stadium Street- Altıparmak Street-Ataturk Street- Gokdere Boulvard- Ankara Street- Kestel

Route C: Yalova Road- Fevzi Cakma Street- Haşim İşcan Street- Tayyareci Mehmet Ali Street

Route D: The West of Organized Industry Region- Mudanya Street- Altıparmak Street-Tayyareci Mehmet Ali Street

The total length of the system was proposed to be 55 km to be completed in 10 to 15 years.

This study examines the first stage of the light rail transit system (Figure 5.20.) which would start from Mudanya and İzmir direction, join at the Mudanya road intersection and follow Acemler-Sırameşeler-Merinos Intersection-Santral Garaj Meydanı-Fevzi Cakmak Caddesi-Sehrekustu Meydanı-Haşim İşcan caddesi- Gökdere Meydanı- Beyazıt caddesi- Prof. Tezok Caddesi route.

The total length of the route is approximately 21 km.

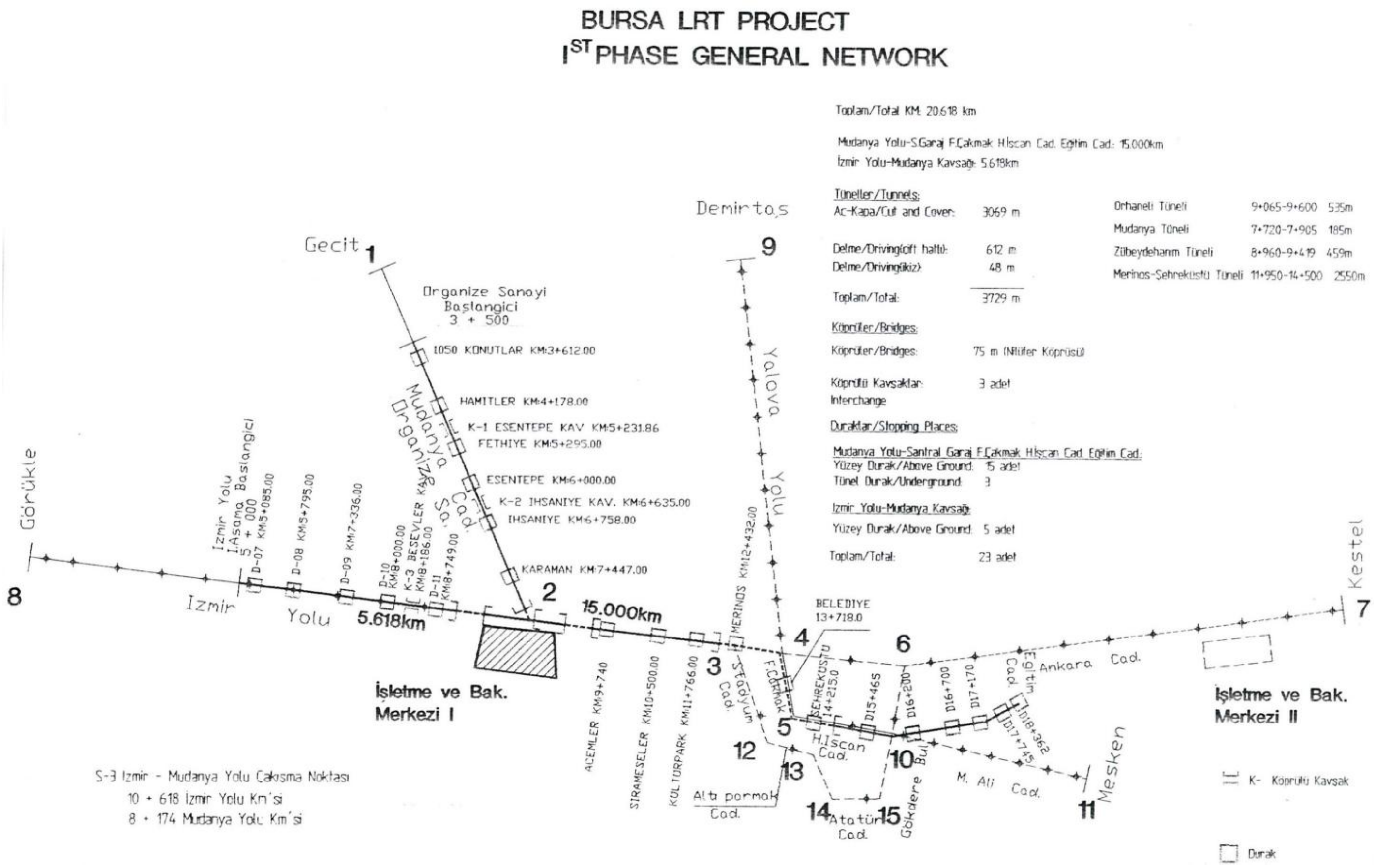


Figure 5.20. Bursaray 1st stage general network
Source: Bursa Light Rail System Optimization Study – First Stage Works, 1997

Bursaray LRT System Plan and Transport Planning Programme (2001) was prepared by Yapı-ICF Kaiser Mühendislik Müşavirlik A.Ş. firm and consultants. In this study, the routes suggested in the "Inner-City and Near-Surroundings Transportation Study and Mass Transportation Feasibility Study (1992)" were analyzed and some alternatives were selected. These alternatives were some line additions to the planned rail transit system network. In this respect, these lines were not the alternatives to each other, but they completed each other. (Figure 5.21.)

Source: Bursa Greater Municipality

Figure 5.21. First and second stages of Bursaray

In **Bursa Traffic Study and Alternative projects (2007),** Bursa was observed under physical, economical, social, transportation and urban development titles. In this respect the data regarding the effect of the central business district to traffic was collected. After the analysis, certain planning decisions were taken and a traffic simulation was prepared in order to solve the problems of urban traffic. It was prepared by Gazi University for Bursa Greater Municipality. (Interview with Bursa Greater Municipality officers, 15.04.2009)

The line of Bursaray came out from the study prepared in 1997; "Bursa Light Rail System Optimization Study" (Interview with Bursa Greater Municipality officers, 15.04.2009). An integrated transport system was planned to be in place after the opening of the rail transit system; Bursaray. In this respect, the minibuses would be converted into feeder buses. However, the private entrepreneurs owning and operating the minibuses rejected this system; because this would decrease their profit. The municipality introduced a quota for the number of minibuses that could operate on the corridor; but the minibus operators demanded a quota three times higher than this (Interview with Bursa Greater Municipality officers, 15.04.2009). In that period, the chairman of the Transportation Commission of the Municipality was also the chairman of the association of minibus drivers; therefore they had a significant influence on the decision making process (Interview with Erdinç Alkan Burulaş Bus Manager, 16.04.2009).

Studies were made accordingly to cancel the parallel bus network operating on the line of the rail transit system. In the B stage of the system there would be a conversion of 6 minibuses into 1 feeder bus. However the minibus drivers did not want to lose the parallel networks. Although it was originally an awarded transport integration project, it could not be accomplished. The buses started to come to the city center. With the decision of the Mayor, they started carrying passengers on a route parallel to the rail transit system (Interview with Bursa Greater Municipality officers, 15.04.2009).

Tacettin Kınay (Department of Transport Planning Manager, 15.04.2009) calls this a “concession era” for the minibus drivers. He further adds that having this concession, they are organized and they have the economical and political power to affect the decisions. They started to demand similar concessions for the latter stages of the rail transit system. As a result, the proposals of the transport plan regarding integration with other public transport systems failed to be realized.

After the B stage was completed in April 2008, the network length of Bursaray system became 22.5 km. The construction of the C stage (6.5 km), that will connect the University with the city center and the eastern parts of the city, has been started. However a change in the route of the line is on the agenda. After the elections in April 2009, new administrative committee demanded to change the route so that it is not passing through the university campus, but instead running adjacent to the campus and serving residential areas. This means that the route will not be in the high travel demand corridor (Interview with Bursa Greater Municipality officers, 15.04.2009).

It was estimated that the rail transit system ridership would be 500,000 passenger/day and 50% of the public transportation would be carried by rail transit system after the completion of the systems. Tacettin Kınay claims that Bursaray builds up the spine of public transportation; so it is important that the other modes support the system, and not compete with it as is the current situation (Interview with Tacettin Kınay, Department of Transport Planning Manager, 15.04.2009).

5.4.2. The systems currently operating in Bursa

Bursaray

The network is composed of three stages as mentioned above: stage A, stage B and stage C, which is under construction. The system started to be constructed in 1998. In 15 June 2002 the first stage; Bursaray A started operating and in 19 August 2002 public transport integration project started. Bursaray B started operating in 12 May 2008 (Burulaş website). Expected ridership levels determined the priority of the stages (Interview with Bursa Greater Municipality officers, 15.04.2009).

Source: Burulaş website

Figure 5.22. Bursaray network

The length of the system is 21.893 km. The system has 23 stations and the feasibility capacity of the system is 267,000 passengers/day (with Bursaray B).

Table 5.9. System characteristics

The system	**Opening year**	**The length of the system (km)**	**Number of stations**	**Number of vehicles**
Bursaray	2002	21.893	23	48

Source: Burulaş website

It was emphasized in the plan report that the system was needed to be supported by feeder bus systems. The integration project has started, but it could not be succeeded because of factors described above. There is enough space for any extensions of the system; however, there is a dependency on foreign resources in terms of the technology (Burulaş A.Ş. handbook).

The route of the system was determined according to the travel demands and the topography. If the route was passing from southern parts of the city it needed to be underground, so this had an effect on route alignment. In addition, land use and the route of the traffic also determined the rail transit line. (Interview with Bursa Greater Municipality officers, 15.04.2009)

5.4.3.Expectations from the rail transit investments

It is stated in the internet web site of Bursaray that; decreasing traffic congestion, increasing total passengers of public transportation, integration of transportation systems and providing a high quality transport service for the city are the main objectives of constructing Bursaray.

After the construction of the system, it was expected that there would be a decrease in travel time by 40% and a decrease in air pollution by 30%. The system aimed to connect the industrial areas with the high density residential areas. It would meet the demand of low density areas with a flexible service. (Bursaray website)

Table 5.10. Expectations from the rail transit investments in Bursa

	Bursa	**Explanation**
Reducing traffic congestion	+	The system network line is situated on the high road traffic corridor.
City image	+	There is a difference between the west and east sides of the city.
Increasing total passengers in public transportation systems	+	Park-and-ride facilities were designed however these could not be implemented.
Urban transformation/regeneration	-	**None of the interviewees emphasized this**
Decreasing air pollution	+	They are stated as the main objectives of the system in the system's official web site.
Encouraging urban development	-	**None of the interviewees emphasized this**
Increasing the viability of the city center	+	Bringing passengers from outer skirts of the city to the city center
Decreasing the operating cost in public transportation, increasing efficiency	-	**None of the interviewees emphasized this**
Other	+	Integration of public transport systems Time savings The system could be implemented by stages. (Bursaray website)

In the interviews, Tacettin Kınay stated that reducing air pollution and decreasing traffic congestion were the main objectives for investing in the system (Tacettin Kınay Department of Transport Planning Manager, 15.04.2009).

After the system started operating, a significance difference started to occur between the eastern and western sides of the city as Erdinç Alkan (Burulaş Bus Manager, 16.04.2009) stated. He argued that this was because of the better image of rail transit systems.

In the plans increasing total passengers in public transportation systems was aimed and park-and-ride facilities were proposed. However the space around the stations was not developed for this purpose. In fact currently, passengers are using these vacant areas for parking purposes although they are not officially designated for this purpose (Interview with Erdinç Alkan, Burulaş Bus Manager, 16.04.2009).

Increasing the viability of the city center was another objective of the system (Interview with Bursa Greater Municipality officers, 15.04.2009).

A very significant objective in building this system was to create an integrated transport project for the city. In each interview, it has been claimed that this was the first public transport integration project to be implemented in Turkey. However, as stated in the previous chapter, political tensions between the rail system operation and private minibus drivers sabotaged the project in a way. Alkan claimed that, in terms of system integration, they had much higher expectations during the planning of the system. Before the public transport integration project, daily 720 buses were entering the city center. However, after the project has started, the number increased to 1300 buses because of these unexpected circumstances (Interview with Erdinç Alkan, Burulaş Bus Manager, 16.04.2009).

5.5. Summary: Decision making and expectations in rail transit planning in Turkey

Analysis of objectives for investing in urban rail systems is important because these objectives reveal expectations of planners and policymakers from these investments. An accurate assessment of the urban rail systems can be made only when these objectives and expectations are fully understood.

It was stated in the previous chapters that the study had two research questions:

a. What are the main objectives of the rail transit investments in Turkey? In other words, what are the expectations from these systems?

b. Are these expectations met?

The research was therefore expected to reveal a set of objectives/expectations for investing in urban rail systems in Turkey. The findings of the study regarding this issue are summarized in Table 5.11 below.

Table 5.11. Expectations in İstanbul, Ankara, İzmir and Bursa

	İstanbul	**Ankara**	**İzmir**	**Bursa**
Reducing traffic congestion	+-	+	+	+
Integration	+	+	+	+
Increasing city image	-	+-	+	+
Increasing total passengers in public transportation systems	-	+	-	+
Urban transformation/regeneration	+	-	-	-
Decreasing air pollution	-	+ -	-	+
Encouraging urban development	+	+	-	-
Increasing the viability of the city center	-	-	-	+
Decreasing the operating cost in public transportation, increasing efficiency	-	-	+	-

It is revealed by the interviews that Ankara, İstanbul, Bursa and İzmir had two main objectives common to all when investing in rail transit system; reducing traffic congestion and creating a better integrated public transport system (Table 5.11). It is clear that reducing traffic congestion is one of the major objectives of investing in rail transit system projects in the cities analyzed in this study. In each interview, it was stated that rail transit systems were seen as a tool to decrease traffic congestion.

In three cities; İzmir, Ankara and Bursa, city image was also expected to be increased after the rail transit systems started operating. However in İstanbul, this was not mentioned.

It was discussed in interviews that one of the major reasons in investing in rail systems was the expected ridership levels that required rail technology. This was not initially introduced as an expectation, but it is clear that for the systems to reach a certain ridership level was another expectation. Since comparison of forecast and actual ridership levels is an important performance indicator, as discussed in the literature review chapter, this issue will also be analysed in the following chapter.

Integration of public transport systems, which was not originally considered as an expectation in this study, was found out to be one of the main objectives in the cities. Bursa had an integration project that would have the rail transit system in the core of transportation network. However, as it was stated before, the project could not be succeeded. In İzmir, after the opening of İzmir Metro, another project that would integrate the fare system of public transportation started. Yet integration was not initially an expected objective in the planning of the system; however during implementation it became important. In İstanbul, there is an ongoing effort in integrating rail transport, sea transport and other public transport systems. In Ankara too, it was expected that the introduction of rail systems would create an opportunity to plan a better integrated public transport system.

Decreasing air pollution, encouraging urban development, increasing the viability of the city center, increasing the importance of public transport management, and decreasing the operating cost in public transportation or increasing efficiency objectives were not as important in the planning of the case study systems. It appears that such possible benefits of urban rail investment are underestimated.

The following chapter introduces a comprehensive performance analysis of the rail transit systems in İstanbul, Ankara, İzmir and Bursa with the objective of revealing whether these expectations were met.

CHAPTER 6

EXPECTATIONS AND OUTCOMES: ARE THE EXPECTATIONS MET?

Planning, construction and operation of rail transit projects require higher expertise than bus systems, while the high performance and service quality needs considerable capital investment. The ability of rail systems to operate large capacity units, with high labor productivity and in low operating costs per unit of time make rail transit a feasible solution where high demand exists (Vuchic, 1981). Having a rail system built in a high-demand corridor is a key factor. If a rail system has a considerably high ridership, this is a proof that it is built on a high-demand corridor and that it is attracting passengers, thus fulfilling the expectations from the investment. Therefore, ridership, which is the number of passengers carried (annually or daily), is generally considered as the indicative of a rail system's success. When systems are planned, they are expected to reach a certain level of ridership, which is used to justify the high-cost investment. Therefore, a reasonable level of ridership is in fact a primary expectation from urban rail investment. All rail systems are built with the expectation that they will attract a certain number of passengers, which would generally be higher than what a bus line would attract.

The purpose of this chapter is to carry out a comparative analysis of the performance of the rail systems in Turkey. In line with the overall research formulated in this study, the analysis aims at comparing what was expected from the systems and what the actual outcomes were, or in other words whether the expectations were met. In the previous chapters of the study, it was shown that in the literature majority of previous research assessed the performance of rail systems by comparing the forecasted ridership with actual ridership on the systems. In addition, comparison of forecasted capital cost with the actual cost of building the systems is another widely used approach.

When analyzing the rail systems in Turkey, it was shown in the previous chapter that one of the most important reasons for building these systems were related to the expected passenger demands on the selected corridors. In other words, planners expected high ridership levels in the selected corridors and justified the rail investment on the grounds that alternative technologies, such as bus systems, could not meet the demand. Therefore, it can be argued that attaining a certain level of ridership, i.e. the ridership that was forecasted, should be a primary criteria in assessing the performance of Turkish systems too. Therefore, the first section below focuses on the ridership of systems: trends in passenger numbers since the opening of the systems are given; ridership levels are compared by calculating passengers per kilometer of system; and ridership forecasts are compared with actual ridership.

In the previous chapter, it was also seen that majority of rail systems in Turkey were built with the expectation that they would help create a more integrated public transport system. Therefore, in the second section below, information on physical and ticketing integration will be presented briefly, and the total ridership on public transport systems will be analyzed over a period of years in order to observe whether there were any significant changes after the opening of rail systems.

Thirdly, capital cost forecasts are compared with actual costs of building the systems since this is one of the major criteria in assessing the performance of rail systems in universal studies, as mentioned earlier.

Finally, in the fourth section below an analysis is made regarding the image of the systems, land-use change, traffic reduction and air quality improvement. System's contribution to the image of the city that they serve was seen as one of the major expectations from the Turkish rail systems in the previous chapter, and a brief analysis is carried out here. While expectations regarding land-use change, traffic reduction and air quality improvement were noted for some of the systems, these require more comprehensive analysis and before-and-after data; and therefore, they are not analyzed in this study, but experts' views and findings of previous studies on these issues are noted where available.

The following analysis, therefore, presents a comparative assessment of the rail systems in Turkey in terms of:

- ridership, including the forecasts and outcomes
- creation of an integrated public transport system and ridership change on total public transportation
- capital cost forecasts and outcomes

- contribution of the systems to city image, land-use development, traffic reduction and air quality improvement

6.1. Comparison of Ridership Forecasts and Outcomes

In Table 6.1. and Figure 6.1., annual riderships of the systems are given. In Ankara and İstanbul the available data is used for the comparison.

It is observed that, ridership on the Istanbul Metro has been continuously increasing since its first year of operation. Zeytinburnu-Kabataş tramway and Aksaray-Airport light metro systems also experience increasing ridership levels, with the exception of early 2000s, when ridership fell probably due to the economic crises in the country. It is also seen that Aksaray-Airport light metro has the highest ridership level compared to all other urban rail systems while Zeytinburnu-Kabataş tram also has a significantly high ridership level that is above the ridership of the Istanbul Taksim-4th Levent metro. It should be remembered, however, that systems have different lengths and therefore different levels of urban coverage. The analysis of passengers per kilometer of rail system would be more reliable for comparing ridership levels, and that is made further below in this section. It should also be noted that the rate of increase in ridership in the Istanbul urban rail systems are significantly higher than that in other systems observed here.

The situation in Ankara shows that in 1999, the number of passengers carried by Ankaray decreased. This was partially because of the newly opened bus lines and the increase in the number of vehicles and partially because of the increase in private car usage. The passengers carried by Ankaray and Ankara Metro have been increasing since 2002 (Pampal et al. 2009). The increase is associated with the introduction of combined ticket system in 2001 (Babalik-Sutcliffe, 2006). The rate of increase in the Metro is more than that in Ankaray; this might be due to the fact that metro is on the urban development corridor and therefore experiences increase as further developments take place, whereas Ankaray is in central and already developed area.

Table 6.1. Annual ridership of the systems

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Ankara Metro	50,133,405	50,715,518	45,951,204	48,933,272	43,535,408	46,677,954	53,168,981	54,306,947	58,502,336	64,237,405	
Ankaray	46,314,659	41,837,873	35,994,344	40,133,589	35,511,894	36,974,956	39,556,061	40,078,899	41,674,242	44,646,512	
Aksaray-Airport Light Metro				55,161,109	52,962,872	56,354,945	64,092,187	68,631,999	77,622,397		
Zeytinburnu-Kabataş Tramway				46,879,641	44,891,357	43,781,365	49,186,407	57,763,383	67,273,579		
Taksim-4th Levent Metro				20,687,387	35,379,375	38,835,756	43,499,956	46,986,372	53,576,758		
İzmir Metro				29,346,544	28,606,211	28,390,870	29,045,535	28,043,254	27,451,159	28,548,741	
Bursaray						44,000,000	42,000,000	43,000,000	38,000,000	37,500,000	45,000,000

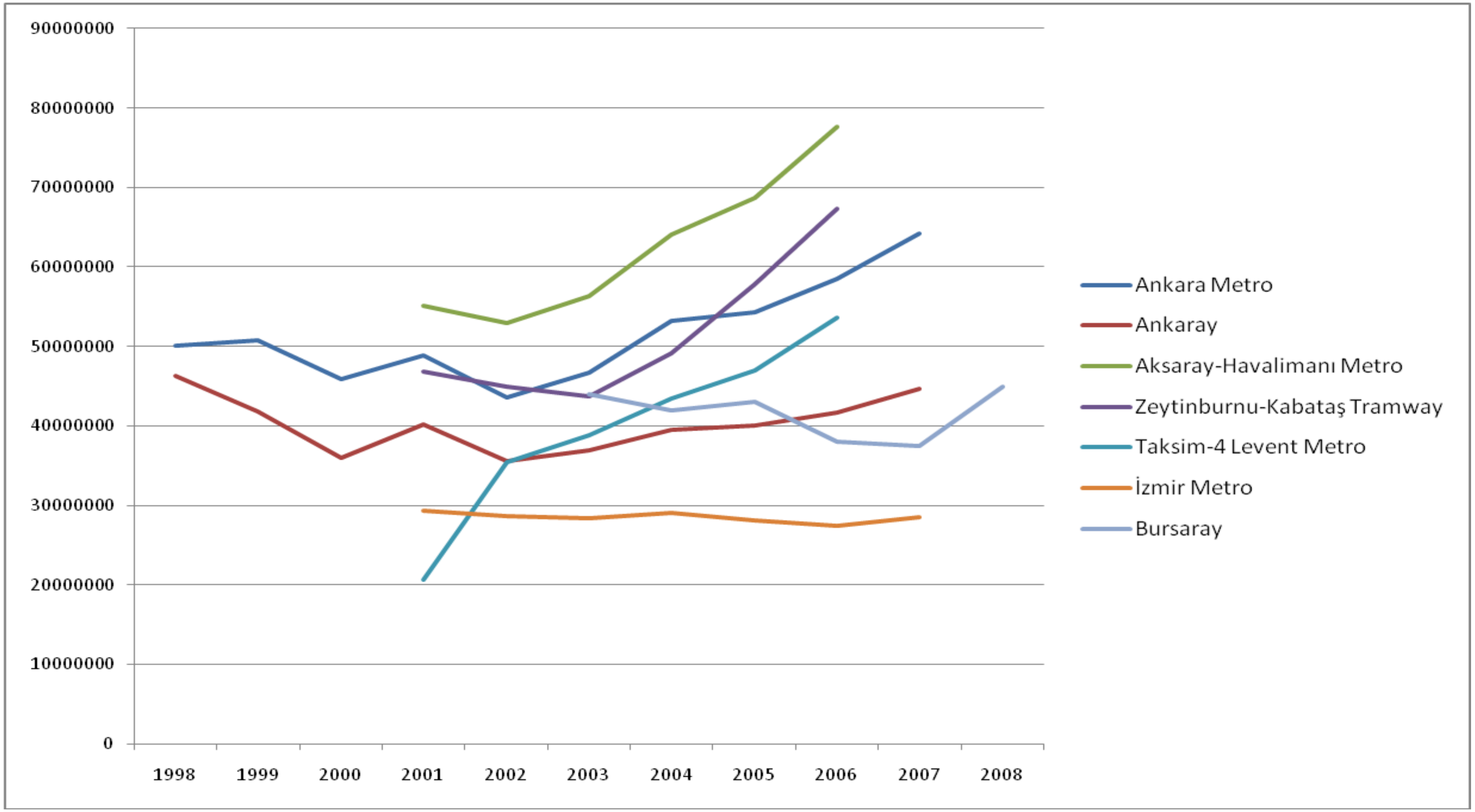


Figure 6.1. Annual ridership of the systems

The graphic shows that in the Bursaray system, ridership has been declining since the system's opening; however, it increased after the opening of the stage B in 2008.

In İzmir, the metro system opened in the second half of 2000, and it is seen that after the first full year of operation in 2001, the ridership reached a certain level and remained almost constant in the following years as the demand pattern became steady.

When annual ridership per kilometer of system is analyzed, it is seen that Taksim-4th Levent Metro has the highest value, followed by Zeytinburnu-Kabataş Tramway and then Ankaray LRT. This makes the Taksim-4th Levent Metro one of the most successful systems in terms of passenger numbers. It is important to note that Ankaray carries more passengers per system kilometer than the Ankara Metro. While Ankaray is an advanced LRT, hence a technology between regular LRT and metro, it still has a lower capacity in comparison to metro. This shows that the Metro in Ankara is not as efficient as it should be yet. It is important to compare the systems according to their technology and therefore capacity. Among the case studies, there are two full-metro systems: Istanbul Taksim-4th Levent metro and Ankara metro. It is clear that the former is more successful in terms of passenger numbers when compared to the latter.

Table 6.2. Annual ridership per km (2006)

	Annual ridership 2006	Length of the system (km)	Passenger/km
Ankara Metro	58,502,336	14.6	4,007,009.32
Ankaray	41,674,242	9	4,887,327.55
Aksaray-Airport Light Metro	77,622,397	19.95	3,890,846.97
Zeytinburnu-Kabataş Tramway	67,273,579	13.2	5,096,483.26
Taksim-4 Levent Metro	53,576,758	8	6,697,094.75
İzmir Metro	27,451,159	11.6	2,366,479.20
Bursaray	37,899,999	22	1,731,146.90

Note: In this table, Zeytinburnu-Bağcılar tramway and Taksim-Kabataş Funicular systems are excluded. The reason why they were excluded is that the systems are newly operating systems and for Zeytinburnu-Bağcılar tramway it would be a double data entry because the passengers carried by the system are also counted in Zeytinburnu-Kabataş Tramway.

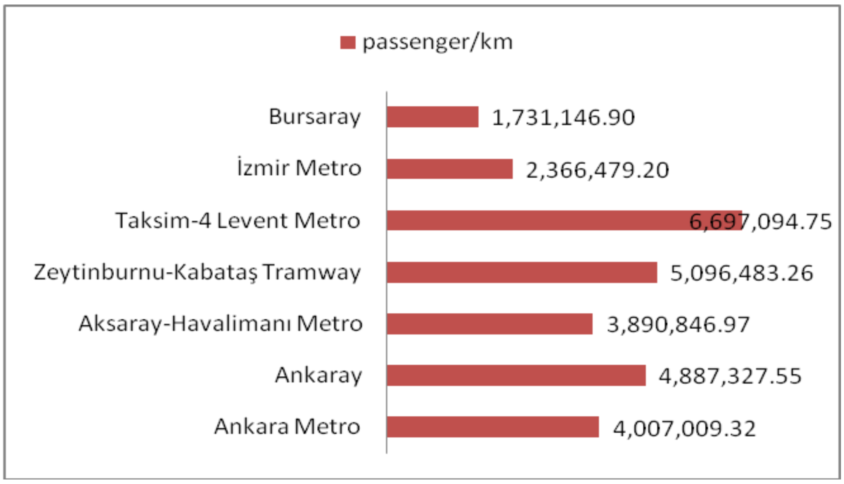


Figure 6.2. Annual ridership per km (2006)

There are three light metro or advanced LRT systems observed here: Ankaray, İzmir Metro and Aksaray-Airport light metro. In fact Bursaray can also be added to this list, since it is a fully segregated and separated system although it takes its power from aerial lines rather than a third rail. Among these systems, Ankaray is the most successful in terms of passenger numbers per kilometer of system, followed by another fairly successful system, Aksaray-Airport light metro. Izmir metro, an advanced LRT system that is quite comparable to Ankaray, carries half the number of passengers of Ankaray per system kilometer. Bursaray system has the lowest value, although it is possible to argue that Bursaray is not an advanced LRT or light metro, but a more regular LRT with lower capacity.

The Zeytinburnu-Kabataş system is the closest to a tram. The system is not fully segregated and all intersections with other forms of traffic are at-grade. It is known that this sort of design decreases the line capacity. In spite of this, Zeytinburnu-Kabataş tramway has one of the highest levels of passengers per system kilometers, closely following the metro system in Istanbul. However, as mentioned in the interviews it is operating overcapacity. If we compare Bursaray system with this tramway, again Bursaray appears to be performing rather poor. In the previous chapters, it was mentioned that after the opening of the system, the Municipality tried to implement the transport integration project. However, the bus drivers and the minibus drivers did not change their lines. The feeder bus system could not operate. Rail passengers were attracted by the increasing bus operations and the number of passengers carried by Bursaray declined. This value would be an outcome of these problems.

We can conclude that, in terms of passengers carried per system kilometer, İstanbul Taksim-4th Levent metro, Ankaray, and Zeytinburnu-Kabataş tramway are the most successful systems, while the Izmir Metro and particularly Bursaray have a poor performance. The Ankara Metro can also be considered to have a rather limited performance for a full-metro.

Another universal way of assessing urban rail performance is to analyze the difference between ridership forecasts and the actual outcomes.

Unfortunately no forecast data could be obtained for the systems in İstanbul. It was stated in the interviews that the Zeytinburnu-Kabataş tram carries approximately 250,000 passengers per day which is over the capacity and above the expected levels. However, no specific forecast data was provided to verify this. For Aksaray-Airport light metro 300,000 passenger/day was given in the first study (1985). However, the route had changed. As it is concluded the actual ridership value for 2008 is less than it was estimated for the year 2005. This is an important overestimation. It was also stated that in Aksaray-Airport light metro line, capacity was reached and that the number of passengers carried is the number that a metro system should carry (Mustafa Metin Yazar, İstanbul Ulaşım A.Ş. 18.02.2009). As for the Taksim-4th Levent metro, again there are no available data.

The ridership forecasts and outcomes for Ankara (2005) clearly indicate that both systems in Ankara failed to reach the forecasted passengers levels (Table 6.3). It is seen that Ankaray was estimated to carry 554,362 passenger/day in 2005. If this estimation is compared with the actual ridership in 2005, it is seen that the system is operating with significantly less passengers. The actual ridership is 77.4% lower than the forecast. When the ridership estimations for the Ankara Metro are compared with the actual ridership, it is seen that the metro too carries much less passengers than it was estimated to carry. Actual ridership is 73.4 % lower than the forecast. It should be noted that the ridership is calculated by counting the passengers buying tickets, and that this number does not include the transfers and the cost free passengers such as disabled people (Interview with Fuat Vural, EGO Transport Planning and Coordination Center, 31.03.2009). Nevertheless, even if such passengers are included it is clear that forecasts are not reached in the rail systems in Ankara.

Table 6.3. Ridership forecasts and outcomes

	Estimated ridership passenger/day	Estimation year	Actual ridership passenger/day	Year	Difference (%)
Ankara Metro	639,511	2005	169,709	2005	-73.4
			200,000	2009	
Ankaray	554,362	2005	125,247	2005	-77.4
			160,000	2009	
Aksaray-Airport Metro	300,000*.	2005	240,000	2008	-20 (see text)
Zeytinburnu-Kabataş Tramway	N.A.		245,000	2008	+ (see text)
Zeytinburnu-Bağcılar Tramway	N.A.	N.A.	42,000	2008	N.A.
Taksim-4 Levent Metro	N.A.	N.A.	170,000	2008	N.A.
İzmir Metro	70,000**	2001	91,708	2001	+31
	220,000***	2010	81,000	2007	-63
Bursaray	205,000	2002	105,000 (without stage B) 127,000 (with stage B)	2008 2008	-48.7 -38

Source: İstanbul: İstanbul Ulaşım A.Ş and İstanbul Greater Municipality websites. Gümüşoğlu, 1992, Gedizlioğlu, 1999. Ankara: Actual annual ridership for Ankaray (2005) is 40,078,899 passengers and for Ankara Metro is 54.306.947. Daily ridership of the systems is calculated by dividing the values by 320 (average day in a year). İzmir: The ridership estimation value 2001 for İzmir Metro was a finding from the interviews in İzmir Greater Municipality and for 2007 from İzmir Metro Management Report 2007. The actual value was found dividing the annual ridership by 320. Bursa: The ridership estimation value for Bursaray is from Burulaş A.Ş. website. * This value was given in the first study (1985) for Aksaray-Bağcılar route. However, the route had changed. It would not define the exact route operating although actual ridership is still under the estimation. This is an important overestimation. ** Stated in the interviews *** In İzmir Transportation Master Plan Update Study (1997), the passenger estimations in the corridors were given for the year 2010. The system would have been considered in which all the stages of the system would be finished and the actual ridership level would increase if all the stages are finished.

It should be remembered that passenger forecasts for urban rail systems are based on certain assumptions regarding the operation of the general transport system, and particularly other public transport modes. In the case of Ankara, the systems were planned to be supported with a well integrated bus transport system. In the corridors of Ankaray and Ankara Metro, it was planned not to have other public transportation systems; besides a feeder bus service was proposed. However the use of private bus systems in the Ankaray corridor and dolmuş in the Batıkent metro corridor continued. Although there is feeder bus services in Batıkent, such supporting services did not take place in other parts of the routes. In addition, company service bus operations increased in Ankara, which provide free commuter journeys (Interview with Fuat Vural, EGO Transport Planning and Coordination Center, 31.03.2009). As a result, other public transport systems compete with the urban rail systems in Ankara, rather than compliment them.

In Bursa, there was a total ridership of 4,500,000 passengers that was estimated for the rail system to carry annually. In the feasibility studies, it was estimated that daily ridership would be 205,000 passengers daily in 2002. According to the project, parallel bus lines were to be eliminated and feeder bus systems were to be integrated with the rail transit system. However, the parallel lines still operate, complicating the operation of Bursaray. Furthermore, service frequency is low for feeder systems; B-9 feeder bus runs every 30 minutes, whereas 50 parallel line buses operate every 5 minutes. The transit rail line is on the urban development areas of Bursa; however as mentioned above its ridership decreases continually with the exception of year 2008 when ridership increased with the opening of the second line, Stage B. It is seen that the actual ridership for the system is also far below the expected level. While the expectation was 205,000 passenger/day for 2002, it is carrying 105,000 passengers per day (without stage B) and 127,000 passengers/day (including stage B) in 2008 (Interview with Erdinç Alkan, Burulaş Bus Manager, 16.04.2009).

For İzmir Metro, in İzmir Transport Master Plan 1992, between F.Altay-Üçyol it was estimated to carry 70.000 passengers daily and between Üçyol-Basmane it was estimated to carry 150,000 passengers/day. However, the route had changed starting from Üçyol and finishing at Bornova. The 1997 study forecasted daily ridership levels between 200,000 and 245,000 passengers/day. For the final route selection between Üçyol and Bornova, in the interviews, it was claimed that the estimation was to carry daily 70,000 passengers. This estimate is also stated in the 2007 performance report of the system. However, it is possible that this is a “revised” forecast. Therefore it was decided in this study to use both this revised forecast and the most recent study’s forecast in 1997, which estimated at least 200,000 passengers. After the system started operating in 2001, its ridership increased to 91,708 passengers/day. This indicates that the system carried 31 % more passengers than the revised estimate, but 63% lower than the estimate of the 1997 Study. The ridership increased significantly after the first year of its operation. In the same year “Transformation in Transportation” project, which introduced route integration of ferries, buses and LRT as well as an integrated ticketing system, started and this seems to have caused a raise in the number of passengers carried by the system. It was estimated that Bornova station would have less passengers and Bölge station would be the dead space. With improvements in the environment of the station (lighting, orientation and so on) more passengers were attracted to the metro station. In addition, developments around the metro station, such as the opening of Yaşar University and residential developments also helped to increase the number of passengers using that station (Interview with Sönmez ALEV, İzmir Metro A.Ş. General Manager, 03.06.2009). In İzmir, too, the system network has not been completed yet. After the completion of the system network, the passengers carried by the systems would increase to estimated levels.

It was mentioned in sections **2.2.2 The gap between expectations and outcomes** and **2.2.3 Reasons for the gap** that there are some reasons for the overestimations in ridership, that it is complicated to quantify the secondary and indirect effects in the decision making process of rail transit investments (Richmond, 1998, p.28). In the interviews in EGO Department of Rail System Management the increase in the usage of private cars and taxis, insufficient number of rail vehicles, unplanned bus systems, company services for employees, and the delays in the other phases of the rail transit systems were mentioned as the reasons for the failure of rail transit systems in attaining the forecast passenger levels.

In a study by Gomez-Ibanez (1985), the actual ridership and financial data was analyzed in the new lines in San Diego, Calgary and Edmonton. He argued that in all three cities proponents of LRT have oversold the systems. Kain (1988) criticized building light rail lines in low density Sunbelt cities like Los Angeles and Dallas. He claimed that both in Dallas and Los Angeles the decisions to build LRT systems was an outcome of a more emotional and psychological attachment to rail rather than an outcome of a cost-effective analysis and/or another method of forecasting. He further added that it had a positive effect on transit ridership in two of three cities whereas the costs per added rider were high. The decisions were made without any consideration of any other alternative such as a bus rapid transit system which would be more suitable. The proposed ridership forecasts were far too high and it is understood that the advocates of rail systems have shown a tendency to overestimate the ridership forecasts. Fouracre also showed that the actual ridership for the metro was below the original forecast in most cities. In his study estimates for only Manila and Tunis were approximately achieved. In other cities such as Calcutta, Porto Allegre, Rio de Janeiro, Santiago, Pusan and even Seoul, the ridership was below the target. He argued that the reasons why the forecasts are inaccurate may lie on ‘over-optimism in the planning phase’ (Fouracre et al., 1990).

It appears that in Turkey too, urban rail systems have a rather limited success in attaining the estimated ridership levels. In addition, similar to the arguments of the above authors, the failure in attaining forecasts seems to be related with the failure in implementation of various measures originally proposed in the planning phase. It can be suggested that in Turkey too there is over-optimism in the planning of urban rail systems.

Observing the share of rail transit in total trips and in public transport trips can also help assess the ridership of urban rail systems within the context of their city. Certainly, there are various factors resulting from the different lengths of the systems that need to be remembered in such an analysis: longer and more extensive systems are likely to have a higher share in total trips. Nevertheless, the modal share of systems can still provide information on the relative importance and role of rail systems in urban transport.

Table 6.4. Share of rail transit

		Share of rail transit in total trips (%)	**Share of rail transit in public transport trips (%)**	**Share of public transport in total trips (%)**
Ankara	Ankara Metro	3.8 (2008)	5.6 (2008)	69.1 (2008)
	Ankaray	2.8 (2008)	4.1(2008)	
İstanbul	Aksaray-Airport Metro	1.77 (20099	5.94(2009)	62.79 (2009)
	Zeytinburnu-Kabataş Tramway	1.68 (2009)		
	Taksim-4 Levent Metro	1.29 (2009)		
	Other rail	1.25 (2009)		
İzmir	İzmir Metro	2.7 (2008)	3.46 (2008)	80.8 (2008)
Bursa	Bursaray	8 (2009)	13 (2009)	59 (2009)

Source: Bursa: Bursa Greater Municipality UKOME, 2009, Erdinç ALKAN, Burulaş 2008, İzmir: İzmir Transport Study Revision 2030, Ağustos 2007 Ankara: EGO, DTPRS, Ankaray Transportation Study, 2008 İstanbul: İstanbul Kentiçi Ulaşımında Sayısal Veriler (Leaflet), 2009, TMMOB İnşaat Mühendisleri Odası

It is seen in Table 6.4 that in İstanbul, the share of rail transit systems in total trips is 5.94% in 2009. It was 4.6% in 2006. Although there is an increase in the value, it is still quite low for a metropolitan city. The share of each urban rail system observed here, i.e. the metro, the light metro and the tramway, have shares below 2% in total trips in the city. Certainly this is related with the length, extensiveness and coverage of systems as opposed to the massive land area that Istanbul covers. Nevertheless, share of different rail transit systems in İstanbul represent one of the lowest amongst the cities observed here.

In 1996, the total share of rail journeys, i.e. commuter rail, in total motorized trips was very low in Ankara: according to the data in 1999 commuter rail was carrying 100,000 passengers/day and it was 2% of total passengers. After the opening of Ankaray LRT in 1996 and the Ankara Metro in 1997, the total share of rail transit systems increased. Ankaray has 2.8% share and the Ankara Metro has 3.8% share in total trips. Although the operating systems are only 40% of the proposed network length, it is clear that these shares are rather low. They are higher than the share of rail in İstanbul; however, once again the population and city size of İstanbul should be considered when comparing İstanbul with other cities.

In Bursa, before the rail system opened, 28% of public transport passengers were carried by municipality's bus system, 27% by company bus services, 40% by minibuses and 5% by private bus systems. In the proposed system this distribution was estimated to be 23% for rail transit system, 25% for company bus services and 52% for the bus systems (minibuses converted into bus systems) (Burulaş). According to 2009 figures, rail system's share in public transport is 13% which is lower than what was expected. Nevertheless, Bursaray appears to have the highest share in total trips (8%) as well as in public transport trips when compared with urban rail systems in other cities. This may again be related to the city size (Bursa is the smallest city with the lowest population amongst the case studies), but it is still an indicator showing the significance of the system in urban transport.

Considering sea transportation and rail transportation, it was observed in İzmir Transportation Master Plan Update Study that in the total daily travels 38% of daily travels were made by pedestrians, 10% of private cars, 16% of taxis, minibuses and dolmuş, 34% buses, 0.4% of rail transport and 1.3% of sea transportation systems. It is seen that the ratio of public transportation systems is approximately 36%. It was estimated that after the rail transit system started operating, the balance between transport modes would be changed and the new rail transit system would have a share of 13% in public transport trips (İzmir Transportation Master Plan Update Study, 1997, p.80-82). However it was only 3.46% in 2008.

Considering the share of public transport trips in overall transport trips in the cities, it is seen that the share is 62.79% (2009) in İstanbul, 69.1% (2008) in Ankara, 80.8% (2008) in İzmir and 59% (2009) in Bursa. Bursa has the lowest share of public transport trips and İzmir has the highest. It is possible that the public transportation integration project ("Transformation in Transportation") helped İzmir to have significantly high modal share of public transport when compared to other cities in the study.

6.2. Creation of an integrated public transport system and ridership change on total public transportation

6.2.1. Integration

Integration, which was not originally considered amongst the main issues in the scope of this study, was observed to be one of the main objectives in the case study cities after conducting the interviews. This issue is analyzed below in terms of both route and fare/ticket integration.

Gerçek (2007) claimed that adjudicating rail transit systems in parts, and without planning the whole, resulted in unintegrated rail lines in certain parts of the systems in İstanbul. Because of this problem sometimes two separate rail stations were built in the same location rather than a single transfer station. Similarly, at-grade tramway platforms had to be raised in the implementation phase due to the introduction of a new system with new and higher vehicles. Problems of route integration exist in İstanbul, resulting in decreased service quality and increased costs in investments (Gerçek, 2007).

Vuchic (2007) also stated in an interview in "Rail Systems Bulletin March-April 2007" that in İstanbul, each rail transit system works quiet successfully, but there is no integration between those systems. If rail transit systems were integrated with each other and with other transport modes, such as buses and ferries, it would attract more passengers to the systems and the management quality would increase. He further added that there should be a standard in the technologies used in the systems and that the transfer centers should be improved.

It was stated in the interviews that there was a certain level of integration between bus systems and the metro system between Taksim and Mecidiyeköy and there were ongoing efforts to better integrate rail transport, sea transport and other public transport systems (Interview with Mustafa Murteza, İstanbul Greater Municipality Department of Transport Planning, 20.02.2009).

It appears that Istanbul rail systems have a rather poor level of route integration, i.e. physical integration. In terms of fare integration, however, the system in Istanbul has important positive aspects. Introduction of Akbil (Smart Ticket) increased travel comfort in İstanbul. Akbil system provides combined journeys on İstanbul sea buses, rail systems, municipal buses as well as some of privately operated buses and marine lines. In terms of fare too, there are poorly integrated links, such as Taksim-Kabataş Funicular; however, getting privately operated bus systems included in the combined/reduced fare scheme is a success that is rarely seen in other cities. The passengers make transitions between Taksim Metro and buses within 1,5 hours free of charge after getting on the first vehicle (İETT website).

It was aimed in Ankara Transportation Master Plan (1995) to integrate the rail station in the city center with bus systems and pedestrian areas to provide a comfortable and effective public transportation system and to reduce private car usage. In addition, it was proposed to build car parks at station sites in residential areas in order to support integration (Ankara Transportation Master Plan, 1995, p.100). The metro station in the city centre has exits to the pedestrian streets; however, there is no pedestrian square or main pedestrian area that supports this important node in the area. The bus stops require reorganization since they stretch over a kilometer along the main boulevard in the city centre. It is difficult, therefore, to suggest that the city centre accommodates an effective rail-bus transfer station. Car parks are not provided in station areas either, except for the one in AŞTİ station, which is not very effective due to its limited capacity and lack of financial incentives for metro users. As a result, in terms of the management of city centre transport, pedestrians, buses and private car traffic are not at all integrated with the rail systems.

After the Ankara Metro opened, the buses that were operating along the metro corridor were reorganized as feeder bus systems and they were pulled out from the center line. With the help of fare integration it was estimated that this would increase the ridership in the rail systems. However, privately operated systems, including dolmuş and minibuses, could not be integrated to the system and this has become a severe integration problem (Interview with Fuat Vural, EGO Transport Planning and Coordination Center, 31.03.2009).

The ticket integration system is not working well either: in Ankara there is a system that allows passengers to have a second transit trip for free within 45 minutes of using their ticket for their first journey. However, this does not include all transport modes, and is valid only on Municipality buses and the rail systems. In addition, it has been seen that 45 minutes was not sufficient considering long distance trips in the city. It was stated in interviews that there were plans to increase this to 60 minutes; however, these plans were not realized.

In İzmir, integration was not stated as an expected objective in the planning of İzmir Metro; however, it should be remembered that it was actually a major component of the "Transformation in Transportation Project" that also introduced the İzmir Metro. The project's aim was to integrate bus systems, sea transportation systems (ferries), commuter rail and metro systems and to improve system performance by restructuring routes, services and fare system of all public transport modes. The project had three phases: the introduction of electronic fare collection (Kentkart) to buses and ferries; the introduction of the metro system and improvements in buses and ferries in order to integrate with the metro system;

and extentions to the İzmir Metro (Öncü, M.A., 2007). It should be noted that there have been various changes in the Kentkart system after the project's implementation in early 2001, and that the fare advantages for public transport reduced in time (Öncü, 2007). Nevertheless, the fare system is still in use and İzmir case represents a relatively more successful experience in route and fare integration.

Bursa also adopted a transportation strategy that put the rail transit system in the core and integrated public transport modes with each other. The main corridors were selected and the project was divided into stages. Attraction of passengers to the public transport modes, decrease in the usage of private cars and decrease in traffic congestion were expected as a result of the integration strategy (Burulaş website). However, as stated in the previous chapter, tensions between the rail system operation and privately operated minibus lobbies sabotaged the integration schemes. This seems to have hindered the project's success to a certain extent.

6.2.2. Ridership change on total public transport

When interviewees stated integration as one of the main objectives for the urban rail projects, it was presumed that this issue is seen important because it can help increase service quality and as a result overall public transport usage. Therefore, total public transport ridership and the effect of the new urban rail systems in overall ridership were also analysed. It can also be remembered from Chapter 2 that in rail transit studies in North America, some critics argued that the rail systems' performance could not be assessed without analysing total public transit ridership because the new rail system may attract passengers from buses and therefore may not result in any significant increase in total public transport usage. From this point of view too, studying total public transport ridership is necessary.

As seen in Figure 6.3, in İstanbul, there was a decrease in public transport ridership between 2001 and 2003, after the İstanbul Metro started operating in 2000. This could be a result of reorganization of public transportation systems or it could be because of the economical crisis in 2001. After 2003, there is an increase in total public transport ridership. It was observed in the rail transit ridership in the previous section that, in İstanbul, there is a continuos increase in rail transit ridership. It could have an effect on the total ridership as well. It is also seen that of all the other cities in the study, İstanbul has the highest value of public transport ridership and this would be result of the size and location of the city itself.

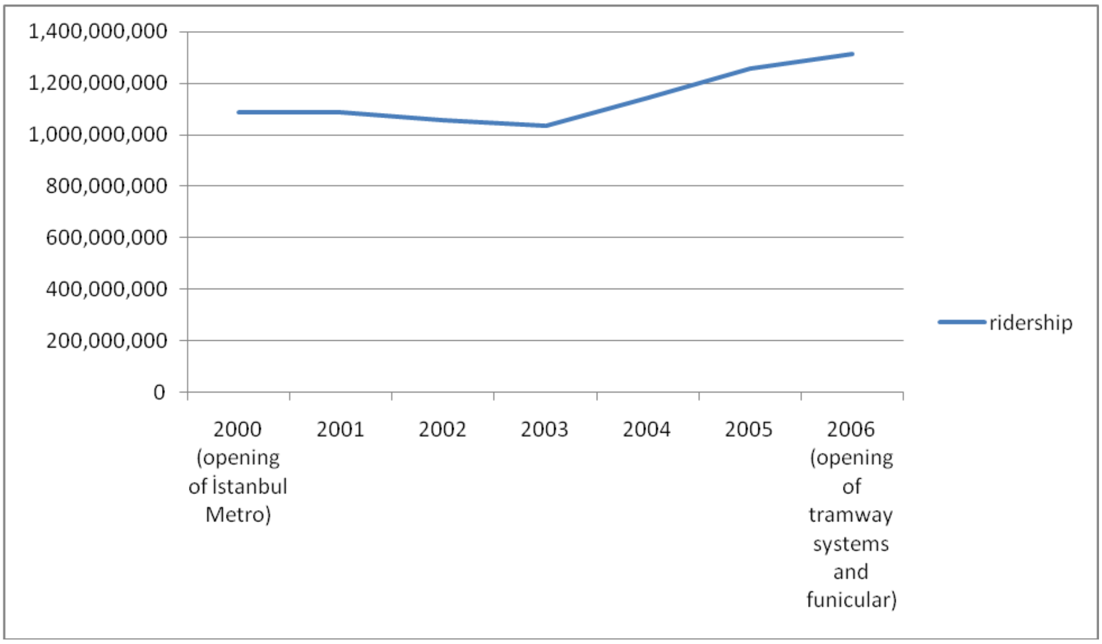


Figure 6.3. Annual ridership of public transportation modes in İstanbul

Note: 2000 is the year that İstanbul Metro started operating. However, the available data is from the year 2001 to 2006. The data is from İstanbul Greater Municipality. The values are the sum of the ridershio of bus, marine and rail transport systems.

In Ankara, it was stated in the interviews that the number of passengers carried by public transport modes did not increase after the opening of rail transit systems. That was because the bus system lines were reduced and it resulted in a balance in the total system. For instance, in the Batıkent corridor, 100 bus vehicles were reduced to 35 bus vehicles. However, it is seen that the introduction of the rail systems attracted more passengers to public transport (Figure 6.4). Another increase could have been expected after the fare integration between rail transit and buses in the early 2000s; however this does not seem to be the case. There is still a competition between municipal public transport modes and privately operated ones in Ankara. Private operators (dolmuş, services) have a strong pressure on the local authority. In addition, local authority policies since the mid-1990s have not been very supportive of public transportation, but favoured private car usage. The level of public transport usage did not continue to increase therefore.

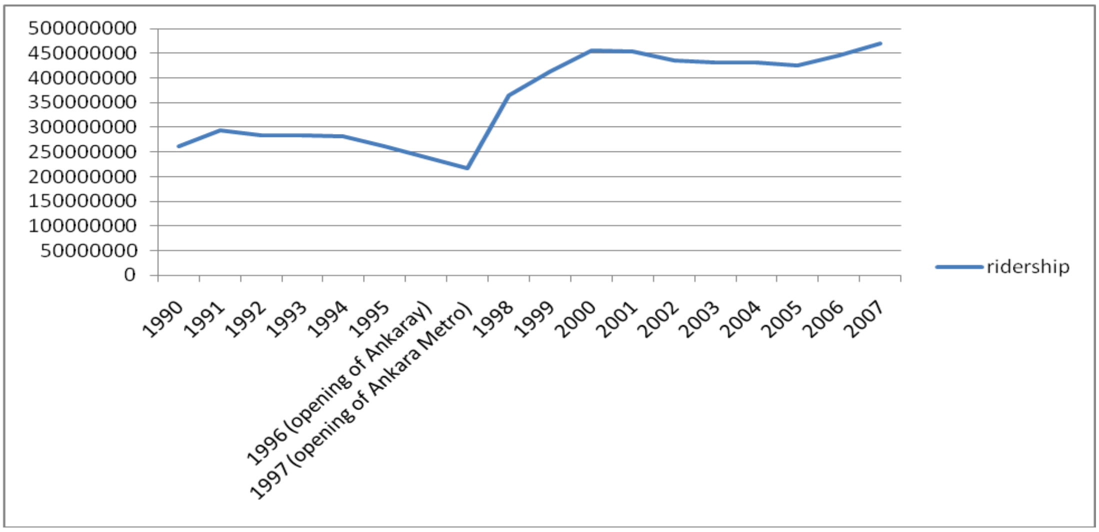


Figure 6.4. Annual ridership of public transportation modes in Ankara

Note: Annual bus transport ridership is found by multiplying the daily values with 112 (an average value). For the years 1998-1999 and 2001-2004 an average value is calculated. After the opening of rail transit systems, the total public transport ridership is found by adding riderhip of rail transit with ridership of bus transit systems.

It is observed from figure 6.5 that there was a significant decrease in public transport ridership between 1996 and 1997 in İzmir. In 1998 the passenger numbers remained almost constant. There was also another significant decrease in 1999 which was described by the municipality officers as an outcome of operation of different modes independently.

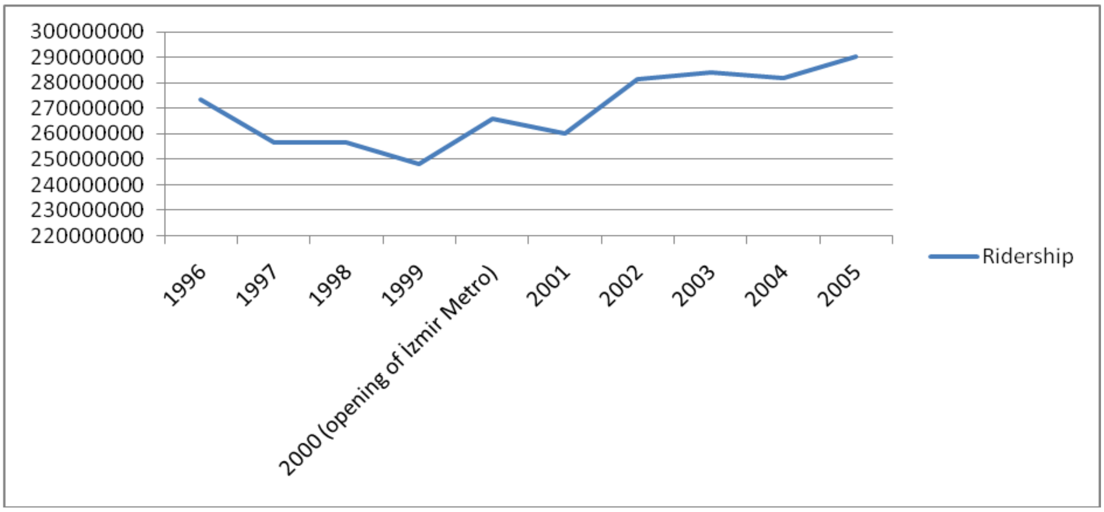


Figure 6.5. Annual Passenger number of public transport modes in İzmir

In 1999, an electronic fare payment system was introduced and this seems to have caused a significant increase in the ridership. After İzmir metro started operating in 2000, there is a slight decrease in the total number of passengers which can be explained by users' initial reaction to changes in the bus routes. Bus routes parallel to the metro line were cancelled and new feeder bus lines started operating. Since 2000, however, the number of passengers carried by public transport modes have been signifiantly increasing. It should be noted that this increase is mostly due to ridership on metro and the increase in ferry systems: bus usage remained constant (Öncü, M.A., 2007). Nevertheless, a steady increase in public transport is an important and positive outcome, which may be closely related to the integration project in İzmir.

In Bursa, annual daily bus trips, as seen in Figure 6.6, have been continuously decreasing since 1998. After Bursaray stage A started operating, first a further decrease was experienced, but then ridership started to increase. It was stated in the interviews that after the opening of Bursaray the number of buses and minibuses were reduced. The initial decrease may be due to the first reaction of users to this reorganization. However, the increase in the following years is an important finding, showing that Bursaray had a positive effect on the overall public transport usage in Bursa.

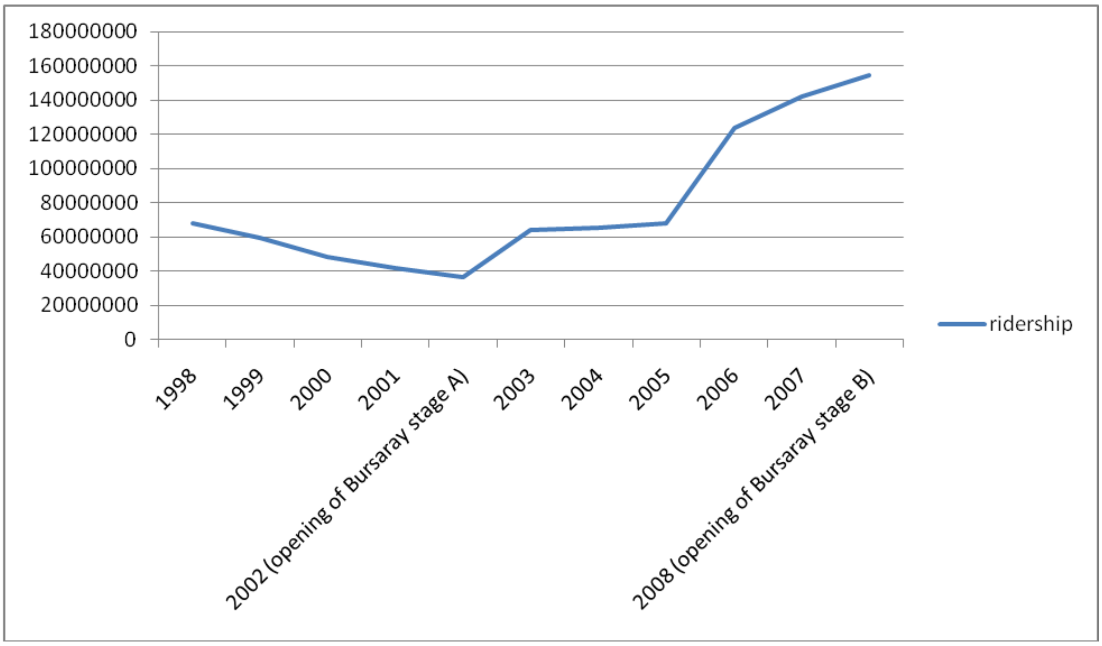


Figure 6.6. Annual Passenger number of public transport modes in Bursa

In 2006, the number of passengers carried by buses in the city tripled and it increased the passengers carried by public transport modes in Bursa. This ridership change was not mentioned in the interviews; this data was collected from municipality records. The passengers carried by Bursaray did not increase sharply as the passengers carried by bus modes.

It is observed in each city that there is a growing trend of using public transportation modes. Public transport ridership increased after the opening of urban rail systems. However in Ankara the rate of growth seems to have decreased in the later years This would be because of having private car oriented policies in the city. There are a lot of road investments encouraging private car usage. Public transportation policies are ineffective as such that the integration between the systems are not maintained and minibuses and private taxis have the power to get passengers from the public transport lines. This reduces rail and bus transit usage in the city. In İstanbul and İzmir with route and fare integration implementations public transport is encouraged. In those cities too road investments cover the biggest part of city's investment programmes however, the level of public transport usage is also increasing, at a rate higher than that of Ankara case. In Bursa, rail and bus transport were tried to be integrated but failed because of the minibuses and buses continued to operate in parallel lines, competing rather than complementing the system. It was seen in the previous section that public transport share in total transport modes is also low accordingly due to the mentioned problem.

6.3. Comparison of Cost Forecasts and Outcomes

It was mentioned in the previous chapters that the planners and the engineers should do a detailed research and data collection before predicting capital costs for a proposed system. This is partially because the investments are massive and partially because there are a variety of choices when deciding on the features of the technologies.

The forecasted costs of building the systems and the actual outcomes are presented in Table 6.5. It is seen that apart from Ankaray, forecasted capital costs were exceeded in all projects. In Ankaray the actual cost was 7% below the forecasted, showing that the system was built within budget. As for the Ankara Metro, the project took place in the investment programme of State Planning Organization (SPO) in 1987. It was proposed to be constructed through Built –Operate- Transfer (BOT) system. The offer of the consortium of Canadian firm UTDC and Gama–Güriş of about 700 million dollars was accepted. However, the project was later rejected by SPO who found that it was not feasible to construct the system through BOT. Afterwards it was decided to be constructed by foreign aid and in 1993 the construction had started (Çubuk, Türkmen, 2003). It was stated in the interviews that Ankara Metro was a turnkey project, which means that the project is to be finished within the financial sources that were estimated in the feasibility studies. It was therefore stated in interviews that there were no gaps between the forecast and actual capital cost of the system and that the system was built within the forecasted budget (Interview with Ertan Sarıgöl, EGO Rail Systems Department of Metro Construction Manager, 01.04.09) However, no figures were given.

Regarding the urban rail systems in İstanbul, data could not be obtained for the Aksaray-Airport light metro and the Zeytinburnu-Kabataş section, which is the main section of the Tramway. The 5.2 km Zeytinburnu-Bağcılar Tramway section cost 58% more than the estimations. It was found that the Taksim-4th Levent Metro cost more than double the amount that was estimated (146% more than the estimation).

The İzmir Light Metro system was also built for more than double the amount that it was estimated to cost (104% above the estimations). It should be noted that the estimated figures given for İzmir are from the İzmir Transport Master Plan Update Study (1997) for the construction of Üçyol-Bornova line, which was later changed. However, this was the only estimation figure that could be found and is considered useful in illustrating the cost assumptions that influenced the decision in choosing technology, such as bus, tram, metro, etc. The Izmir metro project was also a turnkey project. However, underground tunnels resulted in additional costs.

It was proposed in Bursa Rapid Transit Feasiblity Study (1986) that an implementation of a light rail transit system would be financially affordable and could also help environmental, land use and traffic issues. In the implementation of Bursaray, the cost was exceeded and therefore an additional budget of 55.000.000 Euros had to be crated for the section B. This is the actual reason why the construction was divided into two stages as A and B (Bursa Greater Municipality, 2009). Proposed amount was adequate just for the construction of the system from the west side of the city to the Sehrekustu station. After finding new financial resources the stage B was completed. The route of stage B was changed in this period because the compulsory purchase was high and the rail transit system was decided to be underground that increased the total costs (Erdinç Alkan, Burulaş Bus Manager, 16.04.2009). It can be seen in the table that the estimated cost only covered the first stage. When Stage B is included however, it is seen that the system cost 22% more than the estimations.

As a result, with the exception of the systems in Ankara, the cost of building the urban rail systems exceeds the estimated budgets. Although not within the budget, Bursaray has one of the lowest cost-overruns (including Stage B).

Considering the cost of building one km of the systems, it is seen that the metro systems in İstanbul and Ankara have the highest values, which is not surprising considering the high costs generally incurred in metro investments. The light rail systems in Ankaray and İzmir were not as expensive to build as these metro systems but they still had fairly high investment costs. That is because both systems are fully segregated, partially underground, advanced light rail systems and therefore their costs are higher than a regular light rail investment cost and much closer to the cost of a heavy rail transit system. Bursaray, in comparison, is a much lower-cost light rail transit system, and Zeytinburnu-Bağcılar tramway reflects the low-cost construction typical to trams.

Table 6.5. Economical and financial comparisons

	Unit	Zeytinburnu-Bağcılar Tramway (5.2 km)	İstanbul Metro (8.5 km)	Aksaray-Airport Light Metro (19.95 km)	Ankaray (8.7 km)	Ankara Metro (14.6 km)	İzmir Metro (11.5 km)	Bursaray (21.8 km)
Completion period	month	36	96	13 years in stages	48	54	60	39
Estimated cost	US Dollars (2008)	30,542,625	305,812,044	N.A.	716,979,285	1,220,149,378 (Turn-key amount 700.000.000 $ in 1989)	356,776,646	395,165,628
Actual cost	US Dollars (2008)	48,146,028	751,301,723	N.A	663,644,299	N.A (*)	728,837,552	416,498,445 (with Stage B: 497.348.445)
Difference	US Dollars (2008)	17,603,403	445,489,679		53,334,986	N.A. (*)	372,060,906	21,332,817 (with Stage B: 102.182.817)
Percent change	%	+ 58	+ 146		- 7	In budget? (*)	+ 104	+ 1 (see text) (with Stage B: +22)
Cost per system kilometer	US Dollars (2008)	9,258,852	88,388,438		76,280,954	83,571,875	63,377,178	22,814,149

Sources: İBB web site, Türkmen, M. (2001), Ankaray Project Report 2 (1992). Burulaş website.
(*) See explanations in the text regarding Ankara metro.

Reasons for cost underestimations were asked to all municipality officers in the case study cities. Although Ankara systems are not found to have cost overruns, the views of the officers in Ankara Greater Municipality are also provided here: it was stated that the funding for the rail transit investments is generally insufficient. In addition the resources of the municipality are allocated to investments other than rail. Due to limited funds, investments are often delayed, which also results in cost overruns (Interview with Ertan Sarıgöl, EGO Rail Systems Department of Metro Construction Manager, 01.04.09).

The factors affecting costs of rail transit investments were also discussed with Gerçek (İTÜ, 17.02.2009). He explained that the most important factor is the dependence on foreign institutions for funding, which results in very high rates of interest on the money borrowed. There are very limited local resources, and when there are available resources, they are often used for shorter term investments, such as road improvements, grade-separated junctions, etc. Other reasons for cost overruns are expropriation costs and the increase in land prices, which are unexpected costs. For example, Kadıköy Bostancı route was dropped because of high expropriation price. (Interview with Mustafa Murteza, İstanbul Greater Municipality Department of Transport Planning, 20.02.2009)

As mentioned above, delays in the construction generally result in cost overruns because contractors ask for increases in construction costs. Murteza (İstanbul Greater Municipality Department of Transport Planning, 20.02.2009) pointed out that difficulties and problems lie in the implementation stage of the investments: in the planning stage, SPO assesses the plans in detail; the plans are not flawed therefore, but they face various problems in implementation.

6.4. Other Possible Impacts and Expectations

6.4.1. Image

In the section **2.2.1.1.Image expectations,** it was mentioned that rail transit is usually stated to have a positive image when compared to other type of modes. As Vuchic (1981) claimed rail transit system becomes a “landmark by itself and it gives the city a certain special identity and image”. Richmond (1998) also stressed the importance of the image of rail transit in his article called “The Mythical Conception of Rail in Los Angeles” and concludes that “the train provides a solid basis for political support”.

As mentioned in the section **3.2 Increasing popularity of rail transit in urban transport decisions in Turkey,** the rail transit systems are also considered as the more attractive solution by local politicians. Öncü (2007), for example, argues that in many cases in Turkey, the technical properties of the systems, threats and benefits of the projects and the costs are not thoroughly evaluated, and that the "dream of having rail transit systems in the cities" initiates the project implementation process. Özalp (2007) also found that in many cases the decision to build a rail system was already taken by politicians, without considering the land use plans, population size, topography, travel demand, etc.

In İstanbul, although improving city image was not found to be a major objective, in the interviews it was stated that in the plans some changes occurred to improve the image and to gain prestige. (Otogar-Şişli line, for example, will pass through Beşiktaş as a result of this consideration)

Ankara Greater Municipality claims that Ankara Metro and Ankaray are the "mega projects of transportation in Ankara" (Ankara Greater Municipality website). However; as Öncü (2009) argued in the interviews, improving city image was not an objective for the rail systems in Ankara. Yet, Gürel (2009) claimed that rail systems have a positive image on its users and therefore Ankara Metro and Ankaray are used with more care than the commuter rail. (Interview with Ayşe Gül Gürel, EGO Rail Systems Department of Management Manager, 01.04.09)

Source: Retrieved from www.wowturkey.com on 23/09/09.

Figure 6.7. Ankara commuter rail (left) and Ankara Metro (right)

Alkan (2009) argued that after the Bursaray system started operating, a difference between the east and west sides of the city became obvious in Bursa. Alkan (2009) further added that this was because of the better image of rail transit systems (Erdinç Alkan Burulaş Bus Manager, 16.04.2009). İzmir introduced the slogan: “We are weaving İzmir with iron webs! (*İzmir'i demirağlarla örüyoruz*!)”. The municipality distributes brochures, leaflets and posters all around the city to promote public transport. The rail transit network, in particular, is advertised for its comfort and speed.

Source: İzmir Greater Municipality

Figure 6.8. The leaflet of İzmir rail transit systems

The effect of urban rail systems on city image is not a straightforward issue to analyze, and it may be a separate research topic on its own. Therefore, it is not intended to carry out an in-depth analysis of changing image of cities here; however, one of the methods for analyzing this issue was to examine internet web-pages of governor offices in each city and of municipality's city guide documents, again on internet. It should be noted that in none of the mentioned webpages, urban rail systems were used as a “symbol or landmark” by itself as

Vuchic (1981) defined. In municipalities' pages, only for transport-related pages pictures of the systems were observed. This analysis, although oversimplified, shows that the systems may have certain positive effects in terms of image; however, they are not yet perceived, or promoted, as symbols of the cities they serve.

6.4.2.Land use, Traffic reduction and Air Quality Improvement

As car ownership, car usage and traffic congestion are rapidly increasing, investments in rail transit systems are seen as potential planning tools that can solve the congestion problem or at least prevent it from becoming worse. Additionally, rail transit systems have a positive effect on the land use developments. As mentioned earlier, these require more comprehensive analysis and before-and-after data; and therefore, in the scope of this study they are not analyzed, but some discussions are presented based on the interviews.

For the case of İstanbul, rail systems are still limited in size, piecemeal and unintegrated to have any strong land-use effect. It is possible to suggest that 4th Levent metro line reinforced the already developing financial centers in Şişli, Levent and Maslak. However, road connections were also extremely important in the development of these sites.

Gerçek (2009) argued that in İstanbul reducing traffic congestion should have been an objective of rail transit investments, but that the transport policies implemented do not indicate this. The third Bosphorus Bridge that is on the agenda, new car parks, grade-separated junctions and tunnel projects are the indicators that traffic reduction is not an objective. Considering these automobile-oriented policies that Gerçek emphasized, it is clear that Istanbul rail systems cannot result in traffic reduction either. (Interview with Prof. Dr. Haluk Gerçek, İstanbul Technical University Department of Civil Engineering, 17.02.2009). Yazar stated that there was no reduction in traffic congestion due to the rail systems but that in the surveys it was observed that there were passenger transfers from cars to metro in the Taksim-4th Levent line (Interview with Mustafa Metin Yazar, İstanbul Ulaşım A.Ş. 18.02.2009). However, it is well documented in transport planning literature that such modal switch does not result in traffic reduction or congestion relief unless car restriction policies are put in place to decrease the convenience and attraction of car usage.

In Ankara, it is stated that Ankara Metro line is the rail transit corridor stated in the master plan and therefore it is compatible with the development plan and the strategies. It is possible that the metro reinforced the development of the western corridor. However, most of the developments along this corridor are road-oriented rather than transit-oriented (Babalik-

Sutcliffe, 2008). There is no evidence that metro stations resulted in higher densities or more diverse activities.

In the Ankaray Project Report (1992), it was stated that it would be a good opportunity to use the site of Beşevler station's characteristics (different characteristics of land use; educational centers, hospitals, institutions) to create a better area with reduced traffic and transportation problems. The report mentioned that there is a need to redesign pedestrian paths to integrate pedestrians into the system. The Kızılay station of Ankaray was expected to be used as a transfer station from Ankaray to Ankara Metro. For this purpose reorganized traffic, well designed pedestrian ways, comfortable public service and spaces that were free of vehicular movements were suggested (Ankaray Project Report, 1992). However, these schemes were not implemented. There is heavy traffic both in the area of Beşevler station and in Kızılay. Both areas are lacking of good pedestrian access. Although Kızılay station is also a transfer station between buses and rail systems, it is not well designed to be a convenient transfer station for transit users.

Another policy was to reduce the number of buses operating between Dikimevi and Tandoğan. However, people living around the area opposed to this and demanded more bus services; as a result, additional buses started operating. It was stated that this also caused an increase in the traffic congestion. In the Batıkent corridor number of buses was reduced and a decrease in traffic congestion was observed in this area (Interview with Ertan Sarıgöl, EGO Rail Systems Department of Metro Construction Manager, 01.04.09). However, it is clear that buses are not the main reason for the failure in reducing traffic: there have been no schemes to restrict car usage into the city centre; on the contrary many new grade-separated junctions in and around the city centre made it more convenient to drive cars in inner city and attracted further traffic. Traffic levels and car-usage significantly increased in Ankara in the 2000s (Babalik-Sutcliffe, 2008)

In İzmir, car usage is constantly increasing as a result of population increase and increase in motorized vehicles. It is stated that this has a negative effect on the air quality and it would be crucial if no disincentives were put into place. However, there are no comprehensive measures to reduce the private car usage and motorized vehicles in general.

It was stated by the municipality officers during the interviews that traffic congestion decreased after the pedestrianization in Konak area and the implementation of İzmir Metro. Actually not only the İzmir Metro but the integration project in the city had a positive effect on traffic congestion. It was reported that after the project, traffic congestion decreased on the Altınyol corridor connecting the two sides of the İzmir Bay (Öncü, 2007). However, it is believed that any such relief must have attracted more cars since no supportive measures are implemented to reduce car usage. Even if the project resulted in traffic reduction, it is inevitable that the newly available road capacity is filled with new cars since no disincentives were implemented for private transport (Öncü 2007). In the interviews rail transit impact on land use was asked to the interviewees. It was stated that, being the first stage of the rail transit network of İzmir, it could not be said that there is such an impact on land use. It would be seen in the further stages of the system. It was also mentioned that the corridor was not selected to encourage or provide development around the rail transit line.

In Bursa, it was expected that there would be a modal switch from motorized vehicles to Bursaray, which would decrease traffic congestion in the city and increase traffic safety. In addition, it was claimed that there would be a 40% saving in time and 30% decrease in air pollution. However, as stated before, the integration project could not be successfully implemented and that hindered the expected benefits from the investment. As for land-use benefits, it was claimed in the interviews that the rail system covers the whole area of the city and it is situated in east-west direction that supports the developments in the west side of the city. However it was not a primary objective to encourage development in the planning stage of the investment.

6.5. Summary

In this chapter, a comparison was made between forecasts and outcomes regarding the rail transit systems, and a performance analysis was carried. While searching for the data, it is seen that in Turkey there is a significant difficulty in obtaining data; hence there is a lack of reliable data records. In some of the cases the forecasts were not available. Some of the data was put together by the responses in the interviews. On the other hand, in some of the cases there were no available data for the actual outcomes or there were different values. This urges the need for a systematical data collection and recording system for Turkey.

Considering the rate of increase in annual ridership of the systems, it is found that in İstanbul the rate of increase is significantly higher than the other systems. Although Aksaray-Airport system is a light rail transit system, it has the highest ridership level of all other rail transit systems. On the other hand, İzmir Metro has the lowest value and it reached to a certain level that remained almost constant in the following years. In Ankara, the rate of increase in the Ankara Metro is higher than in Ankaray due to different locational aspects. In addition, the rate of growth is much lower than that of the systems in İstanbul. Although there is an increase in 2008 in Bursaray due to the opening of stage B, it is not a proof that this rate would continue in the following years. As a result, riderships of the rail transit systems have been increasing since their opening, with the exceptions of İzmir Metro and Bursaray (Table 6.6).

Table 6.6. Summary of ridership and cost findings

	Name of the system	Annual ridership increase	Attaining estimated ridership	Cost within budget	Increase in total transit ridership
İstanbul	Zeytinburnu-Bağcılar Tramway (5.2 km)	√	-	-	√
	İstanbul Metro (8.5 km)	√	-	-	
	Aksaray-Airport Light Metro (19.95 km)	√	-	n.a	
Ankara	Ankaray (8.7 km)	√	-	√	√
	Ankara Metro (14.6 km)	√	-	√	
İzmir	İzmir Metro (11.5 km)	-	- √	-	√
Bursa	Bursaray (21.8 km)	-	-	-	√

Comparing annual ridership per kilometer of the systems, it is observed that İstanbul Taksim-4th Levent Metro, Ankaray and Zeytinburnu-Kabataş Tramway are the most successful systems and İzmir Metro and Bursaray are particularly having a poor performance. Ankara Metro can also be considered to have a limited performance. If a comparison is made between the systems having similar technologies, it is analyzed that İstanbul Taksim-4th Levent Metro is more successful than Ankara Metro comparing the passenger numbers per kilometer. Among Ankaray, İzmir Metro and Aksaray-Airport light metro, Ankaray is the most successful followed by Aksaray-Airport light metro. However İzmir Metro (an advanced LRT system) carries half the number of passengers carried by Ankaray per system kilometer. Zeytinburnu-Kabataş tramway system has one of the highest values, however this also indicates that it is operating overcapacity and interviewees stated that this was a result of wrong technology chosen, that tram capacity was not enough. Although Bursaray is a technology between a tram and a LRT, it has the lowest value.

It is seen from Table 6.6. that none of the systems reached the estimated ridership levels. Zeytinburnu-Kabataş Tramway is carrying more passengers than expected, as mentioned in the interviews that it is operating overcapacity. Aksaray-Airport light metro could not reach the expected level, however as mentioned in the interviews the number of passengers carried by the system is that of a heavy rail system. For the İzmir Metro two estimates were obtained: according to the earlier one in 1997 the system failed to reach the forecast; and according to the more recent data (2007) it attained the forecast. It is very likely that the recent data indicates a “revised” estimate and that therefore Izmir metro did not also attain the original forecasted ridership. For the other systems analyzed, analysis revealed that their actual ridership remain well below the estimated values.

Considering the share of public transport trips in overall transport trips in the cities, it is seen that the share is 62.79% (2009) in İstanbul, 69.1% (2008) in Ankara, 80.8% (2008) in İzmir and 59% (2009) in Bursa. Bursa has the lowest share of public transport trips and İzmir has the highest. It is possible that the public transportation integration project (“Transformation in Transportation”) helped İzmir to have significantly high modal share of public transport when compared to other cities in the study.

It is observed in each city that the usage of public transportation modes increased after the introduction of the rail transit systems. This shows that the systems had a positive effect on overall public transport.

It is seen from Table 6.6. that with the exception of the systems in Ankara, the cost of building the urban rail systems exceeds the estimated budgets. Although not within the budget, Bursaray has one of the lowest cost-overruns (including Stage B).

If the cost of building one km of the systems is compared, it is observed that İstanbul and Ankara metro systems have the highest values; which is due to the high investment costs of heavy rail transit systems. Ankaray and İzmir Metro systems also have fairly high investment costs although they are light rail investments. That is because both systems are fully segragated, partially underground, advanced light rail systems and their costs are higher than a light rail investment cost and much closer to the cost of a heavy rail transit system. In comparison Bursaray system is a much lower-cost light rail system. Cost of the Zeytinburnu-Bağcılar tramway system reflects the low-cost typical to tram systems.

When all the criteria in Table 6.6. are taken into account, the most striking finding is that none of the rail transit systems studied here were successful in attaining their forecast ridership levels (İzmir attained the revised forecast but failed to reach the original forecast). In terms of cost forecasts, it is observed that Ankara systems are successful since they were within budget. Of all the systems, Bursaray and İzmir Metro appear the least successful according to these criteria, because they could not meet the expected costs and ridership levels and the ridership of these two rail transit systems did not increase over the years whereas ridership has been increasing in the other systems.

CHAPTER 7

CONCLUSIONS

7.1. Summary of the research

In the world, it has become an increasingly important field of research to study the performance of rail systems in order to assess whether expectations from these investments, such as high ridership, reduced traffic, improved air quality, and cost-efficiency in operation, are met.

There has been a particular focus in the world literature on the accuracy of ridership and cost estimations for rail transit systems, and many studies found that ridership was over-estimated while costs under-estimated. In addition, studies looked at other expectations from these investments, and found that not all have been successful in helping increase ridership, reduce traffic congestion and air pollution.

Rail transit investments are constructed with high expectations. While attaining a reasonably high ridership is often considered as a primary objective, there are other important expectations from new rail transit investments, such as an improvement in image, effect on urban development, and reduction in congestion. In addition, attaining the rail system within the forecasted cost appears to be an important planning objective.

In spite of these expectations, studies on urban rail systems show that the actual outcomes can be disappointing. Either in the planning processes or in the implementation and operation processes, a gap between these expectations and outcomes often appears or deviations occur. The previous research show that this gap can be due to over optimistic expectations regarding the performance and positive impacts of rail transit systems, or because of the lack of complimentary or supportive policies that can increase the ridership. There is also broad agreement in the literature that political reasons and politicians' inclination towards rail alternatives are the reasons for this gap between expectations and outcomes, since political bias results in unrealistic expectations.

This study had two research questions:

a. What are the main objectives of the rail transit investments in Turkey? In other words, what are the expectations from these systems?

b. Are these expectations met?

Considering rail transit systems in Turkey, it was seen that there were no comprehensive studies that provided information on the expectations from these investments and on the outcomes. Analysis of objectives for investing in urban rail systems was considered important because these objectives reveal expectations of planners and policymakers from these investments. An accurate assessment of the urban rail systems can be made only when these objectives and expectations are fully understood.

The information on the performance of rail transit systems in Turkey is limited; there are no studies that consider the expectations from these systems and analyze the outcomes. In the planning process, the objectives and expectations are proposed; however after the implementation process, there is no study that analyzes the consistency of the project. As mentioned in Chapter 3, in Turkey too, political decisions have an effect on rail transit investments and there are discussions whether these investments were justified in the first place. It is clear that the tendency in investing in rail transit systems in Turkey is likely to continue: while many systems have opened within the past few years, there are many others that are being planned or constructed. It is therefore important to have a better understanding of why and with what expectations these systems were planned, and what outcomes were attained.

In this study, rail transit case studies were selected from four cities in Turkey: İstanbul, Ankara, İzmir and Bursa. Two fully segregated metro systems: Taksim-4Th Levent Metro and Ankara Metro; three advanced light rail systems: Aksaray-Airport light metro, Ankaray and İzmir Metro; a fully segregated light rail system: Bursaray and a partially segregated tramway system: Zeytinburnu-Kabataş were analyzed.

Transport planning background was examined in these cities. Expectations from rail transit systems were identified and outcomes are analyzed.

7.2. Findings

7.2.1. Expectations from rail transit in Turkey findings

- The observations on the expectations from rail transit investments showed that, ridership is commonly considered as the primary objective. It is also seen that improving image, affecting urban development, reducing traffic congestion and creating a better integrated public transport system are important objectives in constructing the systems.

- The reasons for implementing a rapid transit system vary from city to city. In the study, it is concluded that reducing traffic congestion is one of the major objectives of investing in rail transit system projects in the cities analyzed in this study. In each interview, it was stated that rail transit systems was seen as a tool to decrease traffic congestion. However, it is surprising that there were no complementary measures that could help in achieving this goal. In İstanbul, the third Bosphorus Bridge that is on the agenda, new car parks, grade-separated junctions and tunnel projects are the indicators that traffic reduction is not actually an objective, and not likely to be attained. In Ankara most of the developments are road-oriented rather than transit-oriented. In İzmir, there are no comprehensive measures to reduce the private car usage and motorized vehicles in general.

- It was claimed that **ridership levels** determines the technology that would be used in the corridors. It was clear that the decision for the technology that would be used in the corridor was an outcome of ridership forecasts in each city covered in this study. However, it was also claimed in the interviews that Zeytinburnu-Bağcılar tramway is operating overcapacity with a ridership level of a metro system. Through management tools, the problem is tried to be overcome.

- **Integration**, which was not originally an issue in the scope of this study, turned out to be the main objective in the cities. Bursa had an integration project that would have the rail transit system in the core of transportation network. However, as it was stated before, the project could not be implemented due to oppositions from private transit and dolmuş operators. In İzmir, after the opening of İzmir Metro, another project that would integrate the fare system of public transportation started. In coordination with this project, public transport in İzmir reached higher ridership levels. Yet integration was not an expected objective in the planning of the system.

In İstanbul, still there is an effort in integrating rail transport, sea transport and other public transport systems. However, it has not been succeeded yet. In Ankara, in the Batıkent corridor, it was stated in the interviews that the integration between buses and the metro was successfully implemented. However, such integration is limited in other parts of the city. Considering fare integration, İstanbul, İzmir and Bursa have good implementations however, Ankara systems are lacking such good fare integration systems.

- In three cities; İzmir, Ankara and Bursa, **city image** was expected to be increased after the rail transit systems started operating. Only in İstanbul, this objective was not mentioned at all. An analysis was made observing the web pages of Governor's offices and Municipality Departments of each city. This analysis, although simplified, showed that the systems may have had certain positive effects in terms of image; however, they were not yet perceived, or promoted, as symbols of the cities they served.

- Decreasing air pollution, encouraging urban development, increasing the viability of the city center, decreasing the operating cost in public transportation, increasing efficiency objectives were not found to be important in the case study cities. It appears that such possible benefits are not fully recognized by planners, that these benefits are **underestimated**.

- Although it is possible that a rail transit system can provide all these benefits, or expectations, there is also the possibility that decisions for investing in rail systems are highly influenced and shaped by **political reasons.** Systems that are built predominantly for political reasons, due to the inclination of the city authority to introduce a rail system to the city, may fail to fulfill expectations, such as ridership, traffic reduction, etc.

7.2.2.Ridership findings

- Considering the rate of increase in annual ridership of the systems, it was found that in İstanbul the rate of increase was significantly higher than the other systems. Although Aksaray-Airport system is a light rail transit system, it has the highest ridership level of all other rail transit systems. On the other hand, İzmir Metro has the lowest value and it reached to a certain level that remained almost constant in the following years. In Ankara, the rate of increase in the Ankara Metro is higher than in Ankaray due to different locational aspects. In addition, the rate is not comparable with the systems in İstanbul. Although there is an increase in 2008 in Bursaray due to the opening of stage B, it is not a proof that this rate would continue in the following years.

- Analyzing the difference between forecasts and outcomes, it was observed that the ridership forecasts remain inaccurate in all four of the cities. Zeytinburnu-Kabataş Tramway is carrying more passengers than expected, as mentioned in the interviews that it is operating overcapacity. Aksaray-Airport light metro could not reach the expected level, however as mentioned in the interviews the number of passengers carried by the system is that of a heavy rail system. For the İzmir Metro two estimates were obtained: according to the earlier one in 1997 the system failed to reach the forecast; and according to the more recent data (2007) it attained the forecast. It is very likely that the recent data indicates a "revised" estimate and that therefore İzmir metro did not also attain the original forecasted ridership. The ridership levels in other systems in İstanbul, Ankara and Bursa are approximately 70% below the forecasts.

- The modal shares of public transport and rail transport were also analyzed in each city. Considering the share of public transport trips in overall transport trips in the cities, it was seen that the share was 62.79% (2009) in İstanbul, 69.1% (2008) in Ankara, 80.8% (2008) in İzmir and 59% (2009) in Bursa. Bursa has the lowest share of public transport trips and İzmir has the highest. It is possible that the public transportation integration project ("Transformation in Transportation") helped İzmir to have significantly high modal share of public transport when compared to other cities in the study. On the other hand, considering the share of rail transit in public transport trips, it was seen that Bursa had the highest value (16.7%) and İzmir had the lowest value (3.46%). This showed that in spite of relatively lower ridership, the rail system in Bursa carries a significant share of public transport passengers. However, all these data also need to be evaluated considering the length and coverage of the systems.

- Comparing annual ridership per kilometer of the systems, it was observed that İstanbul Taksim-4th Levent Metro, Ankaray and Zeytinburnu-Kabataş Tramway were the most successful systems and İzmir Metro and Bursaray were having a poor performance. Ankara Metro can also be considered to have a limited performance. If a comparison is made between the systems with similar technologies, İstanbul

Taksim-4th Levent Metro is more successful than Ankara Metro comparing the passenger numbers per kilometer. Among Ankaray, İzmir Metro and Aksaray-Airport light metro, Ankaray is the most successful followed by another fairly successful system, Aksaray-Airport light metro. However, İzmir Metro (an advanced LRT system) carries half the number of passengers carried by Ankaray per system kilometer. Zeytinburnu-Kabataş tramway system has one of the highest values, however it was stated in interviews that it is operating overcapacity and this was also seen as a problem of the system. Although Bursaray is a technology between a tram and a LRT it has the lowest value.

- It was observed in each city that there is a growing trend of using public transportation modes. In all cities, public transport usage increased after the opening of the rail transit systems. This is an important positive effect of the rail systems.

7.2.3. Cost findings

- Considering the forecasted costs and the outcomes, it was seen that with the exception of the systems in Ankara, the cost of building the urban rail systems exceeded the estimated budgets. Although not within the budget, Bursaray has one of the lowest cost-overruns (including Stage B). Alhough Ankara systems are within budget, it should be noted that cost of Ankaray is higher than of a LRT system and it is compatible with a metro system. This is not surprising since the system if fully segregated and mostly underground.
- The cost of building one km of the systems was compared. It was found that Ankara Metro and İstanbul Metro had the highest cost of all modes (heavy rail systems have high investment costs). Ankaray and İzmir Metro have higher costs than expected from a light rail system that is because both systems are fully segregated, partially underground, advanced light rail systems (often referred to as light rapid transit). Bursaray, in comparison, is a much lower-cost light rail transit system, and Zeytinburnu-Bağcılar tramway reflects the low-cost construction typical to trams.
- The reasons of cost over-runs were observed in the interviews as the insufficient funding and the delays that increase the total costs. There are uncertainties in setting budgets for the rail transit investments. Gerçek (İTÜ, 17.02.2009) stated that İstanbul should have a 450-500 km rail network. In the plan, there are projects that

are introduced with this argument. However, in order to construct such a system there should be a budget of 30 billion dollars. Murteza (İstanbul Greater Municipality Department of Transport Planning, 20.02.2009) claimed that approximately 1000 vehicles were coming from foreign countries, each one costing 2 million dollars, for these major investments. If the vehicles were produced in Turkey, each vehicle would cost about 500.000 dollars. Yazar (İstanbul Ulaşım A.Ş., 18.02.2009) emphasized that the production of vehicles has started and it is estimated that in 2030 there will be no dependence on foreign investments for vehicle production. The problem of being dependent on foreign resources is one of the reasons that results in cost escalations.

7.3. Overall performance of the rail transit systems

The expectations from the rail transit investments and the difference between expectations and outcomes were the main questions asked in the study. It is observed that with a gap between the planning phase and the implementation phase, many expectations from rail transit systems in İstanbul, Ankara, İzmir and Bursa were not attained. In addition, some possible benefits are not recognized by the planners and officers responsible of the systems. Some of these expectations are mentioned in the plans, although in the implementation phase they are forgotten. Or alternatively, some of them are not recognized in the plans; however, they turn out to be the most important objective of the systems.

As the main criteria in evaluating the system performances, the cost and ridership estimations are still misrepresented and they are not well documented to have a reliable comparison between the actual outcomes and estimations.

In Table 7.1. overall criteria analyzed in the study are given. It was observed that in each city, the expectations differed. It is because of having different population size, location and characteristic of land use development. However, it is believed that, there should be a common list of expectations while constructing rail transit investments. Therefore, the performances of the systems were evaluated in terms of the objectives used in this study.

Table 7.1. Systems' performance considering the criteria used in the study

	İstanbul	Ankara	İzmir	Bursa
Reducing traffic congestion	-	-	-	-
Attaining forecasted ridership	-	-	-	-
Integration	+-	+-	+	-
Increasing city image	-	+-	-	-
Increasing total passengers in public transportation systems	+	+	+	+
Urban transformation/regeneration	-	-	-	-
Decreasing air pollution	-	-	-	-
Encouraging urban development	-	+-	-	-
Increasing the viability of the city center	-	-	-	+
Annual increase in rail ridership	+	+	-	-
Cost within budget	-	+	-	-

- There was no evidence that any of the systems reduced traffic congestion. In interviews, it was stated that this did not happen in any of the cities.
- None of the systems fulfilled expectations regarding ridership: systems failed to attain the forecasted ridership levels.
- Integrated public transport was an objective in all cities: While İstanbul and Ankara have partial implementations, İzmir succeeded to have attained route and fare integration. Bursa failed to implement its integration plan due to opposition from dolmuş operators.
- In none of the cities, rail transit systems seem to have improved image or became city symbols. However; interviews revealed that the image of Ankara systems was positive and that users of these systems were using these systems with more care, perhaps taking pride in having a rail system.

- In all cities, public transport usage increased after the opening of the rail transit systems.

- The systems did not help regeneration or transformation, but this was not an objective for them (and not all systems passed through such areas).

- None of the systems were reported to result in a decrease in air pollution. Since car traffic reduction did not take place, this result is also not surprising.

- Systems did not have a significant land-use effect. Only the Ankara metro seems to have supported the already developing Batıkent corridor. Certainly, this issue requires a more comprehensive research.

- There is no evidence that the systems had a positive effect on the viability of city centres. In fact they all pass through city centres, except for Bursa, none of the interviewees stated this issue as one of the objectives. They also did not mention any positive effect on city centres, although this issue also requires a more comprehensive research.

- Rail transit systems in Ankara and İstanbul experience increase in their ridership levels, which is a positive aspect regarding their performance. Systems in İzmir and Bursa, on the other hand, did not experience any increase in ridership after the first year of operation.

- Apart from the systems in Ankara, none of the systems were built within budget: there are significant cost overruns.

As a result, the main success in all case study cities was the increase in public transport usage after the opening of the rail transit systems. On the other hand, systems performed rather poor in terms of other expectations, such as attaining ridership forecasts, being built within budget, creating an integrated public transport system, traffic reduction, air pollution reduction, improvement of city image, etc. Hence there is a gap between expectations and outcomes.

The interviews and the analysis revealed that the main reason for the failure to attain expectations was that many policies and measures, such as integration, combined tickets, pedestrian areas, etc., were not implemented although they were proposed during the planning of the systems. It is concluded that one aspect is common in each system: there is an **over optimism in planning** while many elements of the plans, particularly complementary projects, are not successfully implemented.

7.4. Shortcomings in the Planning of Rail Transit and Recommendations

- There is 'over-optimism in the planning phase' (Fouracre, 1990, p. 10) of rail transit investments in Turkey. This results in a gap between planning and implementation – the gap between expectations and outcomes-. As mentioned in the interviews, the officers in İstanbul Gretaer Municipality also claim that difficulties and problems lie in the implementation stage of the investments: in the planning stage, SPO assesses the plans in detail; the plans are not flawed therefore, but they face various problems in implementation. This suggestion ignores possible failures in the planning stage however.

- Rail transit systems are becoming a necessity for metropolitan transportation networks. Also these are massive investments. If there is no strict decision making authority for the investments, failures occur. The municipalities, project consultants, Railways, Ports and Airports Construction General Management (DLH), Prime Ministry State Planning Organization (DPT) and the National Treasury play the key role in the approval of the rail transit system projects in Turkey. However, there should be a national authority or a national transportation center responsible for the rail transit investments: in coordination with the planning and implementation phases. In each city sub-transport centers should be responsible for the investments in the cities. Data collection is one of the most important issues in evaluating the success of the systems. However, this study showed that in Turkey, there is a significant problem in collecting and keeping data. It is extremely difficult to attain cost and ridership forecasts. Furthermore, there is a lack of coordination between the subsequent studies made on rail transit investments: either there is limited information or the data are not coherent with each other. The main authority should also be responsible of this data collection process.

- The decision to invest in a new public transport system is the duty of urban and transport planners. Planners have to decide on which appropriate corridors these investments should take place. These decisions have to be made accurate in order not to waste the resources. There is a need for providing tools to support the decision making process. In the validation studies there should be more criteria considering the technical, physical, urban and environmental aspects of the projects. It was seen that many systems included land-use related factors in the planning of the systems, that the rail systems were built according to urban development plans. In spite of this, planners interviewed very rarely stated urban development as one of the expectations from the systems. Consequently, there was very little interest in whether these systems resulted in development and land-use change.

- There should be penalties for the planners and the forecasters who produce deceptive forecasts. These should be maintained by public hearings and citizen juries in order to allow stakeholders and civil society in the process of decision-making. If these precautions are taken and the projects are implemented with accountable measures then the misrepresentation in transportation forecasting might be neglected. Otherwise the funds for transportation projects continue to be wasted.

- Public transport systems should be organized in a comprehensive plan rather than having partial bus or rail transit plans. If an attraction to public transportation modes is attained, then the number of passengers carried by rail transit systems would increase. This would be maintained by having an integrated transport system. The projects should be updated after the changes occurred in the system and in the surrounding areas.

7.5. Further research

This study opens the way to analyze each system in detail. As mentioned above, there are limited data on the systems. With a study focusing on each system in detail, a scientific data collection would be achieved and this would encourage the ongoing investments to keep required information about the systems in a systematic way. This would help us to evaluate performances of each rail transit system.

In the scope of the study, the systems in Eskişehir, Antalya, Konya, Adana, Kayseri and Samsun were eliminated either because the systems are under construction or because they are street tramways. A further study can include these systems and an overall analysis considering all rail transit systems can be made for Turkey.

Another research recommendation is to evaluate, separately and in-depth, different criteria for the systems analyzed in the study. For example, systems' contribution to city image can be handled as a separate study, with more in-depth analysis of this issue for each city. Similarly, developmental effects, including land-use change, land price change, etc., can be analyzed for each system separately or in comparative approach. Systems' effects on traffic are also important and can be studied for new systems, collecting before and after data. Such studies would bring out additional results and help to understand the performance of the systems considering a variety of different criteria.

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