AUTOMOBILE TRAVEL REDUCTION IN URBAN AREAS
AND CITY CENTERS,
CASE STUDY: ANKARA

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ABSTRACT

AUTOMOBILE TRAVEL REDUCTION IN URBAN AREAS AND CITY CENTERS, CASE STUDY: ANKARA

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This thesis analyzes the car ownership and use issues worldwide and in Ankara. There has been an extremely rapid increase in car traffic in major cities, leading to car dependence and its adverse affects, all over the world. This thesis takes its starting point the driving forces behind car ownership and use, and the increasing problems caused by the car traffic in urban centers. Then, car travel reduction measures and their consequences are reviewed by examples.

The urban transportation in Ankara is analyzed, both in terms of recent policies and the data obtained, in order to find out if the car ownership and use would generate similar problems in Ankara. The applicability of car travel reduction options in Ankara and the conflicts in the recent urban transportation policies are discussed. This research does not recommend simple solutions, but concludes that a broad spectrum of measures must be applied in order to reduce the problems.

Key Words: Car ownership, car use, urban transport, public transport, Ankara

ÖZ

KENTSEL ALANLARDA VE SEHIR MERKEZKEZLERINDE ÖZEL ARAÇ KULLANIMININ AZALTILMASI ANKARA ÖRNEGI

AKAR, Gülsah
Yüksek Lisans, Insaat Mühendisligi Bölümü
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Bu tez dünyada ve Ankara'da araba sahipligi ve kullanimi kavramlarini incelemektedir. Büyük sehirler genelinde özel araç trafiginde hizli bir artis gözlenmistir. Bu çalisma özel araç kullaniminin altinda yatan etkenleri ve giderek artan özel araç trafiginin yarattigi sorunlari baslangiç noktasi olarak almistir. Özel araç kullaniminin azaltilmasina yönelik önlemler ve sonuçlari örneklerle incelenmistir.

Bu tezde Ankara'daki kentsel ulasim, ulasim politikalari ve göstergeleri yönlerinden analiz edilerek özel araç sahipligi ve kullaniminin Ankara'da da benzer sorunlar yaratip yaratmayacagi tartisilmistir. Özel araç trafiginin azaltilmasina yönelik önlemlerin Ankara'ya uygulanabilirligi ve yakin zamandaki ulasim politikalariyla uyusmazligi incelenmistir. Bu çalisma Ankara'daki ulasim sorunu için basit çözümler önermek yerine, genis kapsamli çözümlerin birarada uygulanmasini öngörmektedir.

Anahtar sözcükler: Özel Araç Sahipligi, Özel Araç Kullanimi, Kentsel Ulasim, Toplutasim, Ankara

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LIST OF ABBREVIATIONS

CBD	Central Business District
DIE	State Institute of Statistics
DPT	State Planning Organization
EC	European Countries
EGO	General Directorate of Electricity, Gas and Bus of the Municipality of Greater Ankara
GDP	Gross Domestic Product
METU	Middle East Technical University
PT	Public Transport
TDM	Transportation Demand Management
TOD	Transit Oriented Development
TSM	Transportation Systems Management

CHAPTER 1

INTRODUCTION

Transportation has a major impact on the spatial and economic development of cities and regions. The attractiveness of particular locations depends in part on the relative accessibility, and this in turn depends on the quality and quantity of the transportation infrastructure.

The increasing car ownership and rapidly spreading urbanization is giving rise to considerable traffic and environmental problems throughout the world, especially in city centers.

In the search for solutions, there have been two basic and opposing ideas. The first one suggests that the cities must be adapted to accommodate car travel, by building roads and car parking in response to increase in demand while the second suggests that the role of car should be limited by restraints or by encouraging alternative modes of travel or by a mixture of these. The first idea is linked with notions of personal freedom and the importance of road transport to economic growth. The second is linked with notions of the environmental quality of city life, and preventing the spread of suburban developments based on individual motorized travel.

Cities are changing with the movement of people and businesses out from the centre, increased suburbanization and the desire for lower residential and job densities. The public transport based movement to the central area employment location has been replaced by more complex longer distance car based movements. The unconstrained growth in the demand for travel, particularly by car, is not desirable and there are substantial external costs imposed on people, cities and environment.

Investment in new roads to accommodate the new demand patterns may only result in further suburbanization and the abandonment of the city centre. The addition of new road links means that more traffic will be generated, making the environment more polluted and increasing the urban transportation problems.

New measures are necessary to maintain accessibility throughout the urban space and town centre viability and to reduce the impact that the car has on the use of resources. The difficulty lies beneath the conflicting objectives of policies providing consumers the freedom of choosing, protecting the viability of town centers and giving opportunities to those who do not have access to the car.

The urban transportation indicators put Ankara in a stage between the developing cities and developed cities. Ankara has lessons to learn from developed cities as roles of new technologies, forms of institutional management and the long term consequences of different policies toward the automobile. These experiences, however, especially in the last category, need to be interpreted very carefully in order to provide useful guidance since the cities have entirely different historical experiences in transportation.

In this study, the car ownership and use issues are examined. The aim of this research is to determine the current and future state of Ankara within this context.

Chapter 2 gives brief review of transportation, urban transportation planning and the changing values in transportation planning.

Chapter 3 analyses the driving forces behind car ownership and use. The state of Turkey is explored in this context and as a result it is argued that the car ownership and use will rise in Turkey.

The negative aspects of automobile dependence and the reasons for automobile travel reduction are discussed in Chapter 4. The methods for achieving automobile travel reduction and examples from the world are reviewed.

Chapter 5 investigates the current and the future situation in Ankara. With the analysis of urban transport policies and indicators both worldwide and in Ankara, it is questioned whether Ankara would face the problems that those developed cities did. Urban transportation policies and car travel reduction options are proposed for Ankara. The appropriateness of the recent transportation policies and investments are criticized based on the reviewed policies and experiences worldwide and The Transportation Master Plan of Ankara

Finally the conclusions drawn are given in Chapter 6.

This research suggests that a city center without car traffic and congestion is not an outcome of good fortune or chance. Rather, it is the result of a clear, well-articulated vision of the future.

CHAPTER 2

WHAT IS TRANSPORTATION?

Transportation is the movement of people and of goods between activities which are separated in space. It is a necessary concomitant of the activities of individuals and of the groupings of people, such as businesses, governments, and private institutions within society. The importance of transportation in development is multidimensional, it provides the options for work, shopping and recreation, and promotes health, education and other activities. The desires of people to join activities and need for goods movement create the demand for transportation. People's preferences in terms of time, money, comfort and convenience set the modes of transportation used or their shares.

Prior to the industrial revolution the most important difficulties faced by men in transportation were the physical ones. These were how to overcome the frictions of land travel and how to overcome the shifting winds. Later, mechanical development provided engines and better materials for vehicles and better surfaces, both rail and road, to use in traveling on land. Thus, the physical difficulties of travel diminished. But then population increased and crowded into cities. The difficulty of transportation became no longer how to overcome distance but how to thread through masses of people and vehicles. The physical problem was greatly diminished and partly as a result of this success the more serious transportation difficulties appeared (Creighton, 1970).

2.1 WHAT IS URBAN TRANSPORTATION?

Urban transportation is the movement of people and goods between origins and destinations within an urban area. This movement can be carried out through a variety of modes and meet different needs.

Urban areas have always been the engines of economic growth. To accommodate the economic growth, the resulting increase in population and distribution, urban areas have sprawled further away from the city centers, resulting in the creation of low-density suburban towns at the urban fringe.

The concentration of economic and social activities in urban areas compels commuters to make millions of trips to participate in such activities. The desire to participate in activities generates demand for travel. As the demand for urban travel has exploded in the past few decades, the supply of transportation infrastructure (bridges, roads, tunnels, public transit, etc.) has not kept pace with the ever-increasing demand.

The urban activity system, which refers to the city's social and economic structure, can be influenced by the transportation system of that city. Besides, the changes in the urban activity system affect the ability of the components of the transportation system to provide mobility and accessibility. Combining these two, the transportation system is closely related to the urban activity system and has been an important determinant of the urban form. (Miller & Meyer, 1984)

2.2 URBAN TRANSPORTATION PLANNING

The importance of transport planning has expanded as transportation issues have gained world-wide prominence. In the transportation field today, it is evident that a new strategy is emerging. This 'new' strategy uses concepts and techniques from engineering, urban and regional planning, management, law, political science and a variety of other disciplines to solve transportation problems.

Urban transportation planning can be defined as the process of

1. Understanding the types of decisions that need to be made
2. Assessing opportunities and limitations of the future
3. Identifying the short and long-term consequences of alternative choices designed to take advantage of these opportunities or respond to these limitations
4. Relating alternative decisions to the goals and objectives established for an urban area, agency, or firm.
5. Presenting this information to decision makers

In the short run, urban transportation planning creates more capacity in the existing transportation infrastructure. In the long run, urban transportation planning attempts to influence location decisions and travel behavior of commuters, which may result in smart growth, lower automobile ownership rates and auto trips, and higher transit and non-motorized mode splits. Thus, urban transportation planning strives to improve access for almost all of the society by addressing the root causes of transportation problems.

The cities are growing in size and complexity, and correspondingly, one of the major challenges of urban transportation planning is how to ensure that cities have operationally, functionally and economically efficient services which enhance their environment, their social and cultural values and needs.

Urban transportation planning involves a diversity of basic activities performed by such specialists as policymakers, managers, planners, engineers, and evaluators.

The basic stages of the classical format of the process include:

1. the preparation of land use, transportation and travel inventories of the study area
2. the analysis of present land use and travel characteristics
3. the forecast of land use and travel characteristics
4. the setting of goals and the formulation of transport alternatives designed to accommodate the projected travel demands and land use changes
5. the testing and evaluation of alternative transport plans

These stages have remained the major corner-stones of conventional urban transport planning practice since the inception of the process in the USA during the 1950s, and have been applied world-wide in one form or other to cities (Dimitriu, 1992).

2.3 THE CHANGING PERSPECTIVE

Transport planning has changed radically in the last forty years. The primary objectives of transportation planning, to facilitate access to and participation in activities, has not changed, but the means to achieve these objectives have changed. The role of the transport planner has changed from the provider of roads and additional capacity to exploring the means by which the existing capacity can be better used and allocated to priority users (Banister, 2001).

For many years, growth in mobility was encouraged rather than discouraged, since it was viewed as an inevitable trend, enabled by the growth of income and the selections of individuals and groups. Therefore the main objective of transport policy was to accommodate this growth providing sufficient road capacity, which is called ‘predict and provide’.

However this approach did not work, since the traffic may grow 5% per year and it is impossible to increase road capacity at that rate. If traffic demand is continually growing faster than capacity, capacity itself becomes the constraint on further growth, and the network becomes dominated by bottlenecks. (Goodwin, 2001)

Traffic levels in many car-dependent countries have doubled during the years 1975-1995, but the expansion of the infrastructure has been more modest, typically a 10-15% increase in the road network. These have resulted in the inevitable increase in congestion. Important conclusions have been reached regarding these two trends. Congestion is going to get worse, as the capacity of the network will never increase at a level to match the increase in demand (Banister, 2001).

The consequence of expanding the road capacity at a rate less than traffic growth is the increase in the number of vehicles per kilometer of the road, which means that the network would be operating very close to its maximum capacity. In this situation any failure can become system-wide and minor problems cause chaos, since any system continually operating close to its maximum capacity, on several different dimensions, and subject to random variation is inherently unstable (Goodwin, 2002).

The fundamental relationship of transportation field, the speed-flow curve, defines congestion. As the volume increases, the vehicles go slower. The effect becomes more severe as the traffic flow approaches its maximum capacity, until finally overload is so extreme that vehicles are unable to move. Goodwin (2002) defines congestion due to this relationship as the 'impedance that vehicles impose on each other'. He concludes that the underlying cause of congestion is trying to operate with traffic flows too close to the capacity of the network. The number of cars required to move a given number of people is much greater than the number of buses, then a transfer from car to bus would enable the traffic to go faster. So, if everybody traveled by the slow method of transport, bus, they might all travel faster than if they all traveled by the fast method, cars.

It is impossible to meet the increase in travel demand through new construction. Whatever road construction policy is followed, the amount of traffic per unit of road will increase, not reduce. In many transport systems working close to capacity, additional increases in that capacity will be immediately taken up with 'latent' demand with previous or even worse levels of congestion being quickly reestablished (Standing Advisory Committee on Trunk Road Assessment, 1999). Figure 2.1 illustrates this cycle.

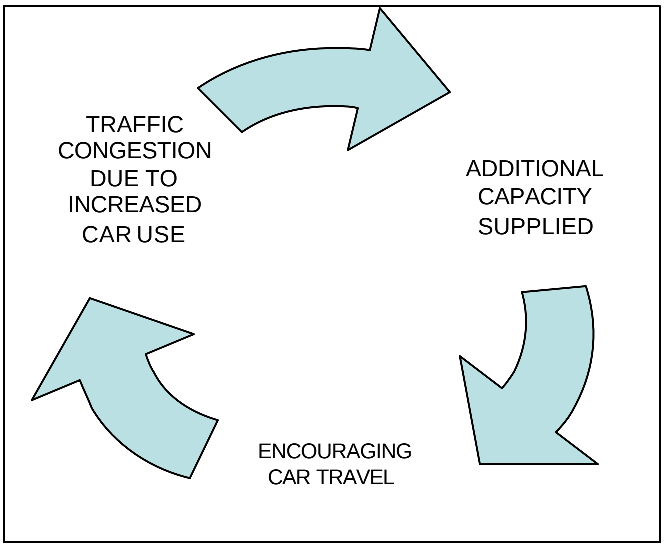

Figure 2.1 The cycle of travel demand and congestion

The idea of traffic reduction became important because of the negative consequences of increasing car ownership and increasing private motorization. In summary, Goodwin (2001) suggested four factors underpinning this change of view in urban transportation planning.

- First, the growth in traffic always seemed to outpace the provision of road capacity, no matter how extensive and expensive the programs of public works.
- Second, the transport sector became identified as one of the major causes of environmental damage, both in terms of land take for road building and also in terms of emissions, with local, regional, and global effects, use of fuel, noise and disruption of communities.
- Third, traffic accidents, at a world level, became higher and higher in the lists of sources of violent death and disablement.
- Fourth, there was a significant shift in the public mood. In the early stages, the opening of a new road had been a popular but increasingly, new roads became symbols of dissent and division, involving demolition of public spaces and loss of green spaces.

These factors were not of equal importance in all countries, but to some degree they occurred everywhere. A policy intervention to stabilize, or even reverse the trend is desired. If this could be done, then it would be possible to achieve a better quality of travel, more efficient use of resources and less damage to environment and life.

Instead of focusing on how to move more vehicles, clearly the focus should be on the more efficient movement of people.

2.4 TRANSPORTATION DEMAND, TRANSPORTATION SYSTEMS MANAGEMENT AND TRANSPORTATION DEMAND MANAGEMENT

Estimation of travel demand is one of the most important areas of urban transportation planning. The starting point of this estimation is the fact that the travel demand is a derived demand, that is, people do not travel for the sake of the traveling experience. Rather, they travel to move from one lace to another, to participate in various activities. Miller & Meyer (1984) suggest that two major implications can be drawn from this derived nature of travel demand. First, transportation demand analysis cannot be performed without considering the socioeconomic activity system. Second, since trips are not made for the sake of traveling, there is the generalized cost of travel measured in terms of the time, monetary cost, inconvenience, discomfort, etc. One would always prefer to spend less time, spend less money and be more comfortable.

In the 1970s as new highway construction became more expensive and difficult to justify, transportation systems management (TSM) came into vogue. The proposed solutions by the TSM approach recommend more effective use of the existing infrastructure. TSM actions propose improved flow without new road construction; rather by preferential treatments for high occupancy vehicles, reduced peak period travel, parking management, promotion of alternative modes of transportation, and transit and paratransit service improvements. (Meyer, 1999)

During the 1980s and 1990s demand management has become part of the transport policy all over the world. Transportation Demand Management (TDM) is a general term for various strategies that increase transportation system efficiency. TDM is the demand side of TSM. TDM emphasizes the movement of people and goods, rather than motor vehicles, and so gives priority to public transit, ridesharing and non-motorized travel, particularly under congested urban conditions. TDM helps individuals and communities meet their transport needs in the most efficient way, which often reduces total vehicle traffic (TDM Encyclopedia, 2004).

The strategies of TDM and TSM may be summarized as follows:

- Reducing the need to travel
- Shifting the mode choice to public modes
- Managing the use of private car

Given that the major focus of demand management is to influence the individual travel behavior of travelers, the challenge for transportation officials has been to find the right mix of incentives and/or disincentives that will encourage travelers to change their normal travel routine.

A radical change is required in both public and private attitudes toward the ownership and use of private automobiles. Modification in travel behavior over time can be achieved once the public understands and accepts the rationale behind the need for more widespread use of mass transport.

CHAPTER 3

CAR OWNERSHIP AND USE WITH EMPHASIS ON TURKEY

In the past 150 years, transportation infrastructure and services, vehicles, and design technologies have experienced a vast change in response to the increasing and complex demands of society. Surface urban passenger transportation has gone through several milestones, from horse-drawn street railways, steam, and cable powered lines to electric streetcars, underground heavy rail line, and urban bus transit. The introduction of new public transportation technologies was primarily motivated by the desire of the user to find faster and more reliable forms of transportation than those that were available at the time, and this motivation eventually resulted in the predominance of the automobile. While this progression provided an unprecedented level of mobility and personal freedom, it paid little attention to social and environmental sustainability along the way. It was not only the technology used, but also socioeconomic factors, urban growth policies, and changing consumer attitudes that made the private automobile the most desirable mode of urban transportation.

The car ownership levels in 26 countries worldwide, including Turkey are shown on Figure 3.1.

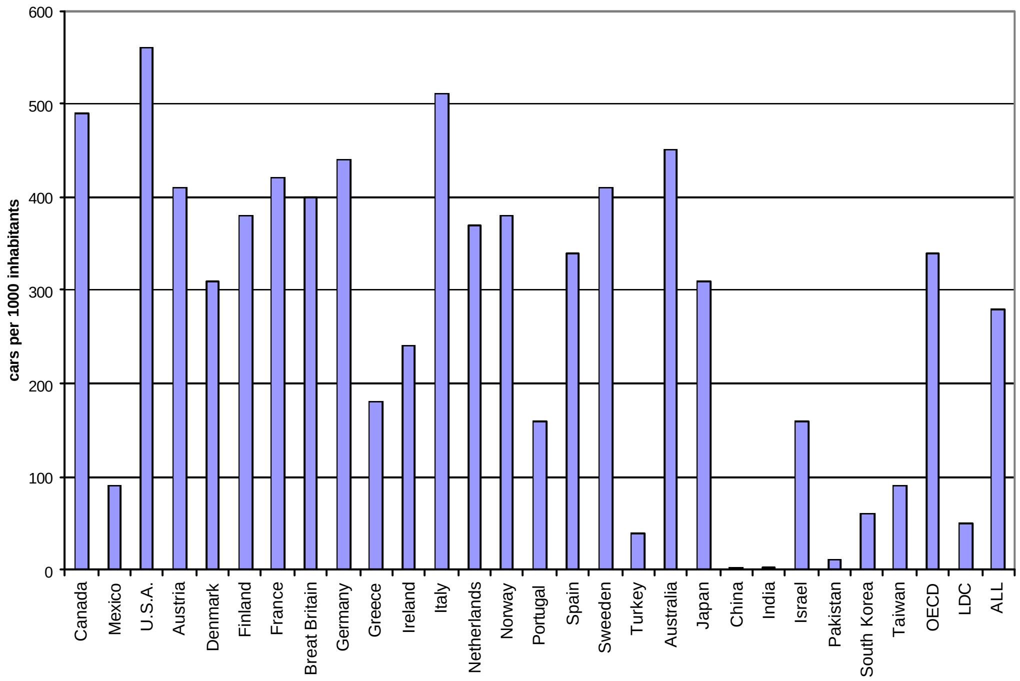

Figure 3.1 Car ownership levels in 26 selected countries

Source: Dargay and Gately (1999)

*LDC: Less Developed Countries; including China, India, Pakistan, Taiwan, South Korea and Israel.

**ALL: Average

3.1 THE DRIVING FORCES BEHIND CAR OWNERSHIP AND USE

Car ownership and use in urban areas can be explained by a number of factors such as income, car prices, land use patterns, availability of public transport, etc. The theoretical framework visualized in figure 3.2 relates the most important factors of car ownership and use. (Korver, Klooster and Jansen, 1993)

Automobile dependence, expressed through comparative levels of car ownership and use and transit service and use, varies widely and systematically across a large sample of international cities. US cities exhibit the most extreme dependence on the automobile, followed by Australian and Canadian cities, with European and Asian cities having very much more transit-oriented cities with greater levels of walking and cycling. (Kentworty and Laube, 1999)

In every country car ownership levels have increased continuously during the last decades. It is generally claimed that ownership levels in individual countries will follow similar trends as their economies develop. Differences in other factors affecting car ownership and use will lead to deviations from the general trend.

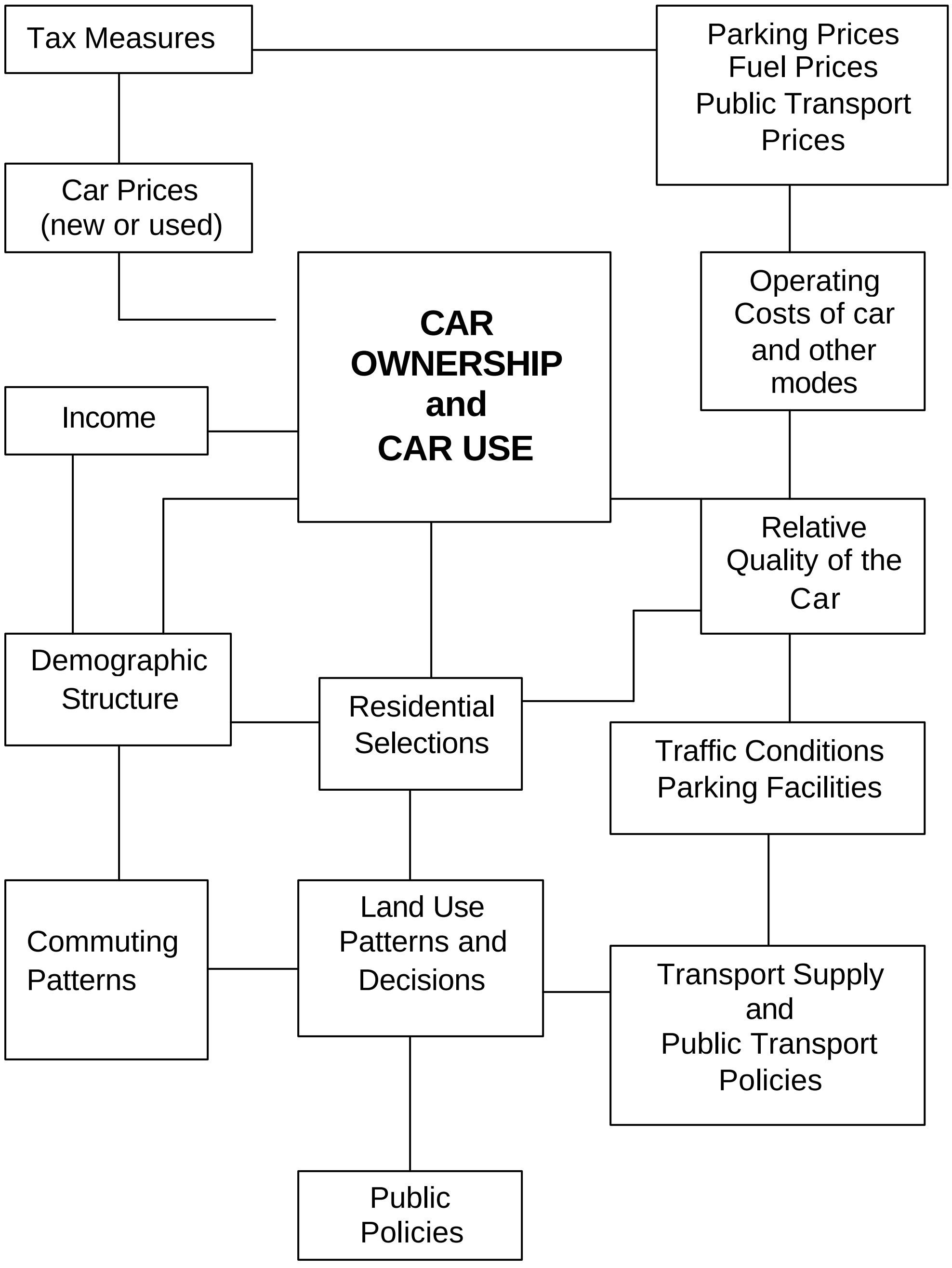

Figure 3.2 Factors affecting car ownership and use

Source: Korver, Klooster and Jansen, (1993)

3.1.1 INCOME; INCREASING WEALTH

There exists a strong historical relationship between the growth of income and the growth of car ownership and use.

Dargay and Gately (1999) have examined the growth in the car for OECD countries and a number of developing economies, including China, India, and Pakistan. The model estimations are based on annual data for 26 countries over the period 1960–1992. Table 3.1 summarizes the historical data for the countries covered in their study.

Based on their research, the rapid expansion in the demand for transportation services may be expected to continue over the next two decades as per-capita income continues to grow. Growth will be especially rapid among low- and middle-income countries, whose income growth rates and income elasticities of car ownership are expected to be high. Continued rapid growth is also expected for the lower-income OECD countries, and somewhat slower growth for most of Europe.

The car ownership levels in different countries over time vary considerably. Relative to growth in per-capita income, the increase in car and vehicle ownership has been greatest in the fastest growing economies of the developing world. For example, for Turkey there is a 2.5% change in GDP, but there is a considerable increase in car ownership, 10.6%, which is the fourth highest change. These percentage increases in GDP and car ownership across countries are illustrated in Figure 3.3. It is seen that Turkey has experienced the fourth greatest increase in car ownership levels. However this high percentage increase is due to the low number of cars present in Turkey.

Table 3.1 Historical data of 26 selected countries, Source: Dargay and Gately (1999)

Country	GDP per capita (1985 US dollars)			Cars per capita			
	1970	1992	Average annual % change	1970	1992	Average annual % change	elasticity
Canada	10.1	16.4	2.2	0.31	0.49	2.1	0.9
Mexico	4.0	6.3	2.1	0.02	0.09	6.1	2.9
U.S.A.	13.0	17.9	1.5	0.44	0.56	1.2	0.8
Austria	7.5	13.0	2.5	0.16	0.41	4.4	1.7
Denmark	9.7	14.1	1.7	0.22	0.31	1.6	0.9
Finland	8.1	12.0	1.8	0.15	0.38	4.2	2.3
France	9.2	13.9	1.9	0.24	0.42	2.5	1.3
Breat Britain	8.5	12.7	1.8	0.21	0.40	2.9	1.6
Germany	9.4	14.7	2.0	0.22	0.44	3.2	1.6
Greece	5.2	6.8	1.6	0.05	0.18	7.9	5.0
Ireland	6.8	9.6	2.7	0.20	0.24	1.4	0.5
Italy	7.6	12.7	2.4	0.19	0.51	4.6	1.9
Netherlands	9.2	13.3	1.7	0.19	0.37	3.1	1.9
Norway	8.0	15.5	3.0	0.18	0.38	3.5	1.1
Portugal	3.3	7.5	4.2	0.05	0.16	6.2	1.5
Spain	5.9	9.8	2.4	0.07	0.34	7.3	3.1
Sweeden	10.8	14.0	1.2	0.28	0.41	1.7	1.4
Turkey	2.2	3.8	2.5	0.004	0.04	10.6	4.2
Australia	10.8	14.5	1.4	0.31	0.45	1.8	1.3
Japan	7.3	15.1	3.4	0.08	0.31	6.2	1.8
China	0.7	1.4	3.3	0.0001	0.002	16.5	5.0
India	0.8	1.3	2.2	0.001	0.003	5.4	2.5
Israel	6.0	9.0	2.1	0.05	0.16	6.5	3.0
Pakistan	1.0	1.4	1.6	0.003	0.01	4.4	2.8
South Korea	1.7	7.3	7.2	0.002	0.06	18.1	2.5
Taiwan	2.2	8.1	6.7	0.003	0.09	17.9	2.6
OECD	7.8	12.2	2.2	0.18	0.34	4.1	1.9
LDC	2.1	4.7	3.9	0.01	0.05	11.5	3.0
Average	6.5	10.5	2.6	0.14	0.28	5.8	2.3

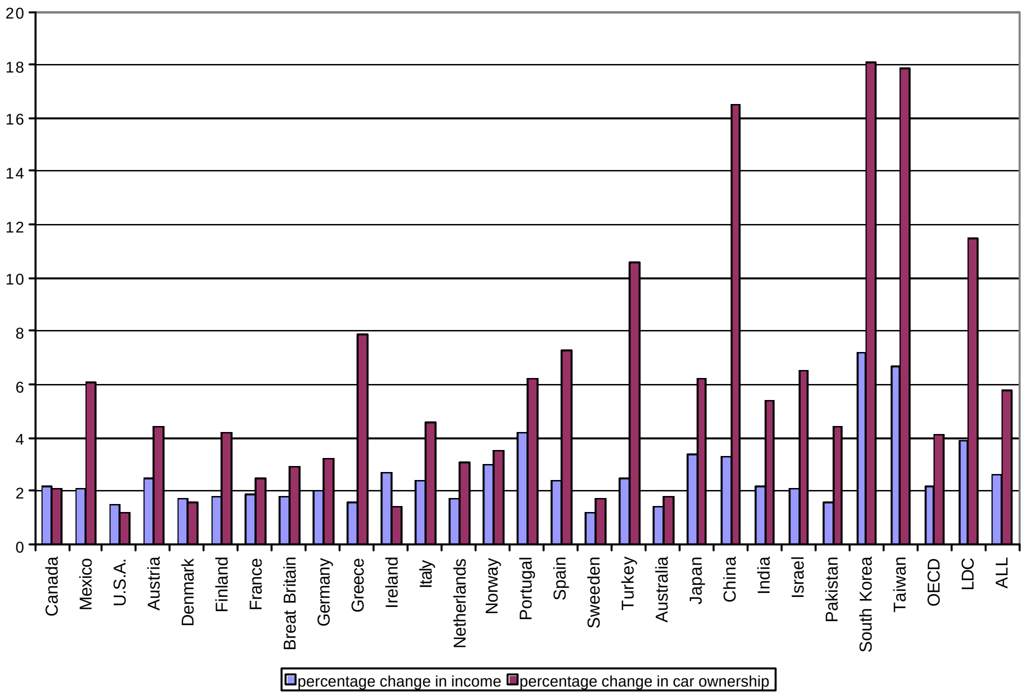

Figure 3.3 Percentage changes in income and car ownership levels

Source: Dargay and Gately (1999)

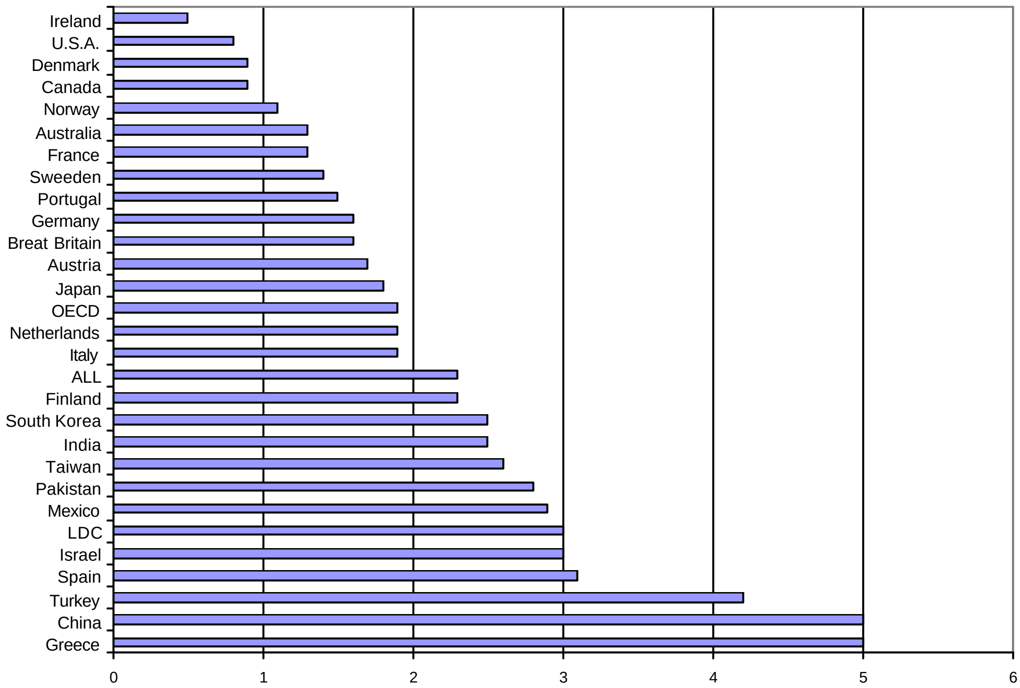

Figure 3.4 The income elasticity of car ownership in selected countries
Source: Dargay and Gately (1999)

The ratio of the average annual percent growth in ownership to the average annual percent growth in per-capita income is defined as a rough measure of the income elasticity with respect to car ownership. Figure 3.4 illustrates the income elasticities of car ownership. Turkey has the third highest income elasticity among the observed countries, 4.2, which indicates that the car ownership levels in Turkey will continue to rise.

3.1.2 LAND USE

The connection between transportation and land use plays an important role in both explanations of sprawl and estimates of the costs of sprawl. Transportation and land use are linked in two basic ways and many more subtle ways. First, transportation investments and policies influence development patterns: In this way, transportation investments may contribute to sprawl, but they can also be used as smart growth strategies to help to fight sprawl. Second, development patterns shape travel patterns; if the design of suburban areas makes transit and walking a challenge, the separation between land uses in low–density developments makes driving a necessity. In this way, sprawl contributes to automobile dependence, but smart growth policies to fight sprawl can reduce automobile dependence. (Handy, 2002)

Consequently it is important to understand how transportation investments and policies shape land use patterns, how land use patterns in turn shape travel behavior, and how transportation itself functions as an element of the built environment in metropolitan areas, as illustrated in Figure 3.5.

Several specific assumptions about the relationships between transportation and land use, some related to the causes of sprawl and some to its solutions, are commonly made by proponents of smart growth. Some of these assumptions are listed below:

• Building more highways will contribute to more sprawl.
• Building more highways will lead to more driving.
• Investing in rail transit systems will increase densities.
• Adopting transit oriented design strategies will reduce automobile use.

Higher urban density is consistently associated with lower levels of car ownership and car use, higher levels of transit use, and lower total costs of operating urban passenger transportation systems. Higher urban density would thus appear to be a positive factor in minimizing automobile dependence and its associated direct economic costs.

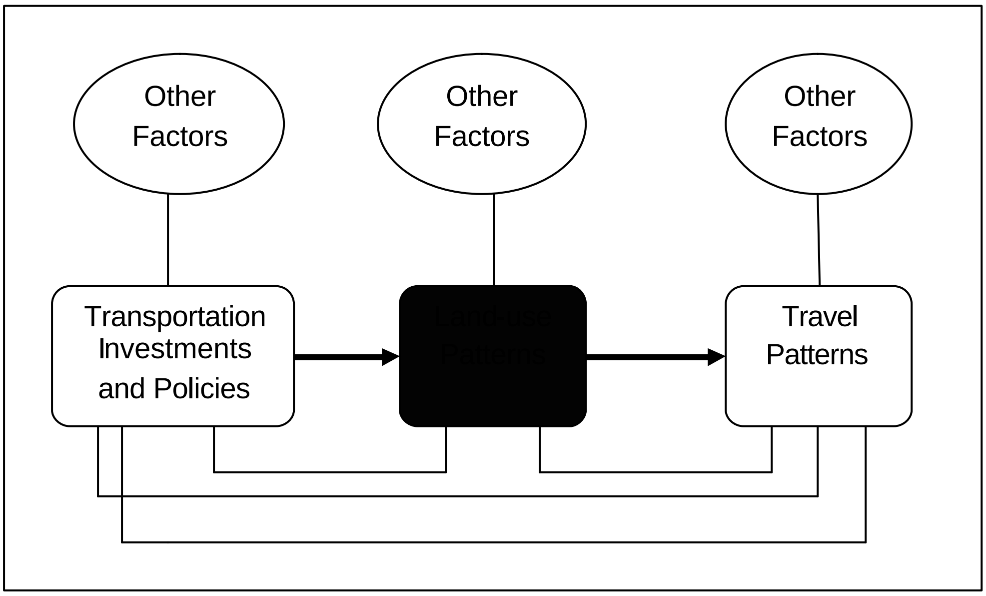

Figure 3.5 Land use and transportation relations, Source: Handy (2002)

3.1.2.1 THE TRANSIT AND THE URBAN FORMS

A transit metropolis is a region where a workable fit exists between transit services and urban form. In some cases this means compact, mixed-use development well suited to rail services, and in others it means flexible bus services well suited to spread out development. What matters is that transit and the city should exist in harmony. Cervero (1998) suggests that there exist four types of transit metropolises. In the following figures, urban centers, main lines and feeder services are represented by circles, lines, and dashed lines respectively.

a) Adaptive Cities

These are transit-oriented metropolises that have invested in rail systems to guide urban growth. They feature compact, mixed-use suburban communities and new towns concentrated around rail nodes. Stockholm, Copenhagen, Tokyo and Singapore are examples of this structure. Figure 3.6 portrays the relationship between transit services and urban form for adaptive cities. The combination of a strong, dominant CBD, concentrated mixed-use development around outlying stations and radial links is the rail oriented, adaptive city's formula to success. Despite both greater Stockholm and Copenhagen having high per capita incomes and vehicle ownership levels by global standards, public transit carries upward of 60 percent of commute trips made by employed residents of rail oriented new towns.

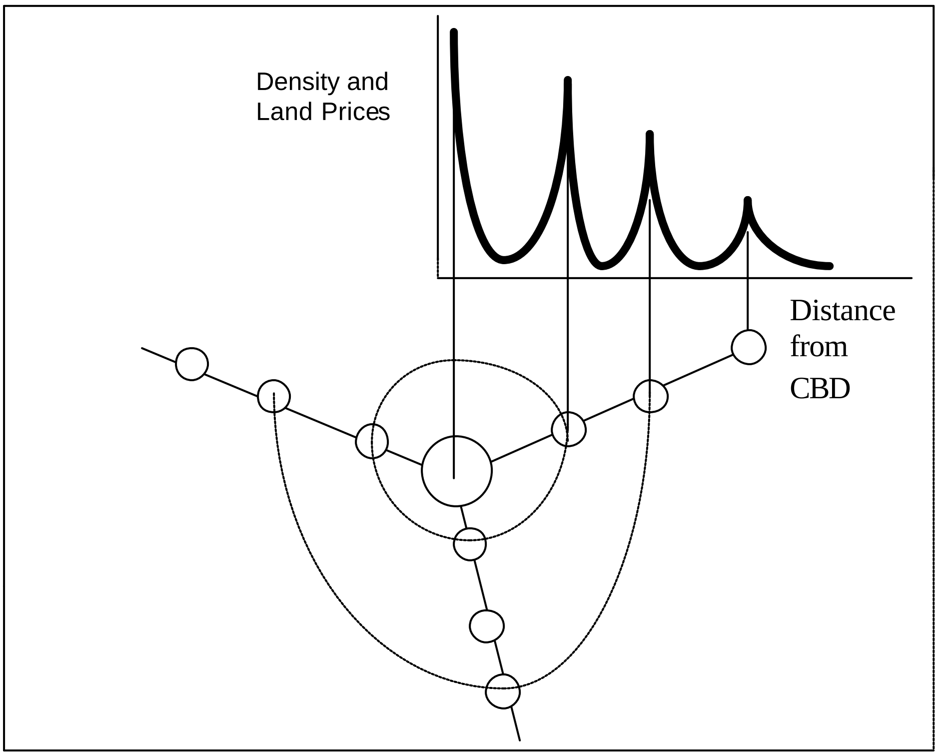

Figure 3.6 Adaptive cities, source: Cervero (1998)

b) Adaptive transit

Adaptive transit represents the opposite approach to planned decentralization. Here, spread-out, low-density development is accepted and accordingly, transit services are adjusted and reconfigured to best serve this environment. Figure 3.7 represents the challenges of designing mass transit in the extreme of thinly spread development with origins and destinations. Such settings produce almost random patterns of trip making. The ongoing decentralization of jobs and retailing to the suburbs over the past few decades in many parts of the world has been largely responsible for the growth in trips passing through the city center. Besides, instead of traveling radially along well-defined corridors between suburbs and CBD, more and more commuters want to move tangentially. A criticism of adaptive transit strategies is that by catering to low-density development, they reinforce and perhaps even perpetuate sprawl and unsustainable patterns of growth and create captive car users.

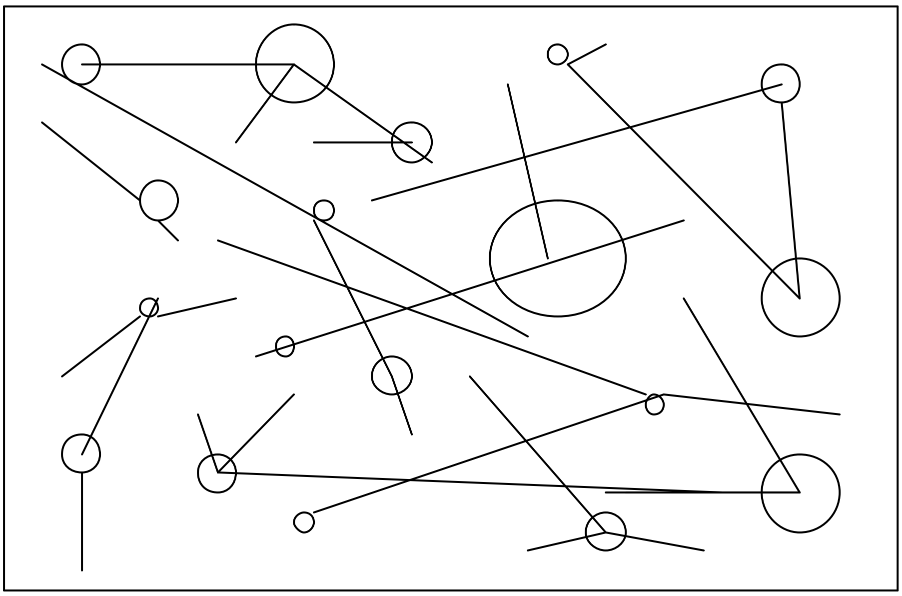

Figure 3.7 Adaptive Transit, source: Cervero (1998)

c) Hybrids

Regions striking a middle ground between adapting their landscapes and their transit services can be thought of as hybrids. Their development patterns are partly transit oriented and their transit services are partly adapted to the lay of the land. Between the extremes of a strong-centered metropolis (Figure 3.6), and a thinly spread, weak centered region (Figure 3.7), the settlement pattern of many hybrids tends toward polycentrism, as represented in Figure 3.8. That is orbiting the dominant center, or CBD, are secondary and tertiary centers and their surrounding. The centers, comprising multiple land uses and pedestrian friendly design, form potential building blocks of a highly integrated regional transit network. Railways or busways normally interconnects them with one another. The cases of Munich and Ottawa are representatives of such hybrids.

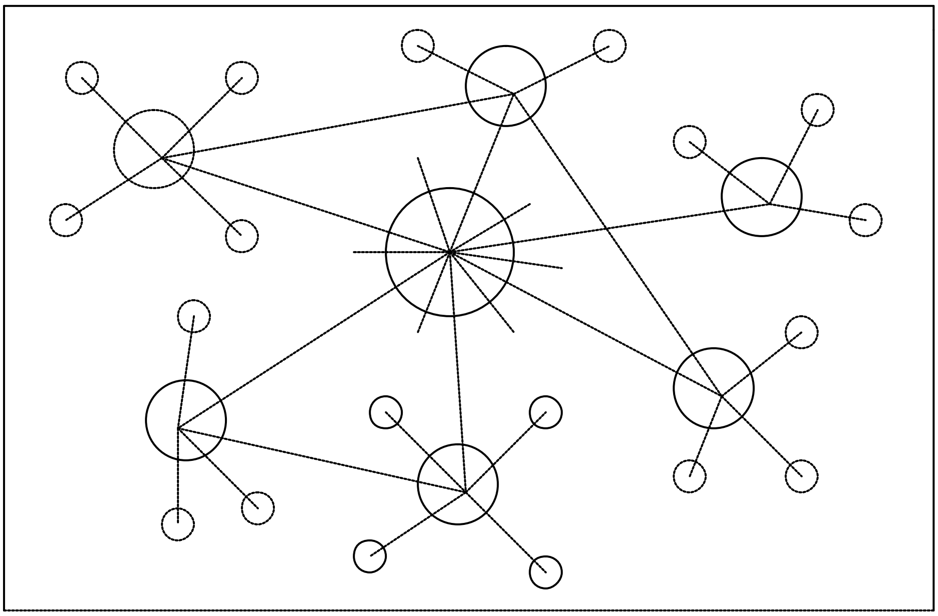

Figure 3.8 Hybrids; poly-centered cities, source: Cervero (1998)

d) Strong Core Cities

Strong core cities have tied rail improvements to central city revitalization efforts. These cities integrate transit and urban development within a more confined central city context. These cities primacies (high share of jobs and retail sales) are in their centers. Zurich and Melbourne highlight successes at using tramways to provide efficient forms of circulation in built-up areas.

3.1.3 PUBLIC TRANSPORT

3.1.3.1 The Demand for Public Transport

Public transport has an important role in everyday life in the cities. Modern city life in unimaginable without good public transport, and public transport can be seen as an integral part of the city.

The private car covers an increasing share of the demand for trips, but it is important to remember that there exist captive public transport users. Public transport is also very important for tackling negative effects of the car and for strengthening the city structure and keeping the cities alive.

The current situation, the environmental concerns and congestion levels, require that public transport attracts a large share of customers that have the private car as an alternative. Tomorrow's public transport travelers should therefore include both car owners and captives of public transport services.

3.1.3.2 Public Transport Use

There are striking differences across countries due to the diversity of economic, cultural, social and spatial structures in the public transport markets. Due to increased auto ownership and suburbanization, all countries experienced a decrease in the share of trips made by public transport.

Not unexpectedly, the data analyzed by Kentworthy and Laube (1999) show the US cities to be the most automobile dependent, with not only scant transit service provision but also very low transit use. Residents of US cities only make one transit trip every six days or so, whereas, their nearest rivals in the Australian cities, make one trip every four days. It is, however, only in the Canadian cities where transit begins to look respectable with one trip every two days or so. From there it rises to much higher levels in European and developing Asian cities and peaks in the wealthy Asian cities at an average of about 1.4 trips per day.

In spite of the rising level of car ownership, about 75% of the urban trips are done by public modes in Ankara. (EGO, 2003) This level of use seems to indicate opportunities of car traffic reduction in urban transportation in Ankara. However this high level of use does not mean that service levels are better or that the number and frequency of public modes are adequate when compared with European countries. (Babalik, 1996) This high use is due to the relatively low level of income and car ownership in Ankara.

3.1.3.3 The Supply of Public Transportation

There exists a variation among countries with regard to public transport modes of operation. The public bus is the most common mode in all cities. Significant differences exist, however, with regard to other modes. In many countries the tram is a common mode. Fewer cities have rapid rail transit. The relative level of service of each mode varies within and between countries.

Public transportation is provided also by means other than rail, bus and tram. Paratransit modes like minibuses or other specified means of transport are available for different purposes. The most common paratransit modes are organized transport service for school children and employees. Table 3.2 shows the provision of paratransit services in European countries. In Turkey, like in many European countries, paratransit modes are being used to meet the public transportation demand.

Table 3.2 Paratransit Services in European Countries
Source: Stern and Tretvik (1993)

Country	elderly	school	work	disabled
Austria		X		X
Belgium		X	X	
Finland		X	X	
France				X
Germany		X	X	
Greece		X	X	
Israel			X	
Italy		X	X	
Norway				X
Portugal			X	X
Sweden	X	X	X	
Switzerland		X		
The Netherlands			X	
Turkey		X	X	
United Kingdom	X	X	X	X

Cities with a higher level of rail service within their transit systems generally have better utilized transit and lower automobile dependence. Rail is the favored form of public transit since it provides the speedy, grade separated and high quality-comfortable services.

The research conducted by Kentworthy and Laube (1999) on rail service levels and overall transit use make it difficult to ignore the significance which rail systems appear to have in enhancing the role of transit in cities. For example, looking just within the US cities sample at those with and without rail systems, it is found that those with rail systems have some 117 annual transit trips per capita, while those that have only buses have 30 annual transit trips per capita. This is not to undermine the critical role which buses play in any transit system, including those with strong rail systems. However, transportation strategies in both developed and developing cities aimed at reducing automobile dependence need to carefully consider the potential of rail to provide a strong, permanent, reliable and highly visible backbone to a transit system which is well-equipped to provide services competitive with the automobile. It is only in the European and wealthy Asian cities, where rail plays the largest role in transit systems, that the overall operating speed of transit exceeds that of general road traffic due to the superior speed of the rail systems.

3.1.3.4 The Challenges for Public Transportation

Good public transport is a key reason for not needing a car. Planners and politicians struggle to find solutions to the imbalance between the modes; seeking ways of promoting public transport. For this reason the key elements that cause the downward trends in use of urban public transport should be examined. The challenges for urban public transport are shown on Figure 3.9.

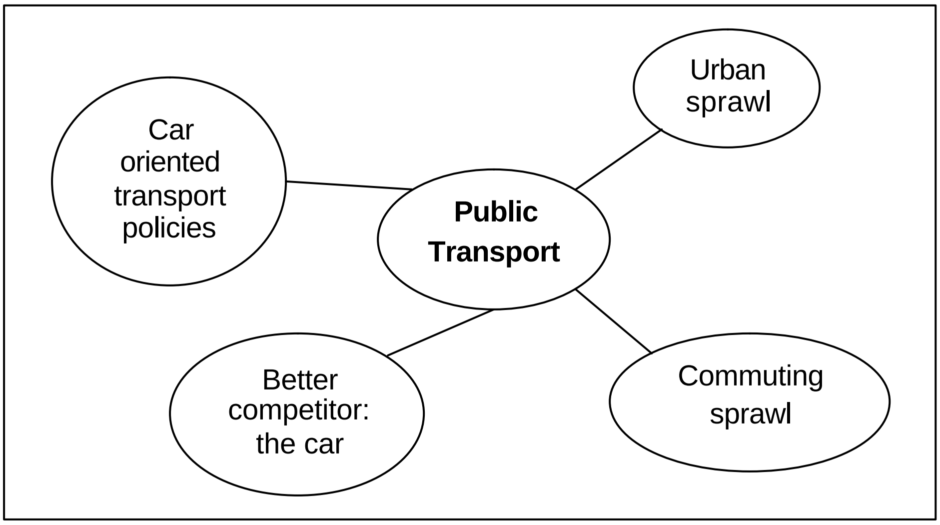

Figure 3.9 The Challenges for Public Transport

3.1.4 LAND USE, TRANSIT USE AND CAR USE

Urban pattern is changing in cities around the world and transportation has the major role in this process. Land use, transit and car use are intrinsically related.

Sinha (2003) analyzed the data related to urban transportation from 46 cities all over the world during the period 1960-1990. (Table A.3.1 in appendix summarizes some of the data).The analysis consisted of simple bivariate regressions to show the certain basic relationships between land use transit use and car use. Key sustainability indicators were regressed at each other and against main socioeconomic and demographic variables to find the correlations.

Table 3.3 presents a partial list of the correlations for land use transportation variables for data of world cities during the period 1960–1990. Urban population density and job density were positively and significantly correlated with transit boarding per capita per year, as identified by the coefficients of 0.67 and 0.77, respectively. On the contrary, per capita demand for transit was strongly and negatively correlated with the provision of roads (-0.67), number of parking spaces per employee in central business district, CBD, (-0.52), private vehicle ownership, (-0.65), and automobile use (-0.52). As for the energy consumed per capita for transportation purposes, it was negatively correlated with the urban population density and job density (-0.60), but positively correlated with the provision of roads (0.57) and the demand for private vehicles (0.84). The share of work trips by transit was negatively correlated with investments in roads (-0.54).

As it is clear from the correlations, land use, transit and car use are strongly related. Their strongest and most effective relationship is materialized in the existence of adequate and inter-modal transportation systems, which is essential for the success of urban transit and for the long-term viability of cities around the world.

Table 3.3 Coefficients for Key Land Use – Transportation Variables

Variables	
Urban Population Density	
Transit boardings per capita	0.67
Total energy consumption per capita	-0.58
Car kilometers of travel per car	-0.51
Cars per 1,000 people	-0.71
Parking spaces in CBD per 1,000 employees	-0.46
Road length per capita	-0.61
Energy consumption by private modes per capita	-0.60
Car kilometers of travel per capita	-0.64
Car occupant kilometers of travel capita	-0.66
Boardings per transit kilometer of travel	0.48
Number of Cars Per 1,000 People	
Energy consumption by private modes per capita	0.84
Transit boardings per capita	-0.65
Parking spaces in CBD per 1,000 employees	0.54
Energy consumption by cars	0.83
Passenger kilometers of travel using transit per capita	-0.54
Road length per capita (m)	0.57
Boardings per transit kilometer of travel	-0.55
Road Length Per Capita	
Energy consumption by private modes per capita	0.63
Car kilometers of travel per capita	0.61
Transit boardings per capita	-0.67
Boardings per transit kilometer of travel	-0.63
Parking spaces in CBD per 1,000 employees	0.66
Vehicles per 1,000 people	0.60
Energy consumption by all modes per capita	0.57
Transit Boardings Per Capita Per Year	
Parking spaces in CBD per 1,000 employees	-0.64
Car kilometers of travel per capita	-0.52
Parking Spaces in CBD Per 1,000 Employees	
Boardings per transit kilometer of travel	-0.52
Job Density	
Transit boardings per capita	0.77
Car kilometers of travel per capita	-0.49
Cars per 1,000 people	-0.65
Road length per capita	-0.62
Total energy consumption per capita	-0.62
Boardings per transit kilometer of travel	0.59

3.1.5 DEMOGRAPHIC STRUCTURE:

The demographic structure determines the number of potential car owners. Potential car drivers and therefore potential owners are those older than the minimum age for driving a car. In most countries this age is 18 years.

The number of driver's license in the total population over 18 years old, is relatively low in Turkey (15%) and high in France (72%), and the Netherlands (71%). The current situation in Turkey can be compared to that in the richer countries some 20-30 years ago (Korver, Klooster and Jansen, 1993).

Holding a driver's license is the logical precondition to car availability. The number of licenses per car can be seen as an indicator for future car ownership that can be expected, since license holders are all potential car owners. As can be seen in Figure 3.10 in Turkey a substantial potential exists for further growth of car ownership, with 4.3 licenses /car.

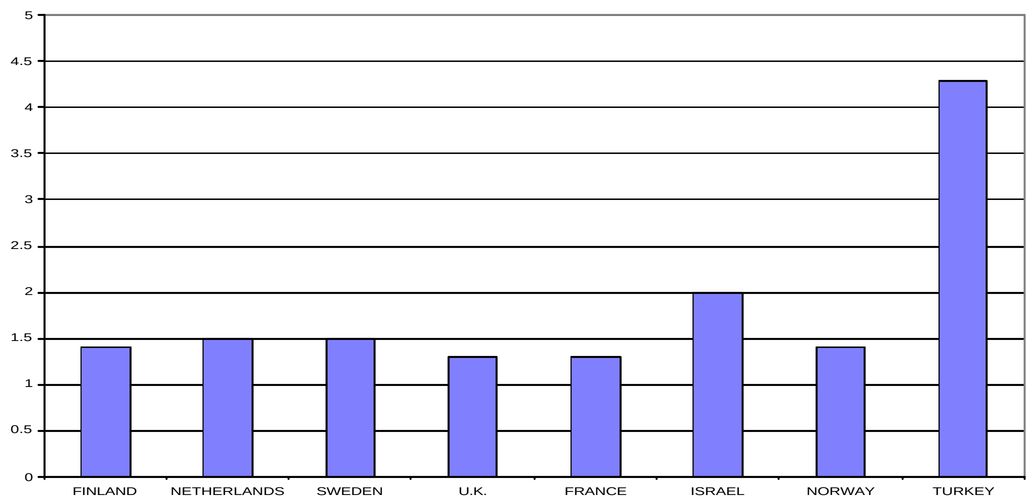

Figure 3.10 Licenses per Car among Some European Countries
Source: Korver, Klooster and Jansen (1993)

3.1.6 COSTS OF CAR OWNERSHIP AND USE:

The cost of cars in terms of the total fixed and variable costs per kilometer is an important policy factor to consider in any efforts to reduce automobile dependence.

Car costs can be classified into:

1. Fixed costs, which are annual costs (insurance and car ownership taxes) and purchasing costs.
2. Variable car costs, which consist of fuel, maintenance, parking fees and tolls.

Correlations of car costs with car ownership and use show that as costs increase the former decline. Likewise, transit's role within the transportation system is higher where car costs are greater. (Kentworthy and Laube, 1999)

Figure 3.11 presents the taxes on motor cars; taxes on fuel, purchase and ownership. It is evident that purchase and ownership taxes vary more than fuel taxes. In most countries with an important car industry, purchase taxes are relatively low (Switzerland and Italy). Ownership taxes are highest in Switzerland, the Netherlands and Austria and lowest in Greece, Sweden, Italy and Turkey.

In terms of policy, it would appear that physical planning strategies to reduce automobile dependence, such as targeted increases in urban density, need to work in concert with economic policies that seek to charge more for car ownership and use in cities, and vice versa. Apart form the countries illustrated in Figure 3.11, Singapore, Hong Kong and Tokyo are good examples of cities where the costs of car ownership and use have been set high for many years and physical planning strategies have emphasized development patterns oriented to transit, walking and cycling.

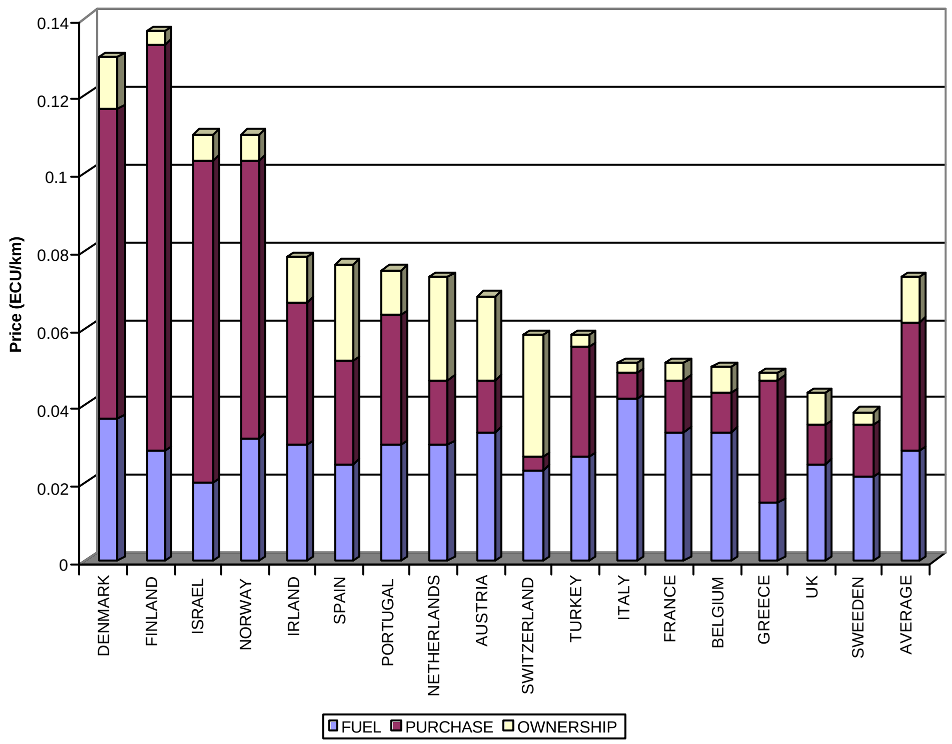

Figure 3.11 Taxes on fuel and cars per km. driven
Source: Korver, Klooster and Jansen (1993)

3.2 CONCLUDING REMARKS ON THE DRIVING FORCES:

The projected growth in car and vehicle ownership depends upon the assumed growth in income. The more rapid the assumed rate of income growth, the greater the growth in car and vehicle ownership. Ownership growth slows at the highest income levels, as saturation is approached.

The most rapid growth within the OECD in car and vehicle ownership will occur in those OECD countries with relatively low incomes but with high rates of income growth, such as Portugal, Greece, Ireland and Turkey. Moreover, that ownership growth will continue beyond the next two decades, as these countries' per-capita incomes catch up with the rest of Europe.

The situation in the more prosperous countries today is a good proxy for the future situation of the less prosperous countries, since all countries follow a similar trend. The general conclusion of this analysis is that car ownership and use will continue to increase in Turkey. The increase in mobility in Turkey is higher than most of the other European countries and with respect to the increase in GDP. (Figure 3.12)

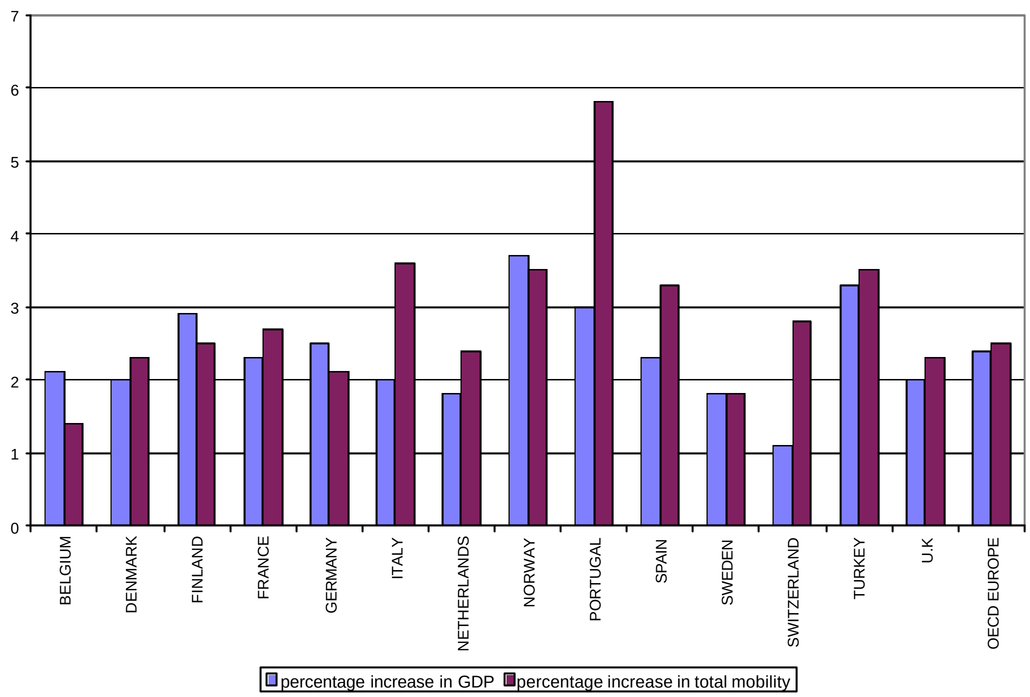

Figure 3.12 Percentage Increases in GDP and Mobility in European Countries Between 1970 and 1987

Source: Bovy, Orfeuil and Zumkeller (1993)

The analysis of mobility among the thirteen European countries reveals common trends and important differences. Only two countries, Denmark and Sweden, experience higher growth rates for public transport than for car mobility. (Figure 3.13) In Turkey, a dramatic increase in mobility levels with private modes is observed. As discussed in the earlier sections, there are many driving forces behind this increased demand for private mobility. Car ownership plays the dominant role in most of the European countries. Although the car ownership levels were low in

Turkey, the rising demand for mobility was met by private modes, resulting in an increase in the car ownership level which means that the same trends will be observed in Turkey, the increase of car use and decrease of public transport. One of the main reasons of this trend is the lack of adequate public transport services, as discussed in section 3.1.3.2.

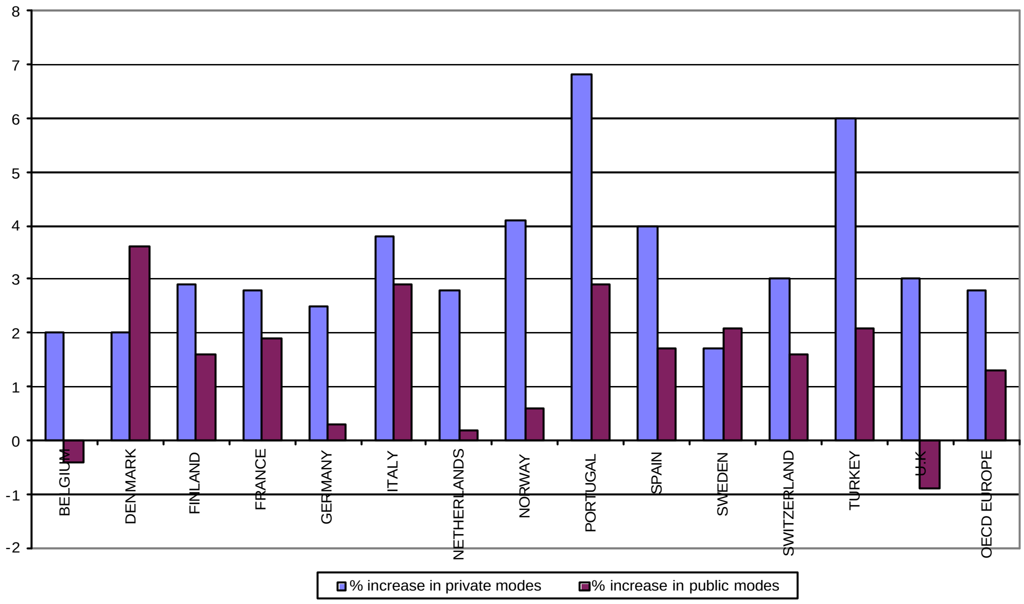

Figure 3.13 Percentage Increases in Private and Public Modes in European Countries between 1970 and 1987

Source: Bovy, Orfeuil and Zumkeller (1993)

The private automobile has a combination of characteristics that make it a formidable competitor to the other urban transportation modes. There are many urban trips for which the automobile's cost effectiveness and service quality are so clear cut that only those people unable to drive afford a private automobile would use a competing mode. Nevertheless, the number of non-drivers in the population, such as children, elderly, handicapped, poor is large enough that there is a considerable captive market for public transportation modes, especially in Turkey.

The number of cars in Turkey is in a rising trend, as illustrated in Figure 3.14.

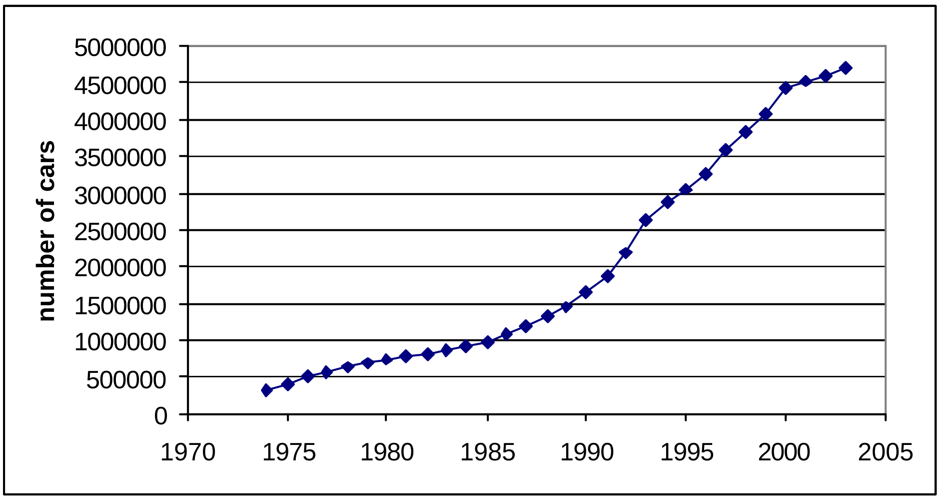

Figure 3.14 Number of Cars in Turkey, Source DIE (2004)

The car ownership levels in Turkey are tabulated in Table 3.4 and illustrated in Figure 3.15. While car ownership level was about 10 cars per 1000 inhabitants in 1975, this level is about 65 cars per 1000 inhabitants in 2000.

Table 3.4 Car Ownership Growth in Turkey, Source: DIE (2004)

years	number of cars	population	cars per 1000 inhabitants
1975	403,546	40,347,719	10.0
1980	742,252	44,736,957	16.6
1985	983,444	50,664,458	19.4
1990	1,649,879	56,473,035	29.2
2000	4,422,180	67,803,927	65.2

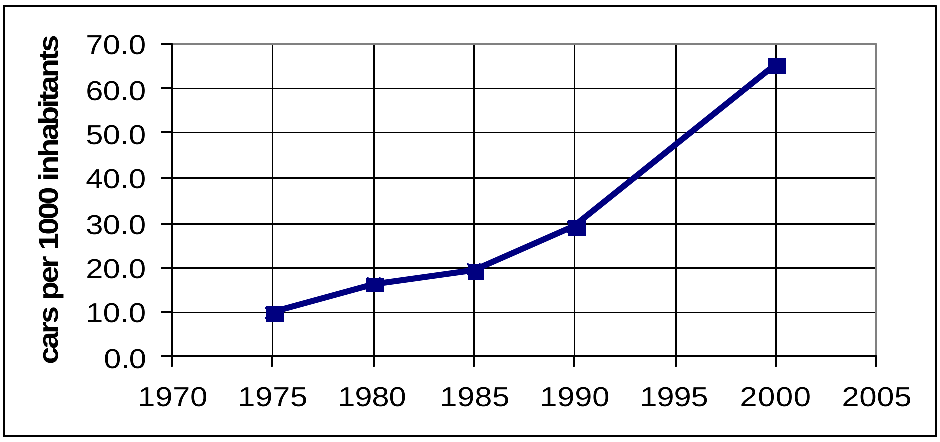

Figure 3.15 Car Ownership Growth in Turkey, Source: DIE (2004)

While car ownership is likely to grow in Turkey, car use, at least in those situations in which the negative consequences are severe, should be discouraged by transportation policies and regulations. Policies which discourage peak-period use, and the use in congested urban areas, city centers, should be implemented.

These patterns suggest some important policy implications which stress the need to strategically reshape urban land use, to emphasize investment in non-auto infrastructure and to ensure that any physical planning strategies aimed at reducing automobile dependence work in concert with economic policies directed at increasing the real cost of both car ownership and car use.

CHAPTER 4

CITY AND AUTOMOBILE DEPENDENCE

The spread of car ownership and use has created major problems in most of the cities. The rate of motorization and its impacts vary from place to place, but the adverse consequences are observed in all cities.

Automobile dependency is the cumulative effect of transportation and land use patterns that result in high levels of automobile use and limited transportation system options. Automobile dependency results from a cycle (Figure 4.1) that increases vehicle travel and reduces non-automobile travel options. Reversing these factors can help create more balanced transport systems.

The opposite of automobile dependency is not a total lack of private vehicles; rather, it is a balanced or multi-modal transport system, meaning that consumers have a variety of transport options, and incentives to use each for what it does best. Efforts to create more balanced transport systems can involve a variety of specific actions to improve travel options, create more multi-modal land use patterns, detailed planning and pricing practices that discourage automobile travel, and increase the prestige and attractiveness of alternative modes.

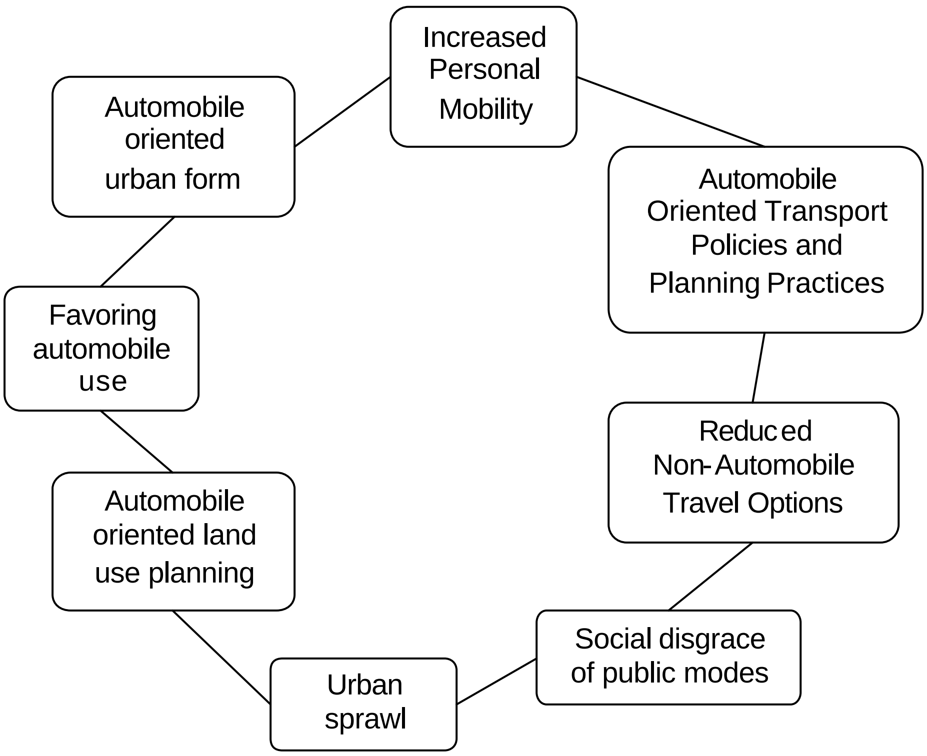

Figure 4.1 Cycle of Automobile Dependency

Two main mistakes are made in discussing car dependence. The first is to think that there is no such a thing. The second is to think that it is inevitable and cannot be changed anyway.

4.1 TRANSPORT POLICY OBJECTIVES IN CITY CENTERS:

Until the late 1960s the objectives of transport policy could be defined broadly as provision for the efficient and safe movement of vehicles subject to the financial constraints of the transport planning authority's budget. However, the debates on transport policy of the early 1970s highlighted much more serious shortcomings of these limited objectives. (May, 1983)

- First, their emphasis was on vehicle movement; as it became accepted that vehicle movement was only desirable for providing mobility for their users, the emphasis switched to efficient movement of people, and to those vehicles, such as buses, which were more capable of achieving this objective.

- Secondly, they were only concerned with vehicle users and not with those, such as residents and pedestrians, whose environment was affected by traffic or by provision of new roads.
- Thirdly, they did not seem to consider the possible encouragement of decentralization and of decline in city centers' commercial activity.

Pharoah and Apel (1995) suggest a 'city friendly' and 'urban compatible' transport strategy. A diminishing role for the car leads to more use of other means of access, thus improving their quality and viability, and a higher quality of urban experience thus reducing the pressure to leave the city or to adopt car based travel styles.

Possibilities should be created for people to live with less use of the car and without making sacrifices in their quality of life. The city friendly transport concepts discusses the promotion of the travel modes as a way of creating lively, unpolluted, successful and attractive city environments.

Most strategies are confined to limiting car use in city centers, either as through routes or as destinations. It is argued that since city centers usually cover a little percent of the total land area of the city, policies to limit that category of traffic will have little overall impact. On the other hand, limiting such traffic is not only much easier (because of the availability of alternative means of travel), but also more useful, since many more people use the city center. Furthermore, limits on city center work journeys will reduce the peak hour traffic congestion on radial routes. (Pharoah and Apel, 1995)

It is necessary to use the limited space available in the city center with wisdom through selectivity. The space necessary to move a certain number of passengers by automobiles would be larger than the space necessary for public transport.
The central area, traditionally the most important part of the entire city, is the natural area where potential changes in travel behavior could best be accommodated.

4.2 THE CONCEPT OF SUSTAINABILITY AND ITS RELATIONS TO CITIES

Sustainability is a concept developed in the global political arena that attempts to achieve, simultaneously, the goals of an improved environment, a better economy, and a more just and participative society, rather than trading off any one of these against the others.

Sustainability can be applied to cities so that a city can be defined as becoming more sustainable if it is reducing its resource inputs (land, energy, water, and materials) and waste outputs (air, liquid and solid waste) simultaneously while improving its livability (health, employment, income, housing, leisure activities, accessibility, public space and community). The biggest threat to sustainability in cities is the automobile dependence. (Newman and Kenworthy, 1998)

4.3 WHY SHOULD CAR TRAFFIC BE REDUCED IN CITY CENTERS?

Car traffic causes increasing problems in cities and mobility is restricted to some extent because of these problems. The urban functions are becoming more difficult to realize day by day because the central parts of towns are becoming adversely affected by increasing traffic, resulting in congestion and air pollution. The reasons to reduce car traffic in city centers may be summarized as follows:

1. *Car travel is increasing rapidly and this is leading to captive car users.*

As people, jobs and other activities have moved away from city cores, the use of the car has increased, since this spatially developing structure is convenient for car use and less convenient for other means of access. The dispersed locations of building developments and poor adaptation to public transport is thus leading to increased dependency on cars. Unless measures are taken, cities can therefore reckon with a continued increase in car traffic with all the negative effects that accompany it.

In suburban settlements where public transport is not available or the quality of service is low, *captive car users* are created as a consequence of the decentralization of both the residential and environmental areas. (Babalik, 1996)

2. *Environment is being destroyed*

Traffic is the largest single source of environmental disturbance in city areas. The worst aspect is air pollution and the high noise levels in city centers.

Car traffic also affects the environment in other ways. The main traffic routes take up too much space in urban areas and often function as barriers. They sometime decrease life standard.

3. *Congestion*

All over the world, car ownership and mobility are increasing along with the economic growth. Together with urbanization, this has led to serious traffic problems in cities. Long traffic jams have become a common daily occurrence in nearly all cities. The increasing uses of cars in city centers are leading to lower vehicle speeds and longer traffic jams. During the peak periods, many streets transform into huge parking lots.

4. *Increasing problems in the standard of bus services*

The increased use of cars is making it more difficult for buses to negotiate the heavy traffic. In many parts of the routes in city centers, average bus speeds are so slow that it is just as quick to walk. Low speeds in bus services result in fewer passengers. A decrease in the number of people traveling by bus will lead to an increase in the number of people traveling by car. Since a bus can carry more passengers to a destination, the previous analysis means the congestion levels will increase with the use of private cars.

5. *Equity:*

Public policies should avoid arbitrarily favoring one individual or group. Automobile dependency violates this principal by favoring motorists over non-motorists, as pedestrians, cyclists and transit riders bear greater congestion delays, crash risk and pollution from motor vehicle traffic.

As a result, it can be well argued that the full costs of operating automobiles, especially single-occupancy automobiles, in the congested central areas of the cities are so high, that modes with higher vehicle occupancy provide more cost effective and environmentally acceptable transportation. Apart from the costs of purchasing and operating (cost of fuel, maintenance, tires), the full costs of automobile use include the value of drivers' time, the environmental effects such as air pollution and noise, whose impacts in densely populated areas are magnified by the large numbers of people affected, the cost of land and structures used for the movement and parking of automobiles, and the negative effects on community values and urban structure. These costs are so substantial that ways to reduce them should be sought.

4.3.1 THE DESIRABILITY OF TRAFFIC REDUCTION

According to many traffic professionals reducing traffic levels especially at the city centers should be an explicit aim of the urban transportation policy. Even if heavy traffic flows could be made clean and free flowing, having significant vehicle flows passing thorough residential and commercial areas could result in severance, make an area unattractive for investors, and restrict the movements of children and other vulnerable groups. (Cairns, Atkins and Goodwin, 2002)

The achievement of traffic reduction at city centers is commensurate with achieving a range of other benefits; improving the quality of the environment for people living, working, visiting, reducing casualties, improving city center quality and creating environmental conditions appropriate to stimulate business investment.

To implement traffic reduction schemes in city centers, managing the public opinion is very important for traffic reduction can sometimes be seen as a negative result. For example, the Oxford Transport Strategy has resulted in a 20% reduction in vehicles entering the central area. There is danger that this would be interpreted as having deterred people from visiting the center. But further monitoring the data showed that the overall number of people visiting the center has actually increased, since introducing traffic restrictions in the central area has reduced through traffic and people arriving and parking, while the number arriving on buses has increased.

As a result car travel reduction in city centers helps to achieve a wide variety of benefits including accident reductions, air quality improvements, reduced neighborhood severance, increased business investment, more attractive living and working surroundings and improved retail vitality. It is important to highlight that the *counts of people* determine how attractive an area has become, not the *counts on the base of vehicles*.

4.4 THE CITY CENTER AS A PLACE:

City centers have survived wars, economic crises, fashionable ideas, and now the automobiles. Our quality of life is affected by a great many things but there is little doubt that for many people the city center is one of them.

Numbers of architects, urban planners, and writer-philosophers see the soul of the city in high-dense living. These people note that throughout history it has been the city which has given us our freedoms, our art, our literature, our commerce and trade and most of our industrial productivity. They say that the central business district is the essence of urbanity. For this reason car travel should be restricted so that the city center will be favored. (Creighton, 1970)

In nearly all parts of the world, there is a growing awareness of the importance of the city center and the fact that something must be done. The special attention which is being paid to the core is justified by the incomparability of its role, within the entire urban organism. It represents its hearth, its brain and its soul. Every town, every city, every metropolis of the world, possesses a core. In the city core then must be represented all the most essential urban qualities and functions with outstanding characteristics and qualities, expressing the essence of urbanity. A city center should have the power of attraction. (Gruen, 1973)

The growth in car ownership and use made mobility easy for those with cars. Living and working in widely dispersed low density areas, often resulted in the demise of public transport and the city center diminishing in importance.

4.5 FEASIBILITY OF CAR TRAVEL REDUCTION IN CBD

It is already understood that cities cannot accommodate all the possible demands for car use, and the car use is already limited at some places and times by congested roads and lack of parking space. The first question to be asked is whether better outcomes can be achieved by limiting car use.

The core question is: 'What happens when action is taken to reduce car travel, especially in city centers?' When such a policy is suggested it will be opposed by two arguments from two sources, namely from local traders who feared that restrictions on traffic would lead to loss of trade, and from some traffic engineers who feared that restricting traffic in some street would cause substantial traffic chaos on surrounding streets.

The retailers claim that their trade depends on good car access and will be harmed by traffic reductions. The results of the studies suggest that provided that car traffic reduction is done well with good simultaneous improvements to public transportation and proper parking facilities (park and ride), then the effect is that retailing benefits and the commercial vitality of the city center is enhanced.

The second objection is from the traffic engineers. There has been some argument whether such schemes just redistribute traffic and cause stress in surrounding streets. Goodwin (2001) claims that those traffic engineers make a fundamentally misleading but widely applied assumption that the total volume of traffic is fixed, and therefore any which is displaced from one street must switch to another street adding to the congestion there. This model assumes that changing the choice of route was the only response that drivers could make to changes in road conditions. In the real world the total volume of traffic is not fixed. It is subject to influence from prices, speeds, availability of alternatives. Before, transport planners thought that the total volume of traffic was an inexorable quantity, driven entirely by income, and largely unaffected by policy. But travel behavior and demand can be influenced by successful transport policies.

Some people believe that people and jobs will abandon the cities unless they are able to use their cars as they wish, while others believe the opposite that people and jobs will move out of cities unless traffic is reduced and environmental conditions are improved. While adapting the city to car point of view used to prevail in most areas, there is widespread and growing support for limiting cars in city centers. The research has showed that the vitality, competitiveness and economic health of the city depend not on more cars, but on a better environment. (Pharoah and Apel, 1995)

4.5.1 THE DISAPPEARING TRAFFIC

Reallocating road space from general traffic, to improve conditions for pedestrians or cyclists or buses or on-street light rail or other high-occupancy vehicles, is often predicted to cause major traffic problems on neighboring streets. Yet, those who have implemented schemes rarely report that such consequences result. Instead, typical comments are of the form: 'a lot of the traffic seems to have disappeared, and we don't know where it has gone'.

The findings suggest that predictions of traffic problems are often unnecessarily alarmist, and that, given appropriate local circumstances, significant reductions in overall traffic levels can occur, with people making a far wider range of behavioral responses than has traditionally been assumed.

The study by Cairns, Hass-Klau and Goodwin (2002) sought to identify all possible case studies of circumstances where roadspace had been reallocated, whether due to positively planned schemes, temporary road closures for maintenance or renewal of transport facilities, or natural disasters. Although the stimulus for change varied, in each case drivers needed to decide what to do when their normal travel patterns were disrupted, and there were useful insights from all the examples as to how they reacted.

Examples included pedestrianization schemes in German and other Continental European cities; the City of London 'Ring of Steel' project following IRA bombing; closures of bridges such as London's Westminster Bridge, Tower Bridge and Hammersmith Bridge for repairs and maintenance; city-center traffic schemes in places like Oxford, Cambridge and Wolverhampton; the introduction of bus lanes in cities such as Cardiff, Bristol and Toronto; the closure of a rural road south of London; the street enhancement projects in Norwegian towns; the Six Towns Bypasses Monitoring Project; the Tasman Bridge collapse in Hobart, Australia; and the effects of earthquakes in Kobe, Japan, and in California, USA, where transport links were suddenly and unexpectedly removed from the network.

The key findings were as follows.
(a) When roadspace for cars is reallocated, traffic problems are usually far less serious than predicted.
(b) Overall traffic levels can be reduced by significant amounts.
(c) Traffic reduction is partly explained by recognizing that people react to a change in road conditions in much more complex ways than has traditionally been assumed in traffic models.

The scale of measured traffic changes is highlighted in Table A.4.1 and illustrated graphically in Figure A.4.1 in appendix. For each of the case studies quoted, traffic levels were monitored on the treated road, or area, and also on surrounding roads.

The data collected by Cairns, Hass-Klau and Goodwin (2002) suggest that traffic reduction is a real phenomenon that occurs when roadspace for cars is reduced. The overall average reduction in traffic is about 22%, meaning that 22% of the vehicles which were previously using the road or the area where roadspace for general traffic was reduced could not be found in the surrounding area afterwards.

It is generally assumed that traffic levels remain fixed. The assumption is that 'nothing will make people get out of their cars—they'll always try and find another way round, and, if necessary, they'll just sit and wait in the traffic'. For future transport policy, it is critical to clarify whether this assumption is correct.

The final finding from the original study made by Cairns, Hass-Klau and Goodwin (2002) was that the reason traffic reduction observed is the fact that behavioral responses that people make following a change in road conditions are much more complex than has previously been assumed, or allowed for in traditional transport modeling. Which complex reactions can result from a change in road conditions is shown in Figure 4.2.

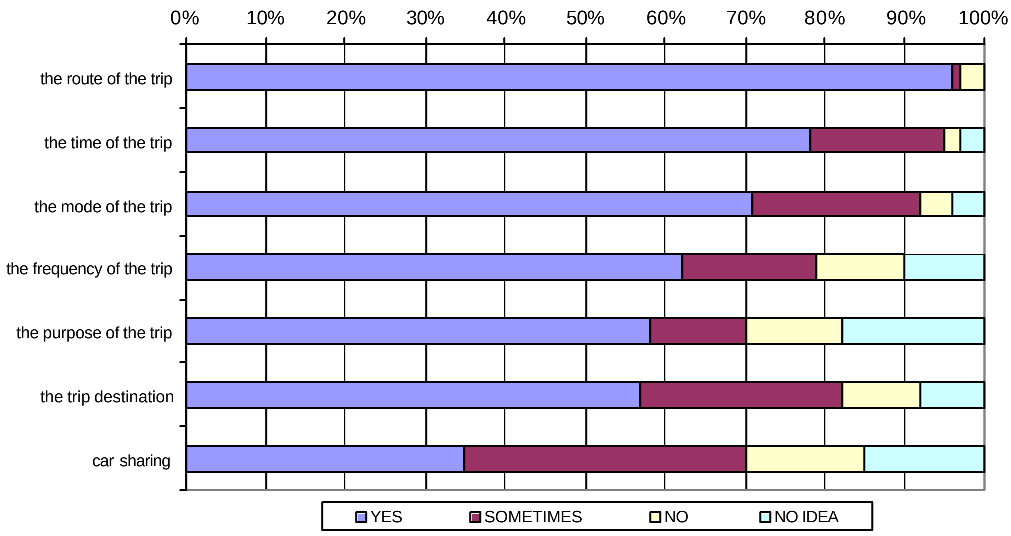

Figure 4.2 Changes in Behaviors of Travelers after a Traffic Restriction Scheme
Source: Cairns, Atkins and Goodwin (2002)

It is important that scheme monitoring includes counts of people as well as vehicles, to balance debate about issues of social equity or how attractive an area has become.

4.6 AUTOMOBILE TRAVEL REDUCTION METHODS

There is a broad consensus of opinion that car traffic should be reduced in city centers, however, there are widely differing opinions on the best way of achieving this goal.

The diversity of modern life means that people cannot reasonably expect to walk or cycle to everything they need, but careful planning can ensure that facilities can easily be reached by public transport. Good planning thus reduces dependence on the car, while bad planning can make it impossible for people to lead a reasonably active life without one.

The approaches to limit car use may be divided into three types:

- Carrots
- Sticks
- Carrots and sticks

The carrots are cases where the alternative transportation modes are improved but without any deterioration in the attractiveness of car use. These cases usually find a significant increase in use of the improved method of transport, but little reduction in traffic levels. Sticks are the cases where car travel restrictions are implemented without any improvement in the alternatives. The 'carrots and sticks' are those cases where the act of improving public transport is simultaneously connected with making car use less attractive. This especially applies to techniques of reallocation of existing road capacity among competing users, for example in bus lanes.

Car travel reduction options in urban areas, particularly city centers can be grouped into the following categories:

a) Direct Restrictions on car use in congested areas, through:
    - Diversion, exclusion and metering of automobile access to specific areas

- Area licenses, parking surcharges and other forms of congestion pricing
- Establishment of car-free zones and closure of selected streets to vehicular traffic or to through traffic

b) Actions to improve transit service, through
   - Provision of better collection, distribution and internal circulation services
   - Greater flexibility and responsiveness in routing scheduling and dispatching of transit vehicles
   - Provision of extensive park-and-ride services from fringe and transportation corridor parking areas
   - Provision of shuttle transit services from CBD fringe parking areas to downtown activity centers
   - Encouragement of paratransit services and their integration in the metropolitan public transportation system
   - Simplified fare collection systems and policies
   - Better passenger information systems and services
   - Provision of shelters and other passenger amenities

c) Reallocation of road space; preferential treatment for transit and other high-occupancy vehicles, such as:
   - Reserved or preferential lanes on city streets
   - Conversion of selected downtown streets to exclusive bus use
   - Strict enforcement of reserved transit right of way
   - Special turning lanes or exemption of buses from turning restrictions
   - Bus priority of traffic signals
   - Encouragement of carpooling and other forms of ride sharing

d) Management and control of parking through:
   - Elimination of free parking in city centers
   - Regulation of the number and price of public and private parking spaces

- Reduced parking supply
- Provision of fringe and transportation corridor parking to facilitate transfer to transit and other high occupancy vehicles
- Strict enforcement of parking restrictions

e) Appropriate provision for pedestrians and bicycles:
  - Bicycle and pedestrian paths and exclusive lanes
  - Secure and convenient storage areas for bicycles

f) Changes in work schedules, fare structure and automobile tolls to reduce peak period travel and to encourage off-peak use of transportation facilities and transit services
  - Staggered work hours
  - Flexible work hours
  - Reduced transit fares for off-peak transit users
  - Increased peak-hour commuter tolls on bridges and access routes to the city

g) Land use planning efforts
  - Mixed type land use will reduce dependence on automobile and encourage walks and bicycle trips
  - Development of high density corridors, encouraging use of transit services
  - Shaping future urban growth to reduce automobile travel

4.6.1 CITY CENTER PEDESTRIANIZATION

This movement was implemented especially in those cities with a strong and culturally important historic city center, a medieval or Renaissance street pattern incapable of dealing with heavy traffic, and an attractive urban environment of squares, beautiful buildings, and untouchable monuments. The view developed that such centers would be more attractive if, instead of providing for traffic growth, traffic was simply banned.

The provision of a good quality pedestrian only space in the heart of a city center is now so widespread and very popular. These places manifestly work, deliver commercial and cultural success. In large areas, there are usually special arrangements to enable public transport vehicles to enter restricted streets, and sometimes cars are allowed during unrestricted times. Some cities have provided inner ring roads to accommodate a proportion of the displaced traffic. (Goodwin, 2001)

4.6.2 CONGESTION PRICING:

A basic economic principle is that consumers should pay directly for the costs they impose as an incentive to use resources efficiently. Urban traffic congestion is often cited as an example: if road space is unpriced traffic volumes will increase until congestion limits further growth. For decades economists have recommended road congestion pricing (special tolls for driving on congested roadways) as a way to encourage more efficient use of the transport system, and address congestion and pollution problems, providing net benefits to society.

In recent years few cities have implemented various forms of congestion pricing, but supporters have been discouraged by the political resistance in other major cities.

Congestion pricing is a particularly effective congestion reduction strategy. Many economists consider urban traffic congestion virtually unsolvable without some sort of congestion pricing (Goodwin, 2000).

Congestion pricing refers to road pricing used as a demand management strategy to reduce peak-period vehicle trips. It is intended to change consumption patterns. Congestion pricing requires time-variable tolls, with higher during peak periods and lower or non-existent when roads are uncongested. Time-variable tolls can be based on a fixed schedule or they can be *dynamic*, meaning that rates change depending on the level of congestion that exists at a particular time.

Cordon (area) tolls are a category of congestion pricing. Cordon tolls are fees paid by motorists to drive in a particular area, usually a city center. This can be done by simply requiring vehicles driven within the area to display a pass, or by tolling at each entrance to the area.

Congestion pricing can be implemented at various scales:

- Point: Pricing a particular point in the road network, such as a bridge or a tunnel.
- Facility: Pricing a roadway section.
- Corridor: Pricing all roadways in a corridor.
- Cordon: Pricing all roads in an area, such as a central business district.
- Regional: Pricing roadways at regional centers or throughout a region.

A variety of pricing methods can be used to collect fees, as summarized in Table 4.1. Newer electronic pricing systems tend to have lower costs, greater user convenience, and more price adjustability, making road pricing more feasible.

Passes

Motorist must purchase a pass to enter a particular area (a cordon), such as a city or a central business district. Passes may be specific to a particular type of vehicle or a particular time. Some systems only require passes during congested periods, such as weekday mornings. Free or discounted passes may be provided to area residents. Passes may be sold directly by government agencies or by retail stores. They tend to be inexpensive to implement and easy to use.

Toll Booths

Conventional tollbooths located on a roadway require motorists to stop to pay with money or tokens. These tend to have high operating costs, are inconvenient to motorists, and increase traffic congestion and local air pollution. Prices can vary by time and vehicle type. Tollbooths are generally spaced several miles apart. They are generally only applicable on bridges, grade separated highways or cordon entrances.

Electronic Tolling

Electronic toll collection refers to automated systems that measure and bill motorists. A small transponder is placed inside the vehicle, which is counted each time the vehicle passes a roadside sensor. The tolling agency maintains an account for each vehicle, which is debited with each use of the roadway. Another system uses a "smart card" charged with a certain amount that is placed inside the transponder. Each time the vehicle passes a charging point the appropriate fee is subtracted. These systems tend to have high implementation costs, and moderate to high operating costs. They have economies of scale, so unit costs decline significantly as the system expands. They can be used on any roadway, not just grade separated highways. It is possible to have many roadside sensors, allowing fine determination of congestion rates.

Optical Vehicle Recognition

This system tracks vehicles as they pass a point in the roadway by automatically scanning the license plate. This information is used to generate a bill that is either subtracted from the vehicle's account, or mailed as an invoice.

These systems tend to have high implementation costs, and moderate to high operating costs. They tend to have economies of scale and can be used on any roadway, as electronic tolling. It is possible to have several cameras, allowing fine determination of congestion.

GPS-Based Pricing

The GPS (Global Positioning System) based pricing uses a small electronic transponder to track an object's geographic location. GPS-Based pricing can incorporate virtually any pricing factor, including factors related to driver, vehicle, time and location of vehicle travel. As a result, it can be most accurate pricing system.

Table 4.1 Summary of Fee Collection Options, Source: TDM Encyclopedia (2004)

Type	Description	Equipment Costs	Operating Costs	User Inconvenience	Price Adjustability
Pass	Motorists must purchase a pass to enter a cordoned area.	Low	Low	Medium	Poor to medium.
Toll Booths	Motorists stop and pay at a booth.	High	High	High	Medium to high.
Electronic Tolling	An electronic system bills users as they pass a point in the road system.	High	Medium	Low	High
Optical Vehicle Recognition	An optical system bills users as they pass a point in the road system.	High	Medium	Low	High
GPS	GPS is used to track vehicle location. Data are automatically transmitted to a central computer that bills users.	High	Medium	Low	High

Several constraints are recognized when developing a plan for pricing. An efficient and reliable alternative mode of transport should be available to those commuters who would be discouraged from driving into the central area, since the economic vitality of the area depends on the accessibility of the central area.

The first task is to define the boundary of the restricted zone. It has to include the areas with congestion problems, minimize the number of entry points that have to be monitored, and take advantage of existing areas that may serve as parking areas near the boundary.

It should be noted that the concept of congestion pricing appears to be within the realm of possible implementation with advances in information technologies. Singapore is leading the way with electronic road pricing. London is using a network of video cameras for congestion pricing. It seems possible that the implementation in Singapore and London might be a way to break the spiral of increasing congestion and decreasing public transport service by creating a situation in which public transport can operate more efficiently and give better service.

Realization of congestion pricing is not easy. It requires a suitable combination of travel and political conditions, the ability to overcome public hesitation.

4.6.3 IMPROVEMENTS IN ALTERNATIVES; PROMOTING PUBLIC TRANSPORT

A very widespread practice is to seek to reduce traffic levels, especially by car, by making the alternatives to car use more attractive. The quality of public transport is one of the most crucial aspects of a successful transport strategy. Public transport facilities must be improved in advance of any curbs on car use. Many cities worldwide with large populations, low densities, and congested CBD are looking into new initiatives in introducing optimal public transportation systems.

No doubt that people are looking for door-to-door services, with maximum comfort, minimum wait time, and highly reliable service. Figure 4.3 attempts to draw the three cases in which a passenger will use public transport:

a) When there is no alternative,

b) When there are features such as short travel time and/or extra comfort, preferential and priority treatment,

c) When the public transport can be linked comfortably to a door-to-door trip chain with smooth and synchronized transfers.

From the user perspective the use of public transport will become attractive even without the feature in (b) if it can easily serve the user’s door-to-door purpose. No doubt that this is a central point in understanding the user’s travel behavior, and it has to do with the integration between the public transport end point and the user's destination point. Figure 4.3 shows that the user will choose the public transport if at its end point he/she can have a comfortable access to his/her destination via walking or a smooth transfer.

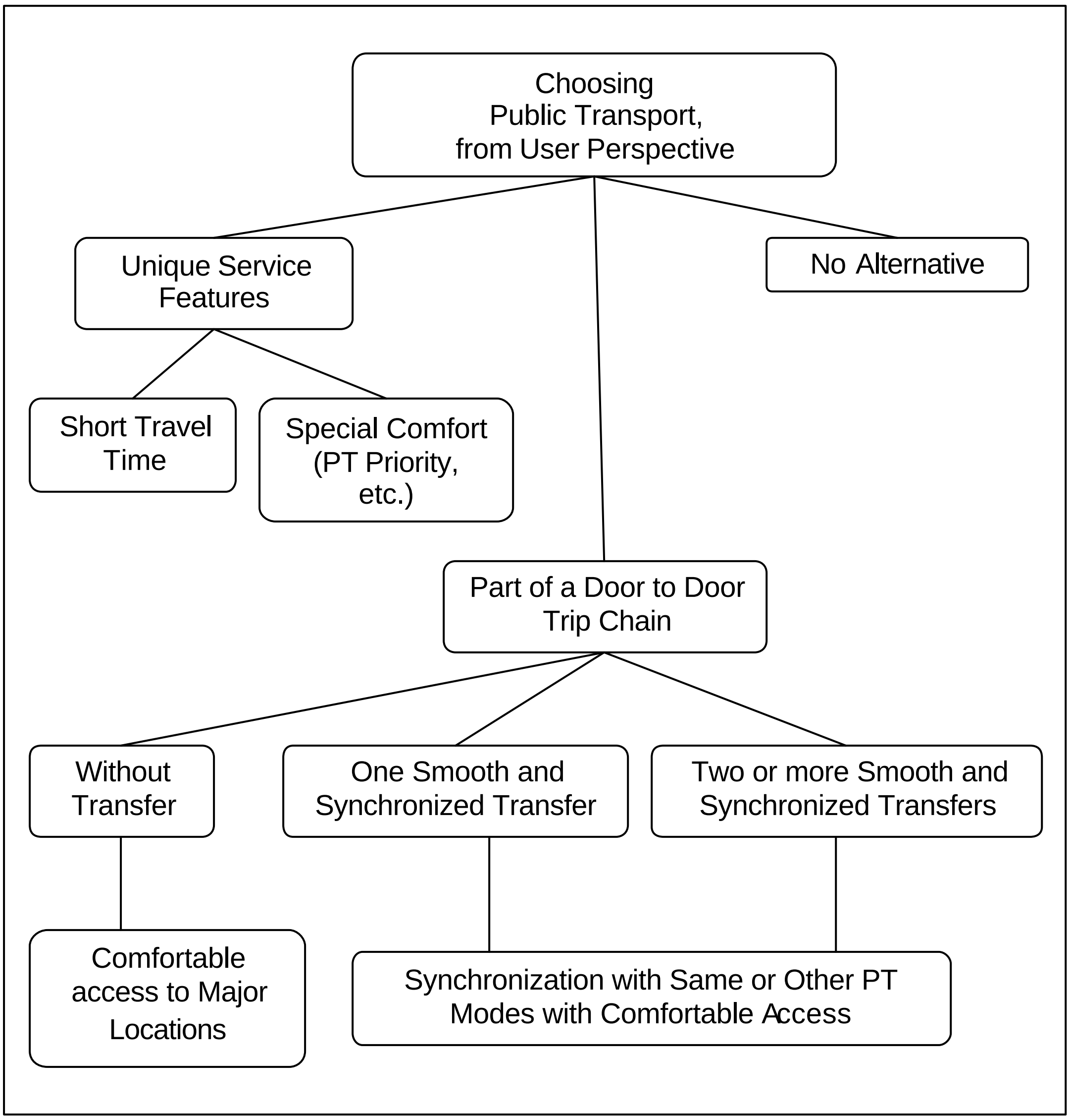

Figure 4.3 Cases when Public Transport is Chosen, Source: Avishai (2004)

4.6.3.1 Integration and Interchanges

One major theme to affect the use of public transport service is on how to achieve multimodal service integration. This public transport integration theme presents one of the substantial weaknesses of current public transport practice.

Avishai (2004) listed five major essential integration elements required for a sound public transportation integration system:

1. Good information on the available options
2. Stability of service
3. Network integration.
4. Ticketing integration using smart cards
5. Maximal synchronization.

Good information on the user's options should cover all public transport modes and needs to be tailored to the user's needs. The information should be based on simplicity and accuracy while taking into account the exact way to reach B from A for any A, B points on the public transport network. The information should comprise all public transport modes and all operators in a single system. The *stability of perception of service* implies infrequent changes that may introduce confusion among the users such as long validity periods for public transport timetables. *Network integration* implies smooth transfers and comfortable interchanges. That is, easy change of routes in a single trip no matter if routes are operated by one or more modes and/or operators, and available interchanges to allow for smooth transfers. *Ticketing integration* is based on a combined tariff using the same payment method such as the same smart card. Finally to *maximize synchronization* for better coordination among the routes and public transport modes and minimization of the transfer and wait times. This synchronization of the user timetables should be carried out both at the planning stage and considering actual situations.

4.6.3.2 Transfers

Public transport passengers usually perceive a transfer (vehicle to vehicle either using the same public transport mode or from mode to mode) as one of the most problematic factors. Such a transfer involves walking and waiting, the two elements that usually are not part of using a car. In existing public transport systems it is recommended to minimize this type of transfer.

Whenever a public transport development alternative is under consideration there is a need to evaluate the adverse effect of transfers. The ways to avoid an inconvenient transfer by introducing the ideas of smooth and synchronized transfers should be searched.

This smooth and synchronized transfer relies on new technologies; moving walkways, escalators, elevators, using carts, electrical slow-speed vehicles, etc. The synchronization is based on an exact arrival/departure timing that can be handled by a certain real-time intelligent control system, and by using certain algorithms to create the transfer meetings in the timetables. Therefore any public transport development alternative that contains large walking and waiting transfers should be eliminated, or revised.

It is worth mentioning that the switch from car to public transport will start only if the public transport system could ''beat'' the car in certain aspects; less travel time, better access, special comfort, etc. For example, if the bus can be reliable, with clean and comfortable seats, and can bring the passengers close to their work, the desired shift from car to bus can be foreseen.

Shifting traffic from automobile to transit on a particular highway not only reduces congestion on that facility, it also reduces the amount of vehicle traffic discharged onto surface streets, providing “downstream” congestion reduction benefits. For example, when comparing the congestion reduction benefits of a highway widening project with some sort of transit service improvement, the analysis should not be limited to just the highway that is expanded. It is important to also account for the additional congestion on surface streets where highway traffic discharges resulting from increased traffic volumes, and the reduction in surface street traffic congestion that would result if the transit improvement attracts highway drivers out of their cars.

4.6.4 CAR POOLING AND HOV

If it were possible to increase the number of passengers per car, the number of cars on the roads could be reduced considerably. When the drivers drive alone, approximately 75% of the seating capacity in the vehicle is not used. One of the lanes on radial roads could be set aside for cars containing at least three or four people. However, the observance of this scheme could prove difficult to control.

4.6.5 TRANSPORT PRICING THROUGH PARKING AND TAXES

From economic theory, if prices are not correctly adjusted to costs, there will be some distortions in the resulting choices. It has been argued that traffic growth has been higher than it should have been, because people have not been faced with paying for the full costs, such as congestion and environmental damage, resulting from their choices. For this reason, there has been much interest in using prices as an instrument of transport policy.

The use of pricing, combined with regulation of the number of parking spaces available, is very widespread in busy areas. In most cases, authorities decide how much parking should be allowed for a building, street, or area, restrict the number of parking spaces to this, and then choose a price which brings about a comfortable level of utilization of those spaces.

It is generally thought that the combination of parking control and pricing is a very powerful tool for influencing the number of vehicles attracted to an area, but there are limitations, especially because this does not affect through journeys.

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4.6.6 RAIL BASED SYSTEMS

Particular consideration to rail based systems and their development should be granted. There exists a powerful relationship between city size and the size and density of rail based public transport. Smaller cities tend to rely on buses, medium cities have tram or light rail systems, the larger cities have more comprehensive networks of underground and suburban railways. (Pharoah and Apel, 1995)

Large cities are to have public transport of sufficient quality to avoid automobile dependency; they require some form of rail system. The large cities cannot provide quality alternatives to the car by relying on buses. In smaller cities, rail systems are usually not economically viable because passenger densities are low.
Railways have a centralizing tendency, and they both enable and require concentrations of people. The railway can collect large numbers of people and deliver them to one of a few destinations. Traditionally this has meant collecting people from their suburban home locations and bringing them to the city center, for a variety of purposes, for work, business and shopping. The car has the opposite tendency to disperse and to decentralize activities. Buses can help to reinforce centralized activities by providing convenient access to suburban railway stations. (Pharoah and Apel, 1995)

The extent of rail networks may correlate not only with city size but also with city structure. Rail can play a greater role where concentrations of activity occur at important nodes in the network. Where activities are located at a number of centers or nodes rail may play a smaller role.

The first line of the Metro in Paris opened in July 1900 and now the system has 199 km (124 miles) of track and 15 lines. There are 368 stations, 87 of these being interchanges between lines. Every building is within 500 meters of a metro station. With such a great penetration of the metro to the city, there is no need to use a car in Paris. Map A.4.1 shows the Metro routes in Paris.

A final, more pragmatic, reason for emphasizing rail systems is that other forms of public transport have been less well developed. While it may be technologically feasible to create a bus system with standards of passenger comfort equal to that of a tram or train, this has not been demonstrated yet. (Pharoah and Apel, 1995) The fact of the matter is that people can be attracted to a high quality rail system, even when this involves giving up use of their car, but examples of large scale mode switch from car to bus are very rare. Thus the cities with the greatest success in promoting public transport use are invariably those that have invested in rail.

4.6.7 SMART GROWTH AND TRANSIT ORIENTED DEVELOPEMENT

Integrating land use and transportation facilities is a key factor for reducing urban car travel and the terms Smart Growth and Transit Oriented Development refer to this idea.

Smart Growth (also called *New Community Design*) is a general term for policies that integrate transportation and land use decisions, for example by encouraging more development within existing urban areas where additional growth is desirable, and discouraging low-density, automobile dependent development at the urban fringe. Smart growth can help create more accessible land use patterns, improve transport options, create more livable communities and reduce public service costs. smart growth is an alternative to urban sprawl.

Transit Oriented Development (TOD) is a smart growth strategy referring to residential and commercial areas designed to maximize access by transit and non-motorized transportation, and with other features to encourage transit ridership. A TOD neighborhood has a center with a rail or bus station, surrounded by relatively high-density development, with progressively lower-density spreading outwards.

4.6.8 BY-PASSES FOR THROUGH TRAFFIC

One way of reducing the traffic in town and city centers which is often discussed is to construct by-passes or ring roads for through traffic. Ring roads will partly act as by-passes for real through traffic (which is often of a relatively limited extent), and also serve to distribute the traffic to suitable radial feeders. It will thereby avoid vehicles having to travel through the city center in order to reach a destination on the other side of the city.

There are many examples of traffic relieving ring roads in European cities. Some are situated very near the city area and have made it possible to achieve a basically carfree city inside the ring.

In Vienna, the A 20 through-traffic route has been recently opened. The new route, located about 4 km outside the city center, carried about 77,000 vehicles per day just after it was opened in 1987. Of these vehicles, approximately 44,000 had moved over from inner city streets and 33,000 from the surrounding regional road network, in the form of induced traffic. It is stated that the new traffic does not obscure the favorable effects the road has on the inner city areas. (PIARC, 1990)

In Zurich, 1985 saw the opening of the new N 20 motorway about 4 km from the center. A year after it was opened, the motorway was carrying about 45,000 vehicles per day. The traffic pressure was significantly relieved on several streets in the area between the center and the motorway, whereas it increased on several motorway access roads. (PIARC, 1990)

By-passes and other pressure-reducing routes might be very effective, especially if measures are taken to divert traffic from city center streets. The capacity that would be released in the center when the traffic was moved to the new routes could be used for other purposes, such as bus lanes and pedestrian routes.

4.7 CONCLUDING COMMENTS ON THE CAR TRAVEL REDUCTION OPTIONS

The model of the city strategy may be presented as one where the proportion of travel by car is stable, or reducing, and where possibilities are being created for people to live with less use of the car, without having to make sacrifices in their quality of life. Within this framework there are a variety of options for action and many different measures and schemes are discussed in the examples of success.

Measures which push people away from car use directly and the measures which pull or attract people to use the alternatives should be implemented together, because direct restraint on car use will be harder if the quality of the public transport remains unchanged and improvements on the public transport by themselves will not tempt people away from cars.

The cumulative effects of combining several options are not simply additive. Some options may be compatible, may enhance each other and in some cases, may be inseparable. For example, the strong auto disincentives such as very high parking fees or auto-free zones might only be acceptable in conjunction with improved public transport service. Other options may, at least partially, operate at cross purposes. For example ridesharing may decrease transit ridership, while flexible work schedules may inhibit the formation of ridesharing. (ITE, 1986)

Apart from actions on individual forms of transport, there needs to be coordination between all forms of transport. There should be park and ride facilities at peripheral sites or at suitable interchange points, where car users can switch to rail, tram, or bus services. Such measures provide the interaction between those areas dependent on the car (low density, dispersed activities) and city centers with good public transport accessibility.

The idea behind automobile travel restriction by using pricing measures is neither new nor very hard to understand. If a finite resource is free, human beings tend to use it all up, regardless of the consequences. If it has a cost, they tend to use it more rationally.

The World Bank is reported to be advising the cities in developing countries to use charging to curb exploding traffic growth, raise money for much-needed infrastructure and free up congested buses, which are traditionally the main form of mass transport. (Jowit, 2004)

Car sharing can be encouraged through high-occupancy vehicle lanes, and employers should develop company transport plans to reduce car dependence.

Orbital or tangential public transport routes to cater for the spatial diversity of trip patterns should be created.

The car is an inefficient user of road space and must be charged for parking and for using road space. The bus (or tram) is the most efficient user of city road space, but sharing that space with the car reduces efficiency. The urban network could be designated for particular uses. (Banister, 2001) For example, in the city center reallocation of a high percentage of the roads to pedestrians and public transport would lead to fewer cars in the city center and the environmental benefits would also be significant. The capacity and quality of the bus system would be dramatically increased as scheduled operating speeds would be improved. Segregated bus networks would then become a reality.

In the longer term, the most important contribution from the transport planner is in the form of a real integration of land use and development decisions, together with an assessment of their transport impacts. Location strategy, together with clear analysis of density, settlement size, facilities and services, and mixed-use development, would all enhance accessibility and provide a choice for individuals not to use their cars. (Banister, 2001)

The solutions for transport planning in cities, particularly city centers, are clear, through the creation of high-quality environments at intermediate densities with efficient and attractive public transport, there is no reason to own or use the car.

4.8 EXAMPLES OF SUCCESS

Initially limiting car traffic was a response to traffic congestion, mostly on radial roads to the city centre at peak periods. The oil crisis in the mid 1970s took the attention towards energy conservation. In the 1980s there was concern about pollution from traffic and air quality. Some cities with historic centers were concerned about the conservation and protection of the spaces. Some cities addressed the social inequalities of access brought about by increasing car use and consequent degradation of alternatives for those without cars. Some pursued positive concepts for the improvement of urban living conditions and raising the quality of city streets and spaces. These more positive concepts have followed from the recognition that there is competition between the inner areas of the cities and surrounding suburban areas oriented to the car. (Pharoah and Apel, 1995)

Measures to restrain traffic in different cities tend to reflect one or more of these concerns. Italian cities acted to protect their beautiful ancient centers; Swiss cities emphasized the problems of air and noise pollution; in Netherlands land shortage was the concern; London was concerned about congestion, and the high cost of land for parking and roads; Athens acted because of severe air pollution. (Pharoah and Apel, 1995) These illustrate that the motivation for traffic limitation is not uniform between cities or over time.

It is argued that the central cities are not the most congested places in the US cities; the most congested places are the freeways. From this point the US cities differ from Turkey and the other European cities.

The use of cars in US cities continues to grow with no sign of slowing down. While there are encouraging signs of automobile travel reduction in many other countries, in many US cities the process of sprawl and highway building seem to be out of control. The best examples of reducing automobile dependence are found in European and wealthy Asian cities. (Kenworty and Newman, 1999)

In this section a general overview of the strategies that the cities have implemented to reduce automobile travel will be made. The cities included in this review are Singapore, Hong Kong, Copenhagen, Zurich, Oxford, Stockholm, London and Munich.

Each city is unique with its urban structure and its urban policies that are shaped by the political and socio-economic structures of the city. What is common is the determinant of the further increase of automobile travel in the city. The relations between the urban development, land use patterns and urban transport systems shape the future of the city and determine the future car use.

4.8.1 SINGAPORE:

The term congestion pricing stems from the idea of making people pay for journeys that result in congestion. Putting this into practice seems very difficult because of potential problems of implementation, enforcement and equity.

Singapore is a rapidly growing city. 70% of its inhabitants live within a radius of 8 km of the central business district of the city. In addition to this, a similar proportion of the city's jobs are located in the same area. These lead to a significant level of congestion.

The example of Singapore seems to have been a great success. Area licensing, a form of congestion pricing, was selected as the policy instrument to restrain the use of automobiles in congested areas. While the short-run objective of this policy was to relieve congestion in central Singapore, the long run objective was to persuade motorists to re-consider their attitudes toward automobile travel (Watson and Holland, 1978).

The key concept was that a special license had to be obtained and displayed if a motorist wished to enter a restricted area within which congestion was to be reduced. A park-and -ride scheme was designed to provide motorists with an alternative mode of transport to complement the area license scheme. Another element of the scheme was an increase of about 100% in parking charges within the restricted zone.

The aim of the government was to reduce congestion during the peak hours, and it was thought that applying restrictions during the morning peak would significantly reduce traffic both then and during the evening peak. Therefore, the scheme was designed to operate from 7:30 to 9:30 a.m. After implementation, congestion developed after 9:30 and the period was extended to 10:15 a.m. During the first few days following the introduction of the scheme, congestion was heavy on the ring road as motorists avoided the restricted zone. This problem was quickly solved as the timing of traffic lights was modified to favor circumferential movements rather than radial inbound traffic (Watson and Holland, 1978).

Singapore was the first city in the world to introduce a scheme of this type. The components of this scheme were implemented by mid-1975. The comparisons of the traffic volumes (Table 4.2) show that a reduction in the share of automobiles entering the restricted zone is achieved. In this respect the area license scheme has been highly successful.

Table 4.2 Modal Split in Singapore, Source: PIARC (1990)

	Before 1975	1983
Cars	56 %	46 %
Buses	33 %	43 %
Others	11 %	11 %

People walking or taking the bus to work have benefited from the improved environment in the central area and from increases in the speeds for buses. Those who buy area licenses are also benefiting from the increased travel speed and less congestion. For those who cannot afford the area license, the park-and-ride scheme can be used. Overall, it appears that the benefits are applied to the majority of the commuters; for the others, reasonable steps have been taken to provide alternatives and minimize the disadvantages.

In September 1998 the government of Singapore replaced the manually enforced area licenses by *electronic road pricing*. Recent developments in intelligent transport system technologies make this much more attractive. It generally covers the same area as before. All vehicles are required to have an electronic in-vehicle unit that accepts credit in the form of a smartcard. Tolls are automatically paid when the vehicle passes under a gantry. (TDM Encyclopedia, 2004)

This type of scheme has considerable promise as a component of an urban transport policy. It is flexible enough to be changed to the needs of a wide variety of cities, creates revenues and requires little capital to implement. However, as Singapore government officials have pointed out, success requires a fundamental restructuring of the public's attitudes toward the ownership and use of the private automobiles.

4.8.2 HONG KONG

Reducing car dependency, congestion and pollution, has become the key transport objectives of many cities. Despite relatively high levels of wealth, Hong Kong has never become a car-dependent location.

There is a great deal of literature on the link between car ownership, public transport use and urban density. It is generally agreed that car ownership is negatively related to urban density. Research is being carried out around the world to find the optimum use of land to discourage car use. The form of the urban areas should encourage a modal switch to public transport and reduce car dependence.

The traditional reason given for Hong Kong's relatively low levels of car ownership and use is related to density of population. Sharon Cullinane (2003) states that the density of urban Hong Kong is about 10 times that of most European cities and 30 times that of the US cities. The form of decentralization of residential areas has been as new towns where most people live in high-rise blocks. The new towns were built close to the existing railway line and the transport links to the central district were improved.

Although the density argument is important, there are several different explanations for Hong Kong's low car dependence.

The cost of private transport in Hong Kong is high. The initial car purchase price is similar to elsewhere in the world. However, for a new car, a first registration tax of between 40% and 60% of the value of the car should be payed. The fuel costs are high relative to international standards (Cullinane, 2003)

There is not sufficient parking space for cars in public places, and apart from the difficulty of finding parking spac es, parking is also expensive. Besides, renting a parking space in a residential block is also expensive and the number of spaces are limited. Many residential blocks hold lotteries to allocate spaces. Tunnel and bridge tolls add to the cost of many journeys. (Cullinane, 2003)

The public transport system consists of a mixture of rail and road based transport. Public transport frequencies in Hong Kong are generally very high. In addition, because of the frequency of the services, integration between modes and vehicles is fairly easy. This is aided considerably by the existence of the electronic smart card, which can be used on much of the public transport. Public transport in Hong Kong is generally perceived very favorably. This can be understood by the survey of young people; most of them agreed with the statement 'public transport is so good that I do not need a car'. (Cullinane, 2003)

The Hong Kong government produced policies to discourage car ownership and use by a package of integrated and balanced measure to encourage excellent public transport and disincentives to car ownership and use. The success of public transportation is aided by the density of population, but this is not the main reason. Public transport is comprehensive, frequent, integrated, of high quality and is fairly cheap, with the result that car ownership is not an inevitable desire.

There are lessons to be learned from Hong Kong's case. Although density is important in explaining the low level of car dependency, it is not sufficient. Controls on parking and the high costs of private transport with the convenient and cheap public transport, have suppressed the demand for private transport.

4.8.3 COPENHAGEN:

The story of Copenhagen is the story of rail transit's role as an instrument. In 1947, Copenhagen planners introduced the Finger Plan, adopting the image of a hand with five fingers that radiate from central Copenhagen to the north, west and south, with each finger aligned in the direction of a historical Danish town. The finger Plan has been implemented, step by step, through a series of local zoning and land use decisions. Radial rail services, along with the reassignment of streets to pedestrians and cyclists, have strengthened the historical city center. Today majority of residents heading to central city jobs take transit to work. (Cervero, 1998)

Apart from the rail based transit, bus ridership is increasing as well. Rail transit continues to handle mainly radial trips, while bus transit caters mainly cross town travel.

As in many European cities, Copenhagen's core retains its medieval street pattern. Copenhagen's first pedestrian street opened in 1962 and quickly became the city's main shopping spine and promenade, indeed the city's main street. Today it is the longest car free street in Europe. Now, Copenhagen has six times as many car free and pedestrian oriented areas as in 1962. (Cervero, 1998)

By design, city traffic engineers have sought to temper car use by holding the total capacity of the central city road network constant since 1970. Besides expanding the city's cycling and pedestrian network, policies have emphasized preferential signalization and reserved lanes for buses, relocation of on-street parking to the periphery, and the expansion and diversification of transit offerings (including electric minibus circulators and new tram lines). In recent years, the city has made impressive headway in promoting intracity bicycle travel as well as enlisting bikes as means of feeder connections to transit stops.

The management of parking supplies and prices has also been effective on central city automobile travel. Over the past few decades, the city of Copenhagen has been reducing parking supplies by 2 to 3 percent per year. Moreover, parking fees fluctuate to ensure that the prices are high enough. Parking rates are highest in areas well served by mass transit.

Lastly, Denmark's tax system has also been used to restrain automobile ownership and use. Presently, taxes and fees roughly triple the cost of purchasing a private automobile.

Copenhagen has shown that the automobile travel can be reduced by innovative social planning.

4.8.4 ZURICH:

Zurich boasts one of the highest rates of transit usage anywhere today, about 560 transit trips per resident per year. This is almost twice as many transit trips per capita as in Europe's largest cities- London, Paris, and Berlin. Zurich is one of Europe's wealthiest cities and unlike these places, has no downtown metro circulator. (Cervero, 1998)

Zurich has pioneered one of the most efficient surface transportation systems in Europe by expropriating a significant share of road space for trams, buses and bicycles. The city responded to worsening traffic congestion not by expanding capacity but rather by redistributing road space to public transit. (Cervero, 1998)

Success lies in the fact that in Zurich the tram and the bus provide a service network which is dense in both space and time. Various fare incentives have further strengthened public transit's position.

Trams account for two thirds of transit services, where trolley and diesel buses make up the city's remaining transit services, filling in gaps as necessary. A watershed in Zurich's transit history was a 1973 referendum that established a 'transit first' program aimed at dramatically enhancing the quality of traditional transit bus services, most notably speeding up the movements of trams and buses. Instead of building an urban metro and freeing up surface streets for cars, Zurichers passed a measure that would give priority to trams and buses on existing streets. The Zurichers feared that an urban metro would destroy Zurich's unique urban fabric by expanding the city's scale. On the other hand, trams, which have been around for more than a century, helped to create pedestrian-friendly city that Zurichers have long cherished. (Cervero, 1998)

In the 1980s an S-Bahn system was developed and coordinated with other transit modes, improving the city's transit offerings. From 1989 to 1992, the daily motorised trips to the city center increased by 50000, rising above 1.35 million. However, the number of car trips remained unchanged, thus the entire growth in traffic was absorbed by trams, trains and buses. The idea is to reward efficiency.

Zurich's planners estimate a single tram line handles the same as ten lanes of car traffic, in addition, trams and buses do not require inner-city parking. (Cervero, 1998)

An equally important part of Zurich's program to speed up trams and buses has been the implementation of a highly sophisticated traffic signalization system. Traffic signals are adjusted to allow transit vehicles to pass through intersections unobstructed. By building separate bus lanes and more dedicated tracks transformed trams into more of a modern light rail type of service.

Besides the transit incentives, there are automobile disincentives. Limits on parking constrained automobile traffic in the city. Parking is fairly scarce and expensive in the city center. Driving in Zurich often means stopping at most intersections, waiting behind buses, stopping for trams, and paying high amounts to park in commercial district (Cervero, 1998).

Ridership gains can be attributed to improved service and fare coordination, deeply discounted fare offerings, and a continuation of auto restraint measures. Today, Zurichers enjoy extensive, frequent, comfortable, and relatively cheap transit services that are envied the world over.

4.8.5 OXFORD

The central aims of the Oxford Transport Strategy (OTS) are to achieve a reduction general traffic and air pollution in the central area and shift from use of the private car to more trips being made by bus, cycle and on foot. This should result in a more attractive environment with the benefits of reduced air pollution, and enable Oxford to meet the challenge of coping with planned growth in population and employment. (OTS, 2000)

The OTS was adopted by the City and County Councils in 1993. It was recognized that Oxford would continue to face growth pressures and that the increased demand for travel could not be met by car based travel alone, without increasing congestion and environmental degradation. An extensive program of measures was developed to be implemented over a 6-year period including

- Expansion of the park and ride car parks and introduction of extensive bus priority measures,
- Capacity enhancements on the ring road, to accommodate displaced traffic
- Development of the cycle network,

With these measures in place, in June 1999, the key central area access restrictions were implemented, featuring

- Closure of Cornmarket Street (major shopping street) to all traffic,
- Daytime closure of the High Street to all vehicles except buses, taxis and cyclists,
- Creation of a bus priority route around the central area, with general traffic pushed further out,
- Broad Street closure to through traffic.

On the contrary to what is expected, trips to central Oxford did not decline, rather, there has been an increase in the number of people coming into central Oxford. The fall in use of the city centre car parks is greatly outweighed by the increase in the use of local bus and park and ride services. The surveys of pedestrian activity confirm this with central area flows up by 6,000 people compared to 1998.

A cordon of 6 traffic counters measures the volume of traffic coming into the central area. Traffic flows are down by an average of 20% over the 12 months June 1999 to June 2000. This has been achieved primarily by eliminating non-stopping trips previously made across the city centre.

Total numbers of cars parking at the three main city centre car parks has shown that total usage is on average 14% (700 cars) lower for January to May 2000, compared to the previous three years.

Use of the park and ride car parks shows substantial increases at 3 of the 4 sites, between 12-15%. The fourth site on the southern approach to Oxford (Redbridge) has experienced a decrease of 10%, which appears to be largely due to the rapid increase in use of bus services on routes from the south of the County. The average of all sites is an increase of 5% for the first six months of 2000 compared to 1999. As the bus operator for park and ride services has reported a 7% increase in use, for the same period, this implies an increase in car occupancy of park and ride users.

Passenger levels since June 1999 have been maintained at 8%-9% higher than the previous year. This equates to approximately 2000 extra trips per day.

The annual surveys across the inner cordon show that the daytime split by mode has moved further away from the private car. As can be seen on Table 4.3, the share of car traffic has been reduced by 15% while the proportion of trips by bus has increased from 27% to 44%.

Central area pedestrian surveys for Autumn 1999 and 2000 record an overall increase on the main shopping streets in Oxford, reversing a trend of decline in previous years.

If this strategy is examined in terms of retail activity; the vacancy rate, for retail units remains remarkably low at under 1%. The new Debenhams and Boots stores along with proposals for doubling the size of the stores show the confidence major trailers have in Oxford.

Table 4.3 Modal Split in Oxford, Source: OTS, (2000)

	Share in Total Traffic (%)	
Mode	**1991**	**2000**
Cars and taxis	54	39
Motorcycle	2	1
Light goods vehicle	4	4
Heavy goods vehicle	2	1
Public transport vehicle	27	44
Cycle	11	11

Oxford City have proposals for further schemes to reduce car travel which include a fifth park and ride site near Oxford, bus priorities on main routes into Oxford, a high speed guided bus network through major investment in comprehensive quality partnership with operators. (OTS, 2000)

4.8.6 STOCKHOLM

Stockholm is one of the best examples of coordinated urban development and rail transit planning. The region is in a star shaped, multi-centered built form and the suburbs are radially linked to the central city. The backbone of the star shaped urban form is the metro. Transit offerings go well beyond mainline rail services; bus, tramway, and metro services have been planned to create a fully integrated public transit system. (Cervero, 1998)

Stockholm's suburbs were consciously planned to promote rail commuting into central city and be self-contained. It is argued that the second objective could not be achieved. Stockholm's suburbs send off large shares of their residents to jobs elsewhere, however commuting to and from new towns is generally done by transit.

Stockholm's transit achievements are impressive, since it is a wealthy region, and car ownership is high. However, many Stockholmers prefer transit for the daily routine of commuting. Cars are used for going out in the evening, taking excursions and hauling groceries. (Cervero, 1998)

The physical integration of suburban development and rail transit is not the only factor behind the transit's popularity in Stockholm. Various supportive policies have been effective as well. While transit fares are kept low, parking and taxi fares are expensive. Curbside parking is generally prohibited. Sweden also has one of the highest value-added taxes on motor vehicles and vehicle registration fees.

4.8.7 LONDON

Since 17 February 2003 the city of London has charged a fee for driving private automobiles in its central area during weekdays as a way to reduce traffic congestion and raise revenues to fund transport improvements. This has significantly reduced traffic congestion, improved bus service, and generates substantial revenues. Public acceptance has grown and there is now support to expand the program to other parts of London and other cities in the U.K. This is the first congestion pricing program in a major European city, and its success suggests that congestion pricing may become more politically feasible elsewhere. (Litman, 2004)

Central London is a particularly suitable for congestion pricing because of its limited road capacity (the streets network in the core area is hardly expanded since the medieval ages) and heavy travel demand result in severe congestion, plus relatively good travel alternatives, including walking, bus and subway services, which are used by most travelers. For decades transport planners have recommended congestion pricing in central London.

How the Program Works

Since February 2003 motorists driving in central London on weekdays between 7:00 am and 6:30 pm are required to pay £5. There are some exemptions, including motorcycles, licensed taxis, vehicles used by disabled people, buses and emergency vehicles. Area residents receive a 90% discount for their vehicles. The charging area is indicated by roadside signs and symbols painted on the roadway. (Litman, 2004)

Payments can be made at selected retail outlets, payment machines located in the area, by Internet and cellular telephone messaging, any time during that day. Motorists can purchase weekly (£25), monthly (£110) and annual (£1,250) passes. A network of video cameras records the license plate numbers of vehicles and matches it with the paid list. The owners of vehicles that have not paid as required are sent a £80 fine. This fine is reduced to £40 if paid within two weeks, and increases to £120 if not paid after a month. (Litman, 2004)

Travel Impacts

Just over a million people enter central London during a typical weekday morning peak (7-10am). Over 85% of these trips are by public transport. Prior to the congestion pricing program about 12% of peak-period trips were by private automobile. During the programs first few months automobile traffic declined about 20% (a reduction of about 20,000 vehicles per day), resulting in a 10% automobile mode share. The majority of drivers changing their travel patterns due to the charge have transferred to public transport with many choosing to travel by bus. Some, who had previously used central London as a cut through, have diverted from the zone. The remainders have switched to using their cars at different times, to different destinations, or to walking. This has significantly increased traffic speeds within the zone. Peak period congestion delays declined about 30%, and bus congestion delays declined 50%. Vehicles can cover more miles per hour, so bus service productivity (riders per day) and efficiency (cost per passenger-mile) have increased substantially. (Litman, 2004)

The program's net revenues will be used to improve public transit services, including more buses and major renovations to the subway system, which is widely agreed to be in need of significant redevelopment. Bus service is being improved in many ways, including an expanded bus lane system.

Public and Political Response

Before implementation the congestion pricing program was widely criticized however now this plan has been generally accepted by the public and interest groups. Within a month of its start residents of other areas in London began requesting to be included. *London First*, a business group whose members account for 22% of the city's GDP, supports the city's congestion charge. Many industries support the charge because its direct costs are offset by savings and benefits, such as faster delivery times. Cert Logistics, a distribution company that delivers to many downtown restaurants and hotels, reports its delivery times have been cut by as much as 50%, and other industries find that their employees spend less time delayed in traffic. (Jowit, 2004)

Traffic Spillover Impacts

There was concern that congestion may increase on nearby roads due to diverted traffic. Although some diversion occurred the effect appears to be too small to measure, and may be addressed in the future by expanding the priced area and charging more variable fees (higher rates in the center and lower rates in outer zones). Although there is 10% more traffic on the peripheral roads, journey times on them have not increased, in part because traffic signal systems on these roads were adjusted in anticipation of these traffic shifts.

Pricing Efficiency

The system is considered reasonably effective yet not optimal because

- ?The fee is not based on how many miles a vehicle is driven within the charging area.
- ?The fee is not time-variable, that is, the fee is not higher during the most congested periods and lower during less congested periods.

The flat-rate system was chosen because it was relatively fast and easy to implement, and simple to understand. A more sophisticated system that allows variable fees is likely to be implemented in the future.

Implications for Other Cities

London's congestion pricing project is considered an important test of the political feasibility of congestion pricing in major democratic cities. London's experience shows that congestion pricing is technically feasible and effective, and that it is possible to overcome the political and institutional resistance to such pricing. As a result, it will help put congestion pricing on the menu of transportation improvement options in other cities.

4.8.8 MUNICH

Munich has pursued a balanced approach to linking transit and urban development. The city is mostly transit oriented in its layout and design, while at the same time its periphery is well served by buses and park and ride provisions as a concession to the spread-out nature of development.

Overall the region is blessed with a successful network of rail and bus services that nicely fit the pattern of settlement. The urban subway, U-Bahn, serves the built-up area, while the suburban railway, S-Bahn, takes people beyond the city. Trams and buses function mainly as feeders.

The chief device being used to discourage car travel is parking restraints. Supplies of on-street parking have been greatly reduced in the central area. Between 1990 and 1995 rates for parking doubled and meters were changed to allow no more than an hour of payment, to deter long term parking. Another contributor to rising transit usage in Munich has been expanding the park and ride facilities. Currently, there are more than 25,000 free park and ride spaces near rail stations, with plans to add another 18,000 spaces in coming years. Park and ride is a clear example of adopting transit provisions to the spread out lay of the land. (Cervero, 1998)

Much of the core has been pedestrianized, with some streets banning all traffic, others allowing only trams, buses and only a certain group of motorists, such as residents and delivery vehicles. Trams are an integral part of Munich, existing with pedestrians in most car-free corridors. Because of their Old World charm, trams blend nicely with Munich's pedestrian districts and the traditional retail core. (Cervero, 1998)

Munich's transit achievements are truly remarkable for a land known for its cars and express-ways with no speed limits.

4.8.9 MIDDLE EAST TECHNICAL UNIVERSITY, ANKARA

It is extensively accepted that trends in car use on college campuses are similar to those experienced by the society. Many of the college campuses worldwide have adopted strategies to provide mobility and access without destroying campus qualities. Many of these solutions are based on the TDM strategies, including prices for parking, expanded transit access, park and ride lots complemented by bus shuttles, rideshare programs, bicycle and pedestrian facilities and traffic calming schemes. (Balsas, 2003)

In Ankara, Middle East Technical University (METU) has implemented some of these measures, to discourage car use and to provide traffic calming.

On university campuses parking is a common problem. METU has not regarded this problem as of insufficient supply but used this as a stick on car use. METU is providing very little additional parking while strongly enforcing the existing spaces. The ‘sticker’’ system is used in METU for the parking places. The students who want to drive and park in METU has to purchase a sticker, each year, to stick on the wind shield of the car. The color of the sticker determines the area to be parked. As the price of the sticker increases the region to be parked gets closer to the desired department. However, each department has a certain quota for available parking stickers, so even if many students want to purchase stickers to park next to the department it is restricted by the quota. The prices of the stickers are considerably high in value. These all discourage car use and encourage car-sharing and sticker-sharing (sharing the cost of a single sticker and using it together).

For the traffic calming in METU, main road around the central region has been changed into a one-way street. There happened a period of some objection just after this implementation, since this resulted in a longer path for most of the drivers, however as time passed, with the better-quality of traffic flow achieved, this implementation has gained acceptance.

The other traffic calming measures in METU are the road humps and the speed limits. Many of the road humps and the low speed limits have been criticized at their first implementation, but just like the case above, as the people understand that these are implemented for achieving better and safer conditions, they are supported.

The case of METU indicates important policy lessons; the role of enforcement and managing the public opinion. Many new implementations may face objections at the first times and only by careful enforcements success can be achieved. The enforcements in METU should not be regarded as restricting the freedom of the individuals; on the contrary they work for the well-being of the university community.

CHAPTER 5

ANKARA

The driving forces behind the car ownership and use, automobile dependency, the reasons and methods to reduce private car trips in urban areas have been discussed in the previous chapters.

Ankara is not yet suffering from traffic congestion as severely as many of the developed countries, but the tendency of growth in car ownership and use indicates the symptoms of the problem. Ankara, having a population of 4 million and nearly 700.000 cars is in the initial phases of this trend.

In this chapter, urban transport structure of Ankara, the ongoing policies and implementations or urban transportation are analyzed. Methods for automobile travel reduction and their applicability for Ankara are discussed. Finally remarks on the urban transportation in Ankara are stated.

5.1
THE CASE OF ANKARA
DEVELOPED CITY OR A DEVELOPING CITY?

Ankara is in a state which has been experienced by most of the developed cities and which is expected to be experienced by most of the developing cities. As reviewed in the previous chapters, the car ownership levels of Ankara are far less than those of developed countries, but there are clear indicators of a trend of increase. Table 5.1 illustrates the rising trend of car ownership in Ankara.

Table 5.1 The number of private cars in Ankara,
Source: Department of Security (2004)

YEARS	NUMBER OF PRIVATE CARS
1995	411,503
1996	440,080
1997	488,885
1998	533,564
1999 2000	578,556 643,291
2001	656,532
2002	659,061
2003*	635,853
2004**	641,535

* In 2003, The Department of Security conducted a correction in their archives so a reduction in the number of cars occurred.

** The number is by the end of April, 2004.

Mobility is rising rapidly in most of the developing world and a greater percentage of this rise in mobility is provided by private modes. In much of the developing world the number of automobiles is increasing at more than 10% a year. This is happening because of increased populations, increased wealth, uncontrolled urban sprawl, and probably an increasingly persuasive picture in the developing world of international lifestyle in which a car is an essential element. (Gakenheimer, 1999)

Conditions of local demand that far exceed the capacity of facilities, lack of adequate public transport systems, agreement problems among responsible officials on appropriate forms of approach to the problem and policy conflicts makes car use the main mode of transportation. Besides, automobile owners are a powerful lobby in most of the developing world. From this point of view Ankara resembles developing cities.

However, Ken Gwilliam, formerly the economic advisor of the transport sector of the World Bank, counts Turkey as a developed country. In his research, the developed countries are taken to be the OECD countries, excluding Mexico.

In developing cities road congestion is observed at much lower levels of car ownership than in the developed cities. Gwilliam (2003) argues that most developing countries have less than 100 cars per 1000 people. The car ownership levels in Turkey are relatively low, but for the cities Istanbul, Ankara, the ownership levels are higher. In some districts of Ankara, the car ownership levels reach nearly to those of the developed cities. Besides, Gwilliam reports that non-motorized transport, walking and cycling accounts for between 25-50% of all trips and motorcycles account for about half the vehicle fleet in the developing cities, which is not the case in Ankara.

In Table 5.2 the car ownership levels (cars/1000 inhabitants) in Central Ankara, Ankara and Turkey are tabulated. The 2004 population values are projected by using the 1990 and 2000 values, assuming an annual linear pattern of increase. Table 5.2 shows while the car ownership level in Turkey is very low (65 cars/ 1000 inhabitants), the level in central Ankara has reached 182 cars/ 1000 inhabitants.

As a result, the urban transportation indicators of Ankara are not quite similar to those of both the developed and developing countries.

Table 5.2 Car Ownership Levels in Ankara and Turkey

Source: DIE (2004), Department of Security (2004)

	Central Ankara (*)	Ankara Total	Turkey
population in 1990	2,583,963	3,236,378	56,473,035
population in 2000	3,203,362	4,007,860	67,803,927
annual increase in population	2.17%	2.16%	1.18%
projected 2004 population	3,490,869	4,365,692	72,948,052
number of cars (including official and commercial cars) (2004)	636,161	662,434	4,713,920
cars per 1000 inhabitants	182	152	65

* The central districts are taken as Altindag, Çankaya, Etimesgut, Keçiören, Mamak, Sincan and Yenimahalle. (Department of Security and DIE, 2004)

5.2 HISTORY OF PLANNING IN ANKARA

5.2.1 URBAN PLANNING IN ANKARA

Ankara was a small and compact city in where the primary mode of travel was walking. The first five-year period that followed the proclamation of the Republic, 1923, and its declaration as the capital, was a period of exploration. The establishment of Ankara Municipality in 1924, constituted the first administrative step. In 1925, development plans for the Ulus area were commissioned. The completion of the Sihhiye District and the construction of the major road connecting Ulus with Sihhiye formed the future core.

The municipality of Ankara organized an international planning competition to obtain a comprehensive development plan in 1928. The first prize was obtained by H. Jansen and 'The Jansen Plan' was put into effect in 1932. Jansen Plan proposed low density neighborhoods. From 1932, up to the early 1950’s the Jansen Plan had a pronounced impact on the development of the city. Districts of Yenisehir and Cebeci, the complex of ministries, parliament, a number of faculties and urban infrastructure were realized as proposed in the plan. However, the implementations were not sustained by a coherent policy and developments outside the limits of the city began to occur. In 1935, a large-scale housing project, Bahçelievler, was started outside the boundaries of the development plan.

Unplanned development continued and the phenomenon of squatting reached considerable dimensions. The rapid urbanization characteristics of the post-war period and rising land prices paved the way for higher building densities. As a result, a new international planning competition was organized in 1955. The plan prepared by Nihat Yücel and Rasit Uybadin was the winner. It designed a city of higher densities than those assigned in the Jansen Plan. This plan was criticized for failing to give consideration to squatting and to the development of the new center at Kizilay.

In 1969, a metropolitan planning authority was established, The Ankara Metropolitan Area Master Plan Bureu (AMAMPB). The AMAMPB carried out comprehensive urban studies in the period 1970-1975 and planned a master plan scheme for 1990. This plan, approved in 1982, constituted a major framework. Unlike the previous plans, AMAMPB made consistent estimations, the problems were truly diagnosed, realistic proposals were brought and the planning could direct the development of the city. This plan pronounced the utilization of the west side of the city, Batikent, Sincan, Eryaman and Çayyolu. But no city infrastructure project was planned in sufficient magnitude to affect the macro-form of the city.

Following the establishment of the Greater Ankara Municipality in 1983, and according to the modified planning law, municipalities were recognized as ultimate authorities in the field of planning.

In 1986, a group of academicians from Middle East Technical University (METU), City and Regional Planning Department were arranged to prepare 2015 Ankara Structural Plan, which proposes a decentralized urban macro-form.

In mid-80's, city of Ankara had two important plans; The Structure Plan for 2015, prepared in 1986, and the Urban Transportation Plan, prepared in 1987. The structure plan is important in its urban development decisions since they are proposed to shape the urban transportation investments of the city. The Transportation Master Plan and the proposed macro-form will be discussed in detail in the following sections.

5.2.2 URBAN TRANSPORTATION PLANNING IN ANKARA

Ankara has experienced a transformation from a densely settled town to a metropolitan city. It was a city of pedestrians at the 1920s, whereas today most of the trips are done by motorized modes. This rapid increase in the demand for motorized transportation was met by vehicles supplied by the public sector having limited sources and by individual operators. As a result of this organization, the supply of transport services has simply responded to demand rather than to determine the urban form.

In 1970's the transportation problems began to affect the daily life in Ankara. As new buses couldn't be bought and the private entrepreneurs weren't interested in public transportation investment, urban transportation turned out to be a serious problem. There was an insufficient offer for public urban transportation during 1970's. Meanwhile the native automotive industry began to produce cars and there occurred a sudden increase in the number of private cars in urban traffic.

Thus the transportation planning studies to solve the urban transportation problems took place for the first time during these years. Ankara started addressing transportation problems and prepared plans based on rail backbone and bus feeders.

There are four main studies carried out in Ankara about rail transit systems and urban transportation planning. Within all these transportation planning studies rail transit systems were suggested as alternative transportation modes

5.2.2.1 Ankara Transportation Study, 1972 (Municipality of Ankara – SOFRETU)

In 1969 to examine the subjects of modernizing the buses, reorganizing the transportation network and building up an underground rail transit system to solve the transportation problems of Ankara were decided to be carried out by the cooperation between General Directorate of EGO and SOFRETU, a French construction and consulting company.

In this study an underground metro line was proposed to be constructed in two stages. The first stage was a 7 km long line between Besevler and Dikimevi and the second was a 7 km line between Diskapi and Kavaklidere. But State Planning Organization rejected this project because the proposed technology was completely depended on French technology and the financing of the project was not clear.

5.2.2.2 Rail Transit Study between 1978 and 1980 (EGO-Yapi Merkezi)

General Directorate of EGO carried out this study without any supports of foreign counselors. Yapi Merkezi, a native company, made the counseling. This study proposed a light rail transit at three stages, total length of 25 km. In the first stage a 3,5 km line was proposed between Stad Hotel (Ulus) and Inonu Square. Second stage was between Kizilay and Batikent and the last stage was between Kizilay and Bahcelievler/Emek.

This project was refused by the government because of the following reasons:

- The proposed system was not based on a wide extended transportation study concerning the whole system and transportation master plan. It was based on a one-corridor research and did not take the integration of the system with suburban train and the bus system into consideration.
- The proposed line was not applicable according to the strategies of urban growing in Ankara Land Use Master Plan.
- The cost of the system, incomes and predictions related to future traffic levels were not realistic.

5.2.2.3 Projects and Feasibility Study of Municipality of Ankara between 1980 and 1984

This study was based on the opinions of the government. This study also used the home surveys, which were prepared, by EGO and Yapi Merkezi in 1979, but used lower levels of traffic projections. Because of this building a light rail transit system seemed more appropriate. Belgian Transurb Consulting Firm provided a short term counseling, which was financed by The United Nations Technical Aid Program. The project was of two stages Kavaklidere-Diskapi and Bahcelievler-Batikent.

This project was rejected by the Ministery of Public Works because;

- The results of 1979 study were used without being updated.
- It was not based on extended land use.
- Since the projections for year 1990 were used, it was insufficient in capacity.

5.2.2.4 Ankara Urban Transportation Study, 1985–1987 (EGO – Canadian Consortium- Kutlutas)

In 1985 Ankara Urban Transportation study was started by an agreement signed by General Directorate of EGO, Reid Crowther International Limited and Kutlutas Engineering Counseling and Construction Company. The purpose was to develop a complete urban transportation system, which would evaluate and respond to future tendency. In order to reach this aim there were two major studies. The first was the studies about land use and the second aim was to forecast the capacity and characteristics of transportation in the future.

The first Transportation Master Plan was realized in Ankara Urban Transportation Study. The Urban Transportation Plan, which was completed in 1987, was decided to be updated and a comprehensive study was started in 1992. After this additional part to the study, Ankara Transportation Master Plan was approved in 1994. The Transportation Master Plan of Ankara foresees an urban transportation system of which the skeleton is formed by rail network. Besides a series of projects, politics and precautions suggested for each transportation type constitute the basis of the plan. The Transportation Master Plan of Ankara is discussed further in section 5.4.

5.3 URBAN TRANSPORTATION DATA OF ANKARA

With the rapid growth of the population and income in Ankara, leading to increased car ownership and use, urban transportation has always been one of the leading problems to be solved. As a result of this increase an important traffic jam problem occured in the centre of the city.

As it was discussed in the previous chapters, car use levels in Ankara will continue rising unless preventing measures are applied. This is a natural result of increasing mobility. Since alternative public transport systems are not compatible with the today's standards, the rising mobility is reflected in terms of private transportation.

5.3.1 HOME INTERVIEW SURVEY RESULTS

Home interview is one of the techniques used in obtaining travel information in urban areas. The car ownership levels in the districts of Ankara, based on the 1992 Home Interview Survey which is the most recent one, could be found in table A.5.1, in the appendix.

Table 5.3 Trip Generation Rates per Capita in Ankara, Source: EGO (1995)

	1985	1992	% increase
public	0,93	1,01	8,60
private	0,23	0,32	39,13
total motorized	1,16	1,33	15,52
pedestrian	0,56	0,63	12,50
total	1,72	1,96	13,95

According to 1992 Home Interview Survey findings, the average daily trip generation rate per capita in Ankara is 1.96. As it is clearly visible from Table 5.3, the average daily trip generation rate per capita in Ankara has increased by 14%

from 1985 to 1992. On the other hand the private daily trip generation rate has increased by 39%. These values give meaningful projections for the future potential increases. Mobility would definitely increase in Ankara, as the employment, income and population continue growing, and the majority in this mobility increase would be experienced by private motorization, which might in turn cause problems in central areas.

5.3.2 COMPARING THE CORDON COUNTS BETWEEN THE YEARS 1985 AND 1992

In the comparison of the counts between the years 1992, which is the most recent one, and 1985, the changes observed in this seven year period are emphasized. The counts are in the direction of periphery to the center. The locations of the cordon stations are illustrated in Map A.5.1, in appendix. Table 5.4 shows a summary of the vehicle and passenger counts. In this section a general overview of the traffic volumes entering the city center will be made.

The public and private modes are separated as follows:
Private modes: private and official automobiles and taxis
Public modes: minibuses, jitneys, public and private buses, service buses

It is observed that during this seven year period the total volume of traffic entering the central area has increased both in terms of vehicles and passengers; however the increase in the number of passengers (30.5%) is far behind the increase in the number of vehicles (64%). This is due to the fact that, the increase in the demand for mobility is mostly met by private modes, as the data suggests, the increase in private vehicles is 78.7% while the increase in public vehicles is 16.6%.

As the transportation demand increases the number of vehicles entering the city centre increases, however, the increase in the number of vehicles entering CBD is not a true indicator of the increasing transportation demand, since the increase in passenger volumes is lower than the vehicle increase. If passengers had chosen public modes, the traffic volumes entering the city center would have been lower. This shows that the car is an inefficient user of the roads. These comparisons are done on the basis of road transport, if there exist rail systems, the number of passengers carried would be clearly much higher, not even causing traffic congestion in the city center.

Table 5.4 Cordon Counts in 1985 and 1992, Source: EGO (1995)

VEHICLES	number of vehicles		% change in the number of vehicles	% share in total number of vehicles	
	1985	1992		1985	1992
TOTAL	150,774	247,234	64.0%	100.0	100.0
PUBLIC	35,684	416,20	16.6%	23.7	16.8
PRIVATE	115,090	205,614	78.7%	76.3	83.2
PASSENGERS	number of passengers		% change in the number of passengers	% share in total number of passengers	
	1985	1992		1985	1992
TOTAL	822,158	1,073,129	30.5%	100.0	100.0
PUBLIC	643,786	785,004	21.9%	78.3	73.2
PRIVATE	178,372	288,125	61.5%	21.7	26.8

This study implies important projections for the future. The changing shares of modes in both vehicle and passenger flows indicate that the percentage of private modes is in a rising trend in Ankara.

5.3.3 MODAL SPLIT IN ANKARA

The main public modes offered in urban transportation in Ankara are minibuses, buses and rail transit. Besides these, the number of school buses and buses operated by business/government offices to convey their employees to/from work has a considerable percentage. The table shows that approximately 75% of the motorized trips in Ankara are done by public transportation vehicles.

The rate of rail transit in Ankara is low when compared to the rates in the big cities of developed countries. The table shows that the total rate of rail transit through public transportation is lower than 15 %.

Table 5.5 Modal Split in Ankara, Source: EGO (2003)

MODES	NUMBER OF VEHICLES	NUMBER OF PASSENGERS CARRIED	%OF PASSENGERS (TOTAL)	% OF PASSENGERS (PUBLIC TRANSPORT)
EGO BUSES	1190	800000	19.3	25.6
ANKARAY	11 series (3 vehicles per series)	160000	3.9	5.1
METRO	18 series (6 vehicles per series)	185000	4.5	5.9
SUBURBAN RAIL	-	110000	2.7	3.5
DOLMUS	2230	780000	18.8	24.9
PRIVATE PARATRANSIT	6500	600000	14.5	19.2
PRIVATE PUBLIC BUSES: BLUE	200	200000	4.8	6.4
GREEN TWO FLAT	372 95	200000 95000	4.8 2.3	6.4 3.0
TAXI AUTOMOBILES (PRIVATE + OFFICIAL)	7660 600000	260000 750000	6.3 18.1	- -
TOTAL PUBLIC TRANSPORT		3130000	75.6	100.0
TOTAL PRIVATE TRANSPORT		1010000	24.4	
TOTAL		4140000	100.0	

5.3.4 DATA FROM THE JUNCTIONS

In Table 5.6, the percentages of cars present in some of the junctions in central Ankara are tabulated. The source data are the counts performed by Greater Ankara Municipality in 1998 during the morning peak 7:30- 8:30. The locations of these intersections are illustrated in Map A.5.2 in appendix.

Table 5.6 clearly shows that approximately 80% of the traffic volumes are generated by private cars in Ankara. The service levels in most of these intersections are very low. (X indicates that the LOS is meaningless since the volume / capacity ratio is greater than 1.2)

In the previous section, Table 5.5 shows that the 75% of the passengers in Ankara are traveling by public modes; approximately 65% using road public modes and 10% using rail transit. So the private cars occupying 80% of the traffic carries only 25% of the passengers, while the road public modes carry the 65%.

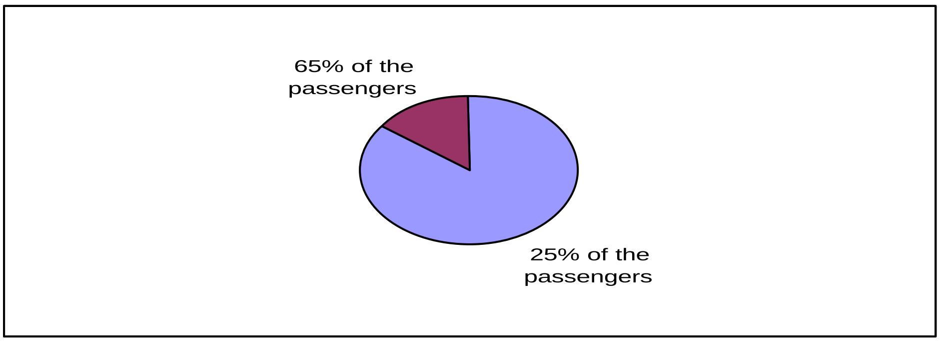


Figure 5.1 Roadspace occupied by passengers using public and private modes at the intersections in central Ankara

Table 5.6 LOS and Percentage of Cars at the Intersections in Central Ankara

Intersection name	Intersection number	LOS	Number of cars	Number of total vehicles	% of cars
DIL TARIH COGRAFYA FAC.	1101	X	5494	6659	82.5%
MITHATPASA – SIHHIYE	1102	Na	1918	2442	78.5%
KIZILAY	1104	X	6340	7133	88.9%
MESRUTIYET-ATATÜRK BL.	1105	Na	3839	4356	88.1%
VEKALETLER	1106	Na	5295	6122	86.5%
AKAY	1107	X	7265	8188	88.7%
TRT	1108	X	6270	6820	91.9%
KUGULU	1110	X	11154	12099	92.2%
STRAZBURG – ADLIYE	1112	C	945	1193	79.2%
HIFSISSIHHA	1119	X	5114	6511	78.5%
NECATIBEY – IZMIR	1124	B	2446	2911	84.0%
KUMRULAR	1125	A	516	578	89.3%
POLIS AKADEMISI	1126	X	2632	3107	84.7%
MILLI MÜDAFAA-YAHYA GALIP	1127	X	1031	2282	45.2%
GENELKURMAY	1128	X	4791	6424	74.6%
TAPU KADASTRO	1129	X	3814	4988	76.5%
ÖMÜR SOKAK	1130	X	4181	5607	74.6%
YÜCETEPE	1139	X	1040	1313	79.2%
DSI – TCK	1140 A	X	5568	6855	81.2%
DMO – KKK	1140 B	X	5655	7018	80.6%
LIBYA – TUNALI	1166	B	2517	3037	82.9%
BÜLBÜL DERESI - OLGUNLAR	1167	C	1494	1981	75.4%
BÜLBÜL DERESI - BAGLAYAN	1169	B	1207	1610	75.0%
ESAT DÖRT YOL	1171	X	3703	4196	88.3%
RESIT GALIP – ESAT	1172 A	X	2841	3423	83.0%
TAHRAN - NENE HATUN	1172 B	X	1684	1948	86.4%
KOCATEPE	1183	X	2385	2698	88.4%
MESRUTIYET – MITHAT PASA	1184 A	C	2808	3340	84.1%
MITHAT PASA - KIZILIRMAK	1184 B	X	1445	1627	88.8%
STRAZBURG	1191	X	4378	6171	70.9%
GÜVENLIK CADDESI	1201	B	1550	1742	89.0%
TUNALI - HACI YOLU	1203	B	1362	1544	88.2%
TUNALI – OLGUNLAR	1204	B	2045	2385	85.7%
KENNEDY – TUNUS	1209	D	1964	2230	88.1%
OSMANLI	2101	X	5335	6975	76.5%
ULUS	2102	Na	4078	5351	76.2%
KOLEJ	2120	Na	5318	6412	82.9%
STAD OTELI	3145	F	1668	2514	66.3%
TANDOGAN	3166	X	5321	6760	78.7%
GENÇLIK – AKDENIZ	3168	E	2485	3006	82.7%
AKDENIZ - FEVZI ÇAKMAK	3171	X	4615	5671	81.4%
BESEVLER	3179	X	5314	6405	83.0%
Average					81.6%

5.4 THE TRANSPORTATION MASTER PLAN OF ANKARA:

Ankara Transportation Master Plan was prepared to solve the transportation problems of the city through a comprehensive point of view, to estimate the future demands and give a direction to precautions and investments to respond these demands and last to adapt the land use plans and transportation plans. (EGO, 1987)

In order to find meaningful, comprehensive and applicable solutions for urban transportation and give a direction to expected future transportation structure, long range principles and goals should be defined. The main function of Transportation Master Plan was to define these major principles and general goals and to produce a policy about transportation modes which would fulfill the principles and goals.

The investments and actions proposed within the framework of the Ankara Transportation Master Plan are intended to serve these basic objectives:

1. *Integration of Land-use and Transportation:*

   The two-way relationship between transportation and land-use is normally taken into consideration within the scope of comprehensive urban development projects. Mass transit is identified as one of the principal means to achieve the desired pattern of growth outside the densely settled and polluted bowl of the existing city.

2. *Increasing Level of service for Users*

   The level of service for a user is made up of the following components:

   - Speed, travel time
   - Reliability
   - Cost
   - Comfort
   - Security
   - Availability

   Transportation projects should be formulated so as to optimize the above-mentioned components whereby the benefits accruing to the community would be maximized, and the requirements of the operating agencies would be met.

3. Priority to People Not Vehicles

The intraurban transportation investments undertaken to enable vehicles to be operated smoothly have not been successful in coping with the problems caused by the ever-increasing traffic volumes, and they require enormous amounts of costs involved in their realization. Yielding only temporary solutions, such facilities as bridges, grade-separated junctions, multi-storey garages and peripheral highways have induced additional trip making, thus further aggravating the already severe congestion problem. Had the priority been given to passenger transportation rather than the movement of vehicles, the existing infrastructure would have been devoted mostly to the transit systems operations together with the large scale investments into new transit facilities.

75% percent of total daily person movements in Ankara is accounted for by transit or paratransit modes. Therefore, the vast majority of investment funds in the transportation sector should be allotted to transit systems. Furthermore, priority should be assigned to transit in the utilization of the existing highway infrastructure.

4. Economic Efficiency

An economic and inexpensive transportation service should be provided. As a general strategy, those transportation measures that involve the utilization of the existing infrastructure should rapidly be put into implementation without ignoring the long-term objectives.

5. Decreasing External Dependency and Energy Savings

It is imperative to give serious consideration to measures leading to reduction in the consumption of resources. A significant amount of energy savings can be achieved in the field of transportation. The use of non-pollutant transportation modes should be encouraged.

6. *Social Equity*

It should be one of the leading objectives of transportation projects to improve the living conditions of the most needy groups in the society.

7. *Integration of Short Term and Long Term Needs*

A great deal of optional measures are available for upgrading the transportation system of Ankara in the short run, but the long-run projects might be more effective and preferable in the face of the prevailing circumstances, hence, it is advisable to design new solutions in the light of both short and long-run requirements.

8. Environmental Impacts

Care should be taken to measure all influences that are likely to be exerted upon the historical natural environment as well as upon the population.

9. *Financial Efficiency*

The transit agencies should have the motivation to improve the efficiency of their operations and seek new methods for relieving part of the burden placed on central authorities, which are responsible for the provision of a wide range of services. Therefore, subsidy requirements should be backed by sound calculations and justifications showing the benefits that would grow from their provision. Also costs should be kept at the lowest possible level for the provision of a given type of service.

10. Public Participation and Communication with Decision Makers

Appropriate measures should be taken to ensure that a sound communication would be established between the planners, decision makers and the public particularly in the project evaluation stage whereby the viewpoints of community groups affected would directly be taken into account.

11. Togetherness of Objectives and Multidimensional Evaluation of Projects

The above mentioned objectives cannot be considered in isolation. In the evaluation of transportation projects a balance should be established between different objec tives.

One such focused imagination is the hope for a door-to-door with smooth and synchronized transfers PT service to achieve the above-stated known objectives. It will require changes in travel behavior, and hence must be done carefully, and especially progressively.

5.5 TDM AND TSM IN ANKARA:

The first priority goal of the urban transportation planning in Ankara should be giving the priority to accessibility of people not vehicles. For this reason the main strategy should be to divert the mode choice of passengers from private modes to public modes.

The increasing pressures in the form of private automobile trips over the small limited area of Ankara city center is leading to congestion problems as the road, traffic and available space conditions are not compatible with the traffic flows entering the region.

The reduction of automobile travel in central Ankara is not a subject which concerns only the measures taken at the city center, but it comprises the concept of the better transportation in the whole city especially by means of improved public transport systems, particularly rapid transit.

The Greater Ankara Municipality and Parsons Brinckerhoff International carried out a study to solve the traffic problems in the central Ankara, in 1998. In this study the boundaries of the city center of Ankara are determined as Diskapi to Kavaklidere in north-south direction and Dikimevi to Besevler in east-west direction. In addition to this, special attention is paid to the interactions between the city center and the peripheral areas.

For improving the traffic and transportation conditions in Ankara TDM and TSM strategies, as listed below, should be implemented in a comprehensive manner. The problems and the symptoms of the possible problems should be researched in a plan with all these strategies.

1. Reducing the need to travel
2. Shifting the mode choice to public modes
3. Managing the use of private car

The most common car traffic reduction measures and public transport promoting methods, as listed below, are examined on the following pages in terms of their feasibility in Ankara.

- Land use planning and decentralization
- Improving the public transportation
- Changes in work schedules
- Parking management
- Pedestrian regions
- Distributing the traffic to alternative corridors
- Congestion pricing
- Diverting the traffic to non-motorized modes
- Reallocating the road-space and forming of gates

5.6 LAND USE PATTERNS AND THE PROPOSED MACROFORM

As discussed in the previous chapters, the urban form is a strong determinant of the travel patterns. In the reviewed examples of success, land use and transit relationship was emphasized.

In 1986 academicians from METU City and Regional Planning Department developed an urban macro-form for 2015. They proposed that the solution lies in decentralizing the urban macro-form. However, decentralization should be realized in such a manner as to ensure the accessibility. The Municipality and/or the public should put the land surrounding the existing urban pattern to appropriate land uses, if the existing decentralization is to be kept under control.

Suburbanization is inevitable; the tendencies that encourage decentralization, analyzed by the METU City and Regional Planning Department Study Group are reviewed below:

- Location Process of Housing Construction: The high density in the city center gives rise to mass housing by cooperatives in the urban fringes.
- Industrial Location: It is obvious that all types of industries tend to locate outside the city, especially outside the CBD.

- Public Establishments: If the present trend continues, only the Parliament and Ministries with high level of public relations would be located in the city centers in future. Health, educational and research construction, universities as well as military and other public establishments have tendency to relocate to urban fringes.
- Private Car Ownership: The suburbanization of high-income groups accelerated the decentralization in Ankara.
- Infrastructure: Through decentralization provision of each areal infrastructure with lower operating costs will be possible. The planned decentralization encourages non-motorized trips, such as walking and cycling. Shorter distances for public transport systems within the areas, such as ring services at the terminals of mass transit, means lower operating and maintenance costs.
- Ownership and Land Prices: High urban land prices have forced people to live in urban fringes.

The decentralization policy proposed by the METU City and Regional Planning Department Study Group is based on the following principles:

1. It is necessary to encourage the new settlements outside the existing topographic bowl.
2. Decentralization should be realized either through strengthening the existing settlement areas or by creating new residential concentrations.
3. Decentralized settlements should accommodate both business districts and housing groups.
4. Distribution of employment can be considered as a tool for decentralization.
5. Decentralization in the form of a star shape along the main axis is proposed. The proposed decentralization should not be misinterpreted as the uncontrolled urban sprawl caused by the increasing car use. The decentralized new settlements should depend predominantly upon public transport systems, and they should be placed on the main routes.
6. The proposed form should be flexible to give opportunities to the implementation of different alternatives in the future.

The generator of the proposed metropolitan form is the transportation system. Implementation of the decentralization policy requires a well connected transport system. In other words, substantial improvements are needed in particularly rail systems to realize the proposed metropolitan form.

In the decentralization plan, the decentralization of both population and employment were deemed desirable in order to cope with the congestion problem of the city and to stop the increased loading of an already insufficient infrastructure of the city. Due to the proximity of population to employment centers most of the trips are expected to be absorbed within these new settlements resulting in a decrease of long trips to the city center. The amount of estimated CBD trips is much lower for the decentralized scenario.

The star shaped decentralization reminds the city shape of Stockholm, discussed in section 4.8.6. The planned satellite communities orbiting central Stockholm are radially linked to the core by rail systems, which is the case proposed by the METU Study Group.

There has not been a dominant vision of how the region should grow in the future and many problems in Ankara are due to the rapid increase in density in the existing built up areas. Consequently, a balance between concentrating development and planned decentralization along transit corridors and adapting transit to serve the existing regions is necessary.

With this decentralization scenario, the urban form of Ankara resembles the 'hybrid' form described by Cervero (1998). As discussed in section 3.1.2.1 hybrids tend towards polycentrism. Their development patterns are partly transit oriented and their transit services are partly adapted to the land use.

For rapid transit to function properly the city should have multiple centers, the development has to be highly dense and preferably clustered. The single center option is inefficient.

The mixed land use policies would result in travel reduction. However if connections, in terms of public transport, between these settlements does not exist, then people would have to come to the city center for transfer purposes, which would in turn make their journey longer and may favor use of cars. If peripheral road serves between these settlements, then the motorists would not enter the central areas for transit passes.

5.7 WHY PUBLIC TRANSPORT SHOULD BE PROMOTED IN ANKARA

Ankara is a city with the need for public transport development. Ankara is experiencing increased traffic congestion particularly in city center and through some corridors reaching the city center.

The known transportation objectives for any urban area can rely only on attractive, well distributed, and comfortable public transport.

Ceder (2004) indicates that the mission of public transport has changed. He argues that whereas until the 70's its main function was to satisfy the individual needs of the less affluent members of society, progressively the policy discourse has been changing, pointing instead to the necessary contribution of public transport for congestion relief and environmental preservation. This represents a fundamental change of emphasis, in the sense that public transport now would be a role geared more to the satisfaction of *collective well-being* than to the direct *individual needs* of those who use it. This case holds true for Ankara. A great majority of public transport users in Ankara are captive users, but a shift of the private motorists to public modes is required in order to achieve a sustainable urban transport system in Ankara.

Providing the minimum level-of-service of public transport certainly helps retain some of its current passengers, but rigid supply patterns and poor quality have also led to the loss of many more over the years.

The public transport plan should be implemented *gradually*, with necessary *complementary* measures, and with the *innovative and challenging* ideas It is as simple as using the carrot and stick technique. Investment in advanced public transport (carrot) should be accompanied with increased parking pricing and restriction on car movements (stick).

In Ankara, with orientation to use private cars, the image of public transport is somewhere down the list. The public transport in Ankara should operate door-to-door services with smooth and synchronized transfers in comfortable interchanges. Each initiative and extension in rail systems should be supported by feeder and distributor bus routes.

Based on the overview expressed in this work, it is recommended for Ankara to gradually build a combination of road and rail public transport systems together with restrictions on car travel.

5.7.1 RAIL SYSTEMS

For the distant residential areas of the city, rapid and high capacity public transport services are essential. As the distance gets longer, it becomes impossible for the busses and minibuses to provide a satisfactory service level since the frequency of these vehicles decrease. This situation leads to increases in the level of car use, as the decreasing level of service of public modes shifts the people to car use.

The transportation master plan of Ankara proposes a balanced and integrated transportation system. The backbone of this structure, the rail system would be supported by bus priority measures and pedestrian zones and integrated with other public transport modes and private transportation. Rail transit systems which are safer, more comfortable and a better alternative to private modes were planned to take place of the rubber tired public transport systems.

There is an increasing demand for fast, comfortable and safe transportation within the city, and this is planned to be achieved by the rail network, which will consist of two different systems.

- Metro System
- Light rail system

The rail rapid system network of Ankara is scheduled to be completed by the year 2015 in a stepwise manner, by the Urban Transportation Master Plan of Ankara, revised in year 1995. The light rail and metro were planned to be integrated systems and they would have many common stations where free transfers would be possible. The existing and planned lines can be found in Map 5.1.

The current situation is summarized as follows:

- Ankaray started its operation between Dikimevi and Asti in 30.08.1996.
- The first line of metro between Batikent and Kizilay started its operation on 28.12.1997.
- The metro connecting Çayyolu to Kizilay is still under construction.
- The extension of ANKARAY, from ASTI to Sögütözü is under construction. Sögütözü will be the common station of the Çayyolu link of the Metro and ANKARAY.
- The construction of the metro line extending from Batikent-Sincan-Törekent has recently started.
- The construction of the metro line extending to Keçiören has recently started.

Implicit in proposing the network plan is the flexibility of the rail corridors to be integrated into other network possibilities. For instance, the construction of a heavy rail transit line does not preclude the possibility of choosing a LRT line in a linking corridor provided that future developments and studies justify such a choice. However in order to keep such options open, measures should be taken to control urban development in and around the likely sites for alignment and stations.

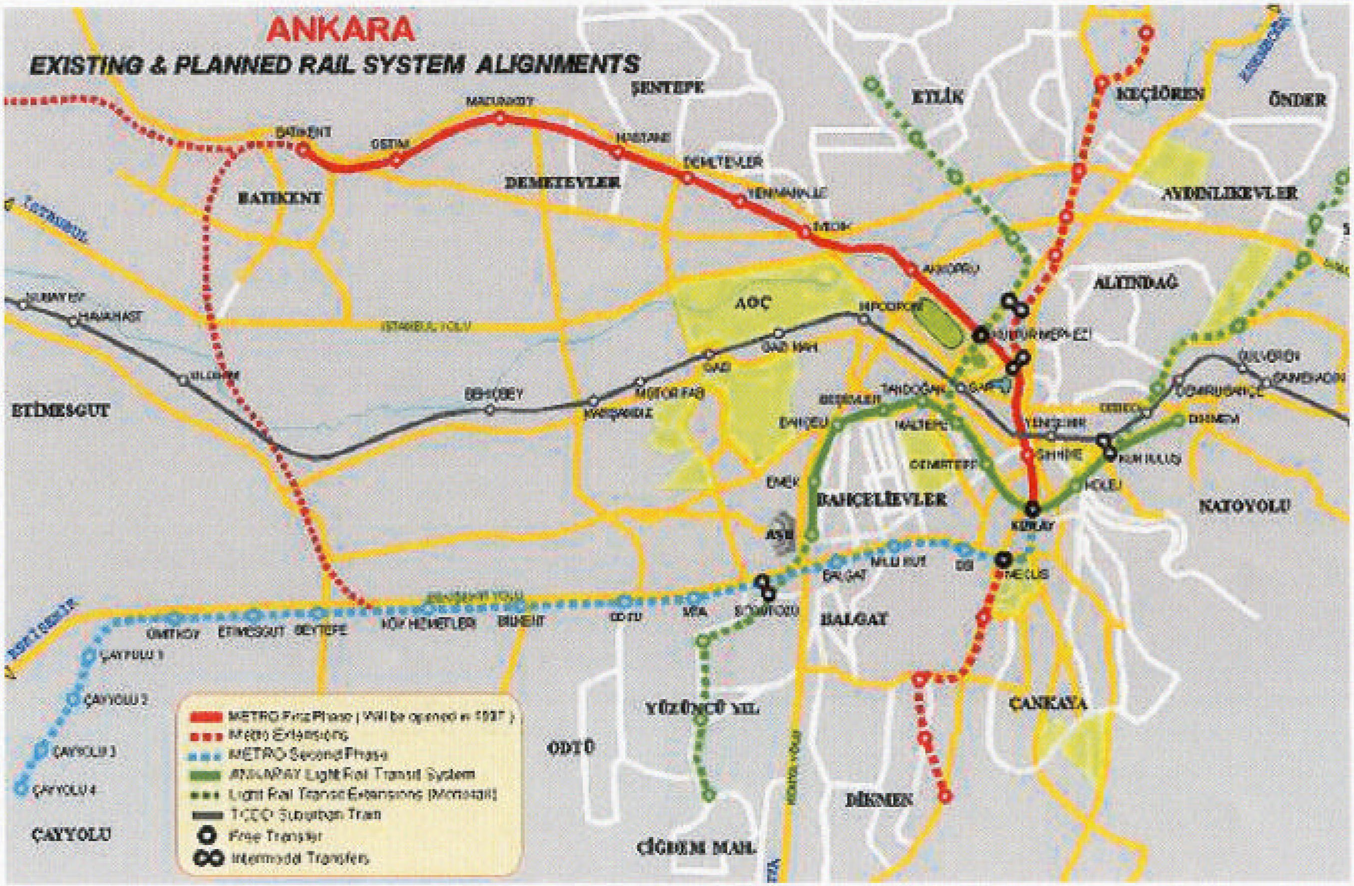
The current debate going on today is about assigning the priorities of the lines. Giving the priority to the line between Batikent-Sincan-Törekent is criticized since this implementation was considered to be realized after 2015, while there exist other lines proposed to be completed before Batikent-Sincan-Törekent line.

In spite of the criticisms of Ankara's rail network plans, rail systems, both Ankaray and Metro, have been undoubtedly successful with people moving about the city. However, population and car ownership in Ankara is growing rapidly and it is expected that the Greater Ankara Municipality will draw up ambitious plans to extend the heavy and light-metro lines.

Radial rail systems can strengthen downtown cores and reinforce decentralization trends. Growth might be funneled in a particular direction as a result of new rail lines.

The timing of transit investments matter a lot. Urban form is largely a product of the dominant transportation technology during a city's prevailing period of growth. If a city has completed or nearly completed its growth than the new rail services do not exert a big influence on urban form. With most of the region's road system and settlement pattern already in place, rail transit systems' incremental additions become too small to substantially affect travel behavior.

In Ankara the rail systems are the prerequisite for the proposed macro-form, so priority of the transportation investments should be the rail network. Rail networks proposed for Ankara can encourage central city redevelopment. They may help to attract people and breathe new life into struggling city center, Kizilay, suffering from accessibility problems.



Map 5.1 The existing and planned rail system alignments, Source: EGO (2004)

5.7.2 BUS PRIORITY MEASURES

Bus priority schemes serve the major objective that the movement of people rather than vehicles should be the primary consideration of urban transportation planning. Buses are more efficient users of road space than private cars (a bus may carry twenty times as many passenger as a car, yet it only contributes three times as much to congestion).

Buses are suffering from the extensive car use in most of the boulevards, streets and intersections in the CBD of Ankara.

Bus priority measures are envisaged to be applied on many corridors in Ankara by the year 2015 by the Master Plan. Buses should operate either as a rapid transit feeder mode or as the major mode on corridors not covered by the rapid transit network providing an efficient transit service.

The general idea worldwide is that; paratransit modes and even high occupancy private vehicles can be allowed to share bus priority facilities at appropriate places and periods provided that adverse effects on bus operation should be eliminated. But the situation for Ankara is rather not suitable for this implementation, particularly for private cars. The private cars might create congestion on the private lanes and in addition to this the control of the vehicles, whether they are high occupancy or not, would be difficult.

<u>THE BUS STOPS</u>: The bus stops in CBD should be designed in a way that the passengers can easily understand the routes of the buses. The buses stopping should not restrict the flowing traffic; the stops should be designed in order to make the buses pass each other properly.

The situation in Ankara shows an inadequate picture. In the CBD, the bus stops are so many and they are very close to each other. Generally it is impossible for a bus to move on, even the process of passenger loading finishes, until the bus stopping ahead moves. This, in turn, affects the motion of all buses using that street, particularly the right lanes. If the bus makes maneuver and shifts to other lanes, then this affects the general traffic. As a result, improving the conditions for bus stops will result in a high quality flow of buses and this may be attractive for passengers.

EXPRESS BUSES: The express buses serving from the residential areas out of the city core to the city center by stopping at a limited number of stops, will decrease the travel time of the buses, and as a result make the buses compete with private cars in travel times. The express buses should be combined with feeder bus services, and park and ride facilities. With proper route selections of both the express and feeder buses, this system also ends the congestion resulting from the huge number of bus stops at the city center.

BUS LANES AND PRIORITY OF BUSES AT INTERSECTIONS: The bus lanes should be implemented at the radial corridors entering the CBD in Ankara. This will reduce the travel time for buses and in turn make buses a popular mode of transport. The traffic volume / capacity ratio is around the saturation level in most of the radial corridors, especially near the urban core, so a fast flowing bus lane, next to the congested other lanes, will make public transport attractive.

The priority of buses at intersections by proper signalization is another means of making public transport attractive by reducing travel times. The signalization priority may be suitable for Ankara, since the routes of the buses are generally on the main boulevard and arterials, which makes the signalization simple.

5.7.3 INTEGRATION OF PUBLIC TRANSPORT SYSTEMS

The optimum use of the public transport systems will be achieved when the systems are implemented in a rational, sustainable and uninterrupted manner. The passenger wants to be transported in the fastest and most direct route and if there would be a transfer, this should be fast, safe, comfortable and there should not be any additional fee. These expectations can be met by a public system based on the combination of rail systems and express bus systems, which serves on main radial corridors as direct as possible, shortening the travel times. The pricing and transferring policies between the modes should be realized, and special care should be give to transfer points. The transferring points should be safe, comfortable and adequate and the waiting times for transfer should be short. Generally there exist three types of transfer points.

1. From automobiles to public transport, either rail or bus
2. From buses to rail systems
3. From feeder buses to major route buses

The aim of the automobile transfer points, park and ride facilities, is to transfer the passengers from private to public modes. These should be designed at the rail system stations and at the end of the major bus routes. If there exist park and ride facilities at the rail system stations located near or in the urban cores, then this facility no longer serves as a way to reduce car traffic in urban areas, on the contrary it promotes car travel by serving as a parking place.

The transfer points are the essential points in the urban transportation system of Ankara. The parking places are playing a great role in feeding the metro and ANKARAY system of Ankara. The case for ANKARAY is not in the form of adequate park and ride facilities, rather the drivers use the streets of the residential areas of Emek, Bahçelievler and the surrounding areas for parking.

As the residential areas spread, the bus service becomes more expensive to implement and the frequency of the buses gets lower, so the park and ride facilities for automobiles gains a higher importance. Rising trend of car ownership is another factor influencing the importance of park and ride facilities. In the case of Çayyolu Metro, proper planning of park and ride facilities is essential to shift the car users to metro. For some locations, which are not served by feeder bus systems, it should be understood that the people are ‘captive car users’. The important point is that, if there are park and ride facilities, these people will drive their cars until they reach the park, and then shift to the metro, which serves the aim of reduction of car traffic in urban center. In other words, their captivity ends, when they reach the park and ride facility near the transit service station.

5.8 COMMUTER TRIPS IN ANKARA AND PEAK PERIOD

Traffic congestion problems result not only from a growing number of car trips, but also from the uneven distribution of trips in time and space. The most common time-related phenomena are the morning and evening peak-periods, associated with commuting trips.

Commuting is the daily travel between home and the work-place. Commuter travel constitutes roughly 20 to 25 percent of the total mobility in the cities. However, the importance of commuting to total travel goes beyond its share for a number of reasons. Due to the concentration of work travel in time and space, in contrast to the more dispersed patterns of other trips, commuting is the main cause of peak travel demand. Its volume defines the necessary capacity and service of urban transport systems.

Despite clear differences between countries, commuter travel patterns are found rather similar. The decentralization of both people and jobs from the central urban areas to the peripheral locations is a wide-spread and ongoing process in European countries, despite quite different planning systems. In most European countries this process has resulted in a reduction in radial commuter flow patterns. The car is becoming the predominant mode for work trips. At the same time, flows well served by public transport decrease, whereas congestion on roads in the urban fringe is exploding.

The unplanned urban sprawl will lead to increased commuting distances and trips. The commuting patterns will become increasingly multi-directional; peripheral areas will attract a growing share of the trips. As Jansen (1993) stated, these more dispersed patterns will not provide the high flows of travelers which can conveniently be served by public transport, but they are much more suited to the ‘go anywhere’ modes, in particular the car.

Transport and land use policies can moderate the strong underlying forces. Land use that controls and encourage employment to be located near public transport facilities, may channel the decentralization processes in favor of public transport.

Transport policies may also stimulate commuter travel. Construction of high speed and high quality public transport systems may change the attitude of the commuters about their mode choice.

The traditional pattern of workers traveling to their work places in central cities is becoming less evident. Due to increasing commuting distances and job relocation travel patterns reflect the growth of multi-centered urbanized areas. If this decentralization is supported by proper public transport systems, particularly rail based systems, serving on the major corridors and integrated with feeder buses, this tendency of decentralization will reduce the car travel in city centers. Besides the rail based public transport, the extensions of the peripheral highways may be a solution for the central area traffic in this situation. Then the commuter trips may be made without entering the urban centre.

Table 5.7 shows the number of commuting trips in some countries. For some countries data were available only for selected cities, Athens, Tel Aviv and Ankara. Mode choice of commuters is one of the most important issues in transport planning. To reduce congestion on the roads in urban areas, it has become an almost universal policy goal to reduce the number of car trips particularly for commuting. As it is clear from Table 5.7, the percentage share of commuter trips is the highest in Ankara, so an implementation to shift the drivers to public modes for commuting would result in a relief in congestion.

While there is increasing awareness that time management can play a positive role in solving transportation problems, some barriers lie ahead. Most temporal policies are not within the realm of transportation planning agencies. Such policies are under the jurisdiction of different bodies, many of which are private sector agents.

The general sequence of the workday is quite similar in most countries, but starting and ending times of work and school do vary across countries. The growth in the off-peak period over the last decade is partially attributed to the growing share of part-time work. In Ankara part-time work is less popular.

Table 5.7 Commuter Trips in Selected Countries and Cities
Source: Jansen (1993)

Country	Work trips per inhabitant	Share in total trips (%)
Austria	0.64	23.5
Finland	0.64	21.0
France	0.64	19.0
West-Germany	0.57	21.2
Netherlands	0.59	16.3
Sweden	0.56	31.3
United kingdom	0.46	21.6
Greece/ Athens	Na	18.0
Israel/ Tel Aviv	0.33	18.0
Turkey/ Ankara	0.57	33.1

Flexibility in arrival and departure time is becoming a popular measure to increase employee satisfaction and to attain a spread of peak-period travel demand. In Turkey flexi-time is not common for state employees, as shown in Figure 5.2. The temporal distribution of trips in Paris shows a different pattern then in Ankara, Figure 5.3, which is due to the flexi time implementations and part time workers.

Reduction of car traffic in the city center of Ankara during peak periods might be possible with the implementation of flextime. This means that employees are allowed some flexibility in their daily work schedules. For example, rather than all employees working between 9:00 to 5:30, some might work 7:30 to 4:00, and others 8:00 to 4:30. Flextime implementations might be successful in Ankara, provided that this policy is supported by both the governmental and private bodies.

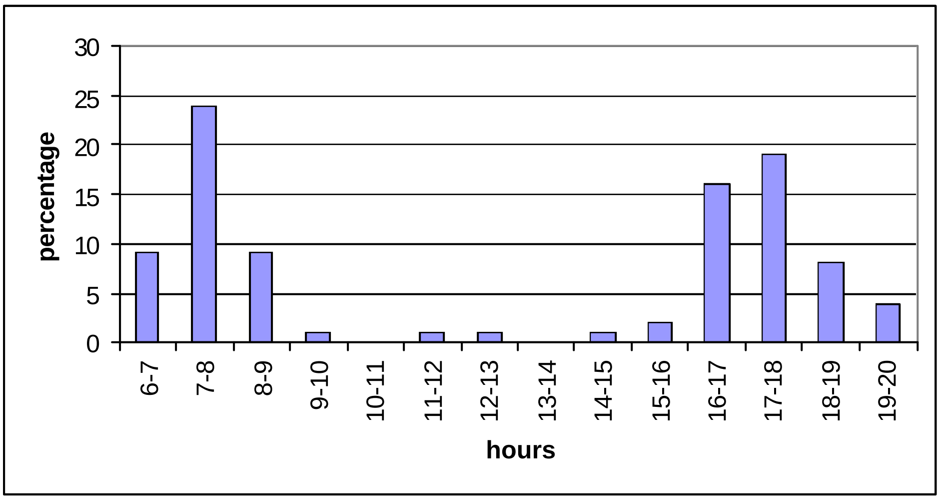


Figure 5.2 Temporal Distribution of Trips in Ankara

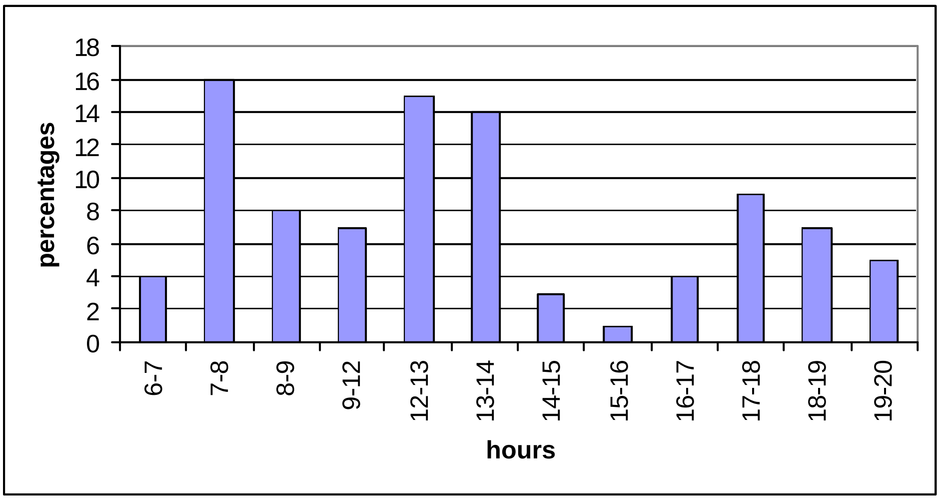


Figure 5.3 Temporal Distribution of Trips in Paris

5.9 PARKING IN CENTRAL ANKARA

The policies regarding the parking places affect the private modes entering the CBD to a great extent. The scarce parking place in the CBD is an important factor that decreases the attractiveness of the private car.

The parking problem is presently most severely felt along the 1 km stretch of the major artery in the central urban area, namely the Diskapi-Kavaklidere connection. It is extremely difficult to find a free parking place in CBD during peak hours.

The long range transportation master plan does not regard the parking problem as that of the inadequacy of available parking space and the implementation of low parking charges. Adopting a rather comprehensive and multidimensional approach it is proposed that the parking supply should be managed and an appropriate pricing policy should be applied in order to restrict the parking demand. It is considered both inefficient and unfair with regard to the distribution of resources, to keep on building multi-storey parking facilities in a city where the number of private cars and the demand for parking space increase rapidly being subject to no restriction.

Once the proposed rapid transit systems, which would provide easy access to CBD during peak hours, are put to service, there will be less need to ride private vehicles and consequently there will be less demand for parking supply. So the implementation of better public transport systems and the management of parking supply should work together to reduce the car traffic in the urban core of Ankara.

Designing multi-purpose parking facilities – including spaces for shopping, office and similar uses - would be wiser than the construction of buildings exclusively devoted to parking. This step may also shift the part of the heavy burden inflicted on CBD core to the peripheral areas. Building these parking facilities in the proximity of rapid transit stations and bus stops would constitute a further incentive for the utilization of transit modes in trips destinated to CBD. It would be more suitable to locate these parking facilities at a distance of two or more stations away from such urban core areas, as Kizilay and Ulus to achieve the effect of reduced car traffic in those areas.

The policies of parking management should be applied properly according to the location. 3 regional policies may be proposed for Ankara, urban core, periphery of the CBD and residential areas.

1) Urban core
    - On street parking prohibition
    - High parking fees
    - Planning of the parking fees to discourage long time parking. Parking fees depending on the duration of parking (higher fees for longer durations) may reduce the private commuter trips to the city center.
2) Periphery of the CBD
    - On street parking prohibition on the main arterials
    - Parking facilities to transfer to the public transportation at the main bus stops and rail stations
    - Linking services form the parking areas to the CBD
3) Residential areas
    - Park and ride facilities at the main bus stops and rail stations

5.10 PEDESTRIAN REGIONS AND CURRENT POLICIES

Due to the rapid increase in the number of motorized vehicles in Ankara, the intraurban transportation planning has largely focused on the construction of roads, intersections, bridges and similar infrastructure facilities without paying any attention to pedestrian transportation. The pedestrian overpasses built in the city center have proved to be more beneficial to vehicle traffic than to pedestrians since they required the users to climb up an unreasonably high number of stairs.

The existing, approved and proposed pedestrian streets are shown in Map A.5.3 in appendix. The central business district extending between Diskapi and Kavaklidere has specifically been delineated in The Transportation Master Plan with a view to help meeting the pedestrianization and transit requirements of Ankara, which should be in a continuous process of development.

The accessibility of these pedestrian zones from all over the city should be of prime consideration. Also within these zones smart connections of human scale should be designed to link various pedestrian streets. The existing pedestrian zones in Kizilay should be integrated with the transportation network. The parking places and the entrée points of buses and cars should be designed in a way that the pedestrian routes reaching to terminals are not blocked or extended to longer distances.

However the developments for pedestrians are not realized in Kizilay. Pedestrians in Ankara-Kizilay region are unable to enjoy their fare share from the city center due to invasion of motorized vehicles into all corners of the urban area. Besides, Atatürk Boulevard was proposed to operate as a motorway crossing the heart of the city, acting like a barrier in the middle of the city center, by the Municipality of Greater Ankara in 2003, without paying any attention to pedestrian accessibility.

5.11 DISTRIBUTING THE TRAFFIC TO ALTERNATIVE CORRIDORS:

One of the potentials to reduce congestion in the CBD is to divert the through traffic especially from the Atatürk Boulevard. The private car drivers should be encouraged to use the alternative routes rather than passing through the city center. This may be done by signalization periods (longer waiting times for private cars) and restricting some of the lanes at certain intersections to create control points to act as gates to divert some of the traffic to other corridors. Diverting the private cars to other routes will not only benefit the main boulevard, but also supply better driving and traffic conditions for the buses using the congested corridor.

5.11.1 DEVELOPMENT OF THE CBD RING ROAD

The main boulevard of the city center of Ankara, Atatürk Boulevard, is overloaded by the radial corridors from the periphery of CBD. The solution might be to reroute the drivers to the peripheral routes.

In the Traffic Improvements Study carried out by Parsons Brinckerhoff and Greater Ankara Municipality a CBD ring road is proposed to act as an alternative way to entering the city center for through traffic.

By using the existing road network, it is possible to create a continuous CBD ring road. The proposed CBD ring road can be seen in Map 5.2. This ring road will involve some peripheral arterials around the CBD. Fatih, Kazim Karabekir, Degol, Maresal Fevzi Çakmak and Merasim streets may serve as a bypass road around the west part of the CBD, without entering the city center. Akdeniz Street, Balgat and Çetin Emeç Boulevard may be an alternative for this west part of the CBD ring road. On the east part of the CBD ring road, Talatpasa, Cemal Gürsel, Ziya Gökalp, Libya Streets together with Baglar and Bülbülderesi Streets acting as a couple of one way streets, will provide traffic flow without entering the city center. On the southeast direction Çankaya and Ugur Mumcu Streets, together with Dikmen and Hosdere Streets on the south direction, may serve as the part of the CBD ring road. The qualities of these roads should be raised to supply traffic in a continuous manner.

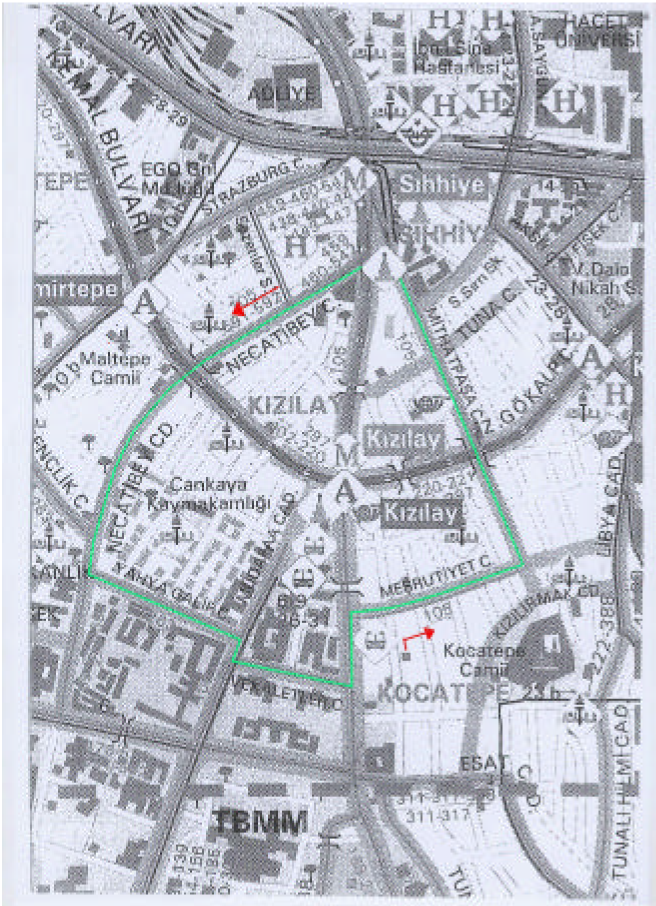
Map 5.2 The CBD Ring Road

5.11.2 THE CORE CIRCULAR ARTERIALS:

Apart form the CBD ring road, there exist a peripheral corridor around the central Kizilay, as illustrated in Map 5.3. The traffic in this corridor flows in counterclockwise direction starting at Sihhiye intersection and finally coming to the same point by following the roads below:

- Necatibey Street
- Yahya Galip Street
- Milli Müdafa Street
- Vekaletler Street
- Atatürk Boulevard
- Mesrutiyet Street
- Mithatpasa Street

These core circular arterials may act as an alternative to Atatürk Boulevard, which is the main arterial of the CBD. The availability of alternatives to the main boulevard of the city makes the background of another proposal, congestion pricing.



Map 5.3 The Core Circular Arterials

5.12 ROAD AND CONGESTION PRICING POLICIES:

Congestion pricing policies might be implemented for Ankara. This type of planning might be more appropriate for Ankara rather than complete pedestrianization, by allowing the public transport modes entering the central area, since Kizilay acts as the major transfer point between the residential and business districts of the city. Most of the trips have Kizilay either as origin, destination or transfer point.

While the public transport vehicles, emergency vehicles and licensed taxis would be let through, the private cars should be charged for driving along the Atatürk Boulevard.

The main problem of this implementation would be, there should exist alternative connections for through movement other than the road where road pricing is implemented. In Ankara, pricing might be implemented along the Atatürk Boulevard, between Akay and Sihhiye. The alternative routes that may serve for the transit crossing vehicles may be as proposed by the CBD ring road and CBD inner ring road, as discussed in section 5.11.

The vehicle counts at the Kizilay intersection, as tabulated in Table 5.8 shows that the majority of the traffic volume flows through the south-north corridor of the city. Reducing the number of cars in this corridor would certainly help to prevent the traffic congestion in the city center.

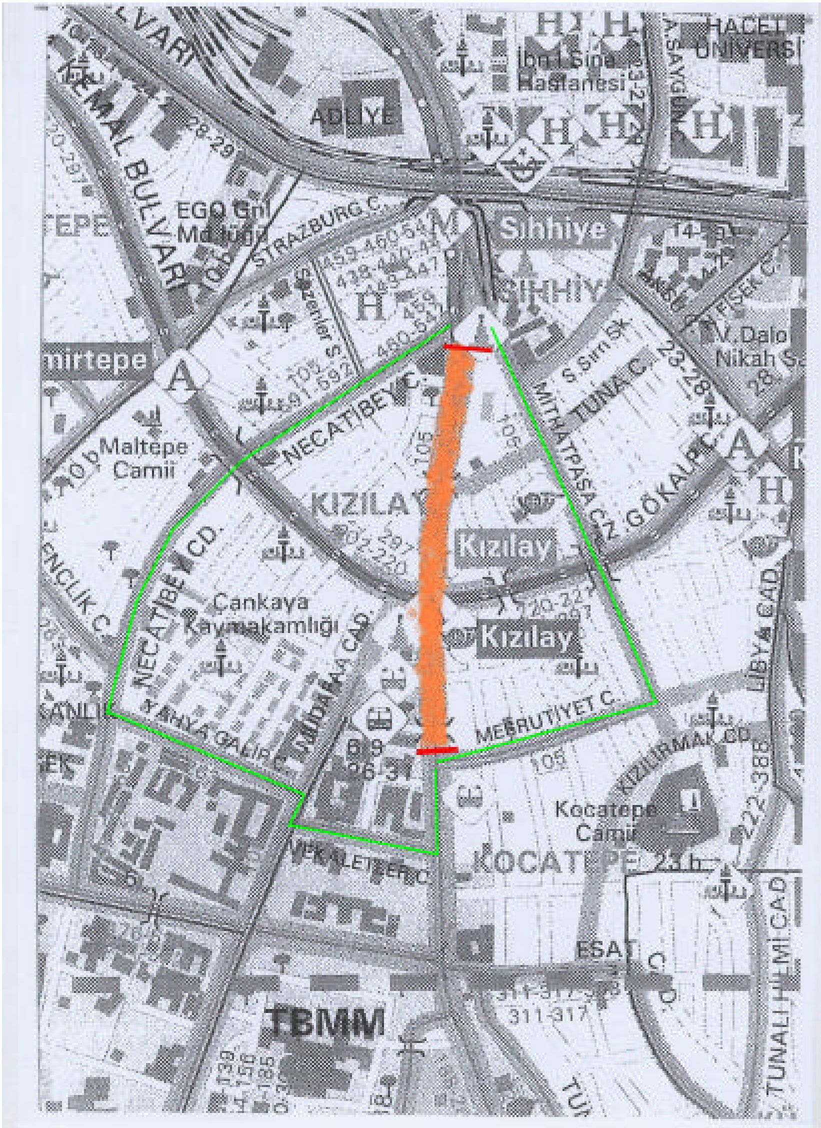
Table 5.8 Vehicle Counts at Kizilay Intersection
(The count is performed during the morning peak: 8:00-9:00 am and the values are in passenger car units)
Source: Greater Ankara Municipality (2003)

DIRECTIONS	NUMBER OF VEHICLES
SOUTH-NORTH	1810
SOUTH-EAST	458
SOUTH-WEST	982
EAST-WEST	930
EAST-SOUTH	470
EAST-NORTH	50
NORTH-SOUTH	1658
NORTH-EAST	276
NORTH-WEST	982
WEST-EAST	516
WEST-SOUTH	514
WEST-NORTH	280

The scheme of this proposal is illustrated in Map 5.4.

The charging point for the north direction (Çankaya to Kizilay) might be positioned near Mesrutiyet Street. The private cars that would not enter the priced zone would turn right to Mesrutiyet Street from the Atatürk Boulevard, while the public buses would continue their way along the Atatürk Boulevard. The case in Ankara at the moment is that the bus route runs along Mesrutiyet Street. Providing the flow of public transport vehicles along Atatürk Boulevard would favor public transport, as this implementation would shorten their travel time both by improved road capacity by reallocation and length of the road.

For the south direction (from Sihhiye to Kizilay) the charging points might be placed near Necatibey Street. The private cars that would not enter the priced zone would divert their way to Necatibey Street, while the public modes would continue along the Atatürk Boulevard.



Charging points Priced Section Alternative Core Circular Arterials

Map 5.4 Proposal for Congestion Pricing

Below are some principles that should be kept in mind while implementing congestion pricing in Kizilay.

- This strategy should be integrated with other TDM strategies to provide incentives to use alternative modes.

- Time variable tolls (higher rates during peak periods and lower rates during off-peak periods) would be more appropriate to reduce peak period congestion.

- From the user perspective, the system should be convenient; the system should not require vehicles to stop at toll booths and create queues. As discussed in section 4.6.2, there are various pricing methods. Newer methods provide greater convenience, making them more acceptable. Electronic tolling, as used in Singapore, or optical vehicle recognition, as in London, would be more appropriate than purchasing a pass or toll booths.

- There should be multiple payment options. (cash, credit card, internet, and mobile phone messaging)

- Discounts for frequent users should be avoided. Weekly or monthly tickets should not be more economic than single passes, as this arrangement contradicts the TDM objectives.

- Taxis should not be allowed to pass through. The congestion pricing charge may be charged to the customer.

- Charges should reflect as closely as possible the marginal social cost of each trip in terms of the impacts on others. (Vickrey, 1992)

- Charges should vary smoothly over time. If charges vary discontinuously, excessive incentives are given to rush to get ahead of a jump in the charge, or to lag waiting for a drop in the charge.

- Efficient charges cannot be determined solely by individual trip, but must take into account the impact of the trip on other traffic from the time the trip is made until the end of the congestion period. For example; if queuing conditions are such that flow through a charging point is at capacity from 7am to 10am, a car going through the charging point at 7:10 may encounter a short queue and be delayed by only 5 minutes, but will be responsible for being there and causing delay in the queue from 7:10 until 10:00, a car going through the charging point at 9:55 may have been delayed by 15 minutes, but will impose only 5 minutes of delay on others. Unless a motorist gets entirely free of the queue, he will increase total waiting time of others, so charges should not be calculated in terms of individual delay. (Vickrey, 1992)

- Efficiency can be enhanced, by charging on the basis of how much congestion exists during the time of the trip. This can be handled by installing check points (by optical vehicle recognition, electronic sensors or GPS devices) to meter the level of congestion existing throughout the priced route.

Some researchers argue that congestion pricing represents 'double taxation' since motorists already pay fuel taxes and vehicle ownership taxes. However, they do not pay for the delays that they impose on other vehicles.

The deficiencies of the ideas claiming that, restricting traffic in a road would cause congestion in the alternative neighboring routes and commercial activities would be reduced, were criticized in section 4.5. The restriction of traffic in a route does not carry whole the pre-existing traffic to the alternative routes, since the traffic volumes are not fixed, rather they are subject to change by transportation policies. Behavioral changes in the drivers should be expected; some would prefer not to use their cars. This was already discussed; the overall reduction of traffic may be experienced by this implementation. Besides, the economic viability of the center does not depend on the number of vehicles entering, but the number of people entering the region, as most of the vehicles use Kizilay as transit passing.

When pricing is implemented, less car traffic would use the Boulevard, so one of the lanes might be allocated for the pedestrians, creating a more pedestrian friendly and pretty city view. Besides a tramway line running through this priced region may serve the pedestrians to access from one edge to the other, and also provide connection between the public transport modes.

The policy of introducing the pricing between Akay and Sihhiye, over the Atatürk Boulevard, conflicts with the recently constructed grade separated intersections, as one discourages car traffic and the other encourages car traffic in the city center.

5.13 DIVERTING THE TRAFFIC TO NON-MOTORIZED MODES

Because of the climatic and the geographic conditions of Ankara, the construction of separate bicycle lanes in main corridors is impossible. For an employee working in CBD and living in Çankaya-Oran, it is impossible to reach his workplace and then back home, by bicycle. So, an improvement of bicycle transportation is not offered for commuter trips.

The key factor of Transportation System in Ankara is the accessibility of pedestrians to bus stops and rapid transit stations. The accessibility of station points at the origins and destinations of commuter trips is the main issue underlying the high percentage of public transport use. This should be taken into account when planning the new residential areas. The connections of residential, recreational areas and transit stations should be in a walking distance. If this is not possible, there should be bus feeder systems, to reduce the private car use.

5.14 FORMING OF GATES AND REALLOCATING THE ROAD-SPACE

In Ankara, Kizilay, the land is scarce, so this land should be used in a selective manner favoring the pedestrians and public transport vehicles.

Reallocating the road space between the modes is one of the most commonly used methods of reducing car traffic in central areas. The use of the cars is restricted in some streets by avoiding some lanes and/or various movements, such as left and right turnings. These lead to a more efficient use of the bus system, and consequently make bus travel more attractive. Besides, in car restricted streets the pedestrian movements turn out to be safer and accessibility of public transport systems increases.

Forming of some ‘gates’ at the critical points of the traffic network might be a solution for reducing car traffic. The gates can be implemented by physical means in the form of lane reduction, and by signalization to filter the private modes; assigning longer waiting time for private modes. The use of gates may divert the car traffic to other streets. Besides this changing of the route affect, the use of gates is expected to realize a change in the behavior. The use of gates undoubtedly favors public modes and this may shift the private car users to public modes. Creation of gates in the Eskisehir and Çankaya corridors may reduce the car traffic considerably, since the car ownership levels in these residential zones are respectively high.

5.15 ÇAYYOLU LINK OF THE METRO

Greater Ankara Municipality carried out a research on the traffic volumes existing in the western corridor of the city, the Eskisehir Road- Inönü Boulevard. This corridor connects the new residential areas to the CBD. In this study the number of vehicles, their types and their occupancies are observed at some stations between the METU Junction and Konutkent entrance at the morning peak period. This data implies important conclusions.

The locations of the station points are illustrated in Map A.5.4. From the data it is observed that the number of vehicles increase in a percentage as high as 815% from the station K1 to station K13A, which are the farthest and the closest points to the urban core respectively. These increases are most clear at the connections of the Eskisehir Road with Konutkent, Ümitköy and Etimesgut. The transfer of the traffic between two corridors, Eskisehir Road and Istanbul Road, takes place at Anadolu Boulevard and this adds to the volume of traffic. The volume of passengers show a sharp increase after Ümitköy-Etimesgut Junction and then increases in a stepwise manner to approximately 13000 persons.

The traffic counts also show the composition of traffic on this road. The percentages of private modes show similar values throughout the road, and vary between 85% and 88%. However the proportion of the passengers traveling by private modes decrease from 70% to 35% as the stations get closer to the CBD. This implies that the private vehicles, which occupy the 86% of the road traffic carries only 35% of the passengers, while the public vehicles take up the 14% of the total traffic carries the 65% of the passengers. (Table 5.9)

Table 5.9 Vehicle and Passenger Counts along Eskisehir Highway
Source: Parsons Brinckerhoff & Greater Ankara Municipality (1998)

VEHICLES					
station	total	public	private	public%	private%
K1	403	59	344	15	85
K7	2704	328	2376	12	88
K9	2905	409	2496	14	86
K13A	3288	464	2824	14	86
PASSENGERS					
station	total	public	private	public%	private%
K1	1861	549	1312	30	70
K7	9560	5132	4428	54	46
K9	10601	5997	4604	57	43
K13A	12845	8344	4500	65	35

As a result this corridor increases the congestion at the city center because of the large number of private cars. The reasons for the high rates of car use in this corridor can be summarized as:

- The high level of car ownership in this region due to high income residents
- The insufficient public transport facilities
- The distances between the city center and the residential areas are long and this makes public transport in the form of buses and minibuses unattractive.

The high volume of traffic from this corridor is expected to be solved by the metro, but it is suspicious that the metro connecting Çayyolu to Kizilay would achieve this aim, as there are competitive projects to the metro line. The grade separated junctions that are constructed and continuing construction along the Eskisehir Road, from the fringe to the center, are expected to provide an uninterrupted, continuous flow to the city center. This project directly supports car use towards the city center, which will, in turn create even more congestion in the city center and abolish the success of the metro.

Restrictions on car use should be implemented to divert the drivers to metro use. Besides adequate park and ride facilities, in addition to feeder buses, should be provided for the users, as the high income inhabitants in this region might prefer to drive their own cars, rather than using the feeder bus, to the metro station.

5.16 THE DEBATE; SIGNALIZED INTERSECTIONS OR GRADE SEPARATED INTERSECTIONS?

When a flood comes, if there are no barriers to slow down its flow, its destroying effects at the last point would become more hazardous. The traffic volumes entering the city center have the same effect. By providing an uncontrolled, non-stop flow of vehicles more and more vehicles enter the central areas for a given duration and this will in turn cause more problems at the city center.

The traffic volumes reaching the city center from the distant districts of the city through the grade-separated intersections might be regarded as a flood. Controlling the traffic volumes should be the aim of the urban transportation implementations, but the grade-separated intersections treat the traffic volumes in the opposite way. The volumes using the grade separated intersections reach the city center with no control.

By signalized intersections the volume of traffic entering the city per a given duration of time can be controlled by creating waiting times out of the city.

If the signalization provides an easy flow to the central parts, then unrecoverable problems may arise in the central traffic. The same conditions apply for the case of unsignalized, grade-separated intersections. The traffic reaching the city center should be stopped at the outer parts of the city. This may also shift the drivers to alternative roads rather than the city center.

The most appropriate measure may be the controlling of the signalizations from a main control point. For the successful implementation of the traffic signalization system throughout the city, a central signalization system should be developed, supported by a camera system for monitoring the traffic flow. This performance would allow for interrupting the signal programs to control the city traffic. (Aslan, 2000)

The Transportation Master Plan emphasizes giving priority to passenger flows rather than vehicles, and proposes that the bottlenecks occurring in certain intersections should be solved by giving priority to the flow of public modes. Therefore, the project of building grade separated intersections is in conflict with the general policies of Transportation Master Plan of Ankara. (Babalik, 1996)

5.16.1 THE SITUATION AT AKAY INTERSECTION; BEFORE AND AFTER

The counts from the years 1998 and 2002, prior and after the construction of the grade separated intersection at Akay, leads to a conclusion that a tremendous increase in traffic flow is observed. Table 5.9 tabulates the traffic volumes from and to four directions connected by the junction as origins or destinations separately. These four directions are Çankaya, Kizilay, Eskisehir and Esat directions.

From Table 5.10, it is seen that the traffic flow originating from Eskisehir direction has increased by 103.51 %, which is far greater than the others. While the traffic volume increase is mostly experienced from the Eskisehir direction, the volume of traffic originating from Çankaya direction is very close to the volume approaching from Eskisehir direction. Çankaya, just like Eskisehir Road, is mostly occupied by high-income people. An increase of 11.03% percent is observed in Çankaya direction, which is smaller than the Eskisehir direction. This is from the fact that Çankaya has passed its fast urban growth stage, and now growing slower compared to the other residential areas. In 1998 the traffic flow from Çankaya was about 1.7 times of that of Eskisehir Road, but recently in 2003, it is exceeded by the Eskisehir direction.

Which is more striking and more important in the scope of this study is that the number of vehicles traveling to Kizilay, the city center, has increased by 123.76%.

Table 5.10 Vehicle Counts at Akay Intersection,
Source: Greater Ankara Municipality
(The values are in passenger car units)

Traffic flow to destinations	1998	2002	Change (%)
Çankaya	2430	3074	26.50
Kızılay	2630	5885	123.76
Eskişehir	3675	3833	4.30
Esat	2068	782	-62.19
Traffic flow from origins	**1998**	**2002**	**Change (%)**
Çankaya	4804	5334	11.03
Kızılay	2749	3560	29.50
Eskişehir	2793	5684	103.51
Esat	457	197	-56.89

There are different factors causing such a big increase in the number of vehicles traveling towards the city center. One is the increasing car ownership throughout the city. Especially, the increase in the number of vehicles originating from the Eskisehir direction is the reflection of this situation. However, this is not the sole reason for this remarkable increase in the number of vehicle flow to the city center. The number of cars in Ankara has increased by approximately 25% between the years 1998 and 2002, which is far behind the increase in the traffic flow entering the city center, this finding supports the idea that the increasing traffic entering Kizilay, from Akay intersection is mostly because of the policies favoring private transportation, by providing a continuous and fast flow into the city center.

5.17 THE ROLE OF ENFORCEMENT AND MONITORING

The traffic system should be seen as a social system where drivers are interacting with other drivers and road users. Rules and regulations are important to help the actors of the system to function in a safe and effective way.

When a new law is implemented the population is normally informed about the new legislation through information campaigns and police enforcement against violations of the law. Therefore, the effects of the rule and the effects of the enforcement are difficult to separate.

Several evaluations of decreased speed limits show that reductions of mean speed reduce the number of accidents with personal injury. Although posted speed limits affect driver speed adjustment, the average compliance is not so high. There is also general agreement that police surveillance has an effect on driver speed adjustment. Both speeders and non-speeders have been observed to slow down in the vicinity of a police unit. (TDM Encyclopedia)

Enforcement is needed to increase the effects of rules and must be visible to be effective. It was found that drivers on high-enforcement roads reported significantly higher perceived probabilities of detection than drivers on low-enforcement roads.

Police surveillance should be visible to drivers so that the drivers' perceived probability of detection increases, which is an important factor in driver decision making.

5.18 REMARKS ON THE RECENT LAND USE AND URBAN TRANSPORTATION POLICIES IN ANKARA

The observations on the urban transportation and land use data of Ankara has shown that, Ankara used to have a compact city form, and now the development of the urbanization is directed towards west with new settlements. Batikent, Eryaman, Sincan and rapidly growing settlements along the Eskisehir Road are of specific importance. The suburbanization along the western corridor, which was one of the goals of the urban development plan of 2015, seems to be achieved.

Generally higher income inhabitants occupy the southern, south western and central regions of the city. As a result the car ownership levels are higher in those regions. In the western and the southern settlements car is being used increasingly for commuter travels, both through and into the city center. Today nearly 90% of the vehicle flows on the arterials reaching the city center from the southwest and south areas of the city are cars.

Introduction of rail systems along the main axis of urban development reflects the principal of integrated public transport policies with decentralized urban development patterns. This aim is accomplished for northwestern parts, Batikent, but the realization of this aim seems to be suspicious along the Eskisehir Road, because of the competitive projects implemented encouraging car use.

Ankara is facing with extremely conflicting urban policies in our days. Although the projects of rail systems are under construction and some are planned, there are projects that support the private transit towards the city center.

Finding solutions for congestion problems in the central intersections of the city are being stressed. But the improvement of certain points of the transport network does not represent a comprehensive perception of the transport system of a city.

The metro projects show that there is a tendency towards the improvement of public transport modes in Ankara; however the grade separated intersection projects conflict with this tendency. The trend of constructing grade separated intersections favor car use in general.

Evaluating the current policies and investments from the 'carrots and sticks' point of view, which suggests that policies to favor public transport and car travel restriction should be implemented together, the conclusion seems to be a complete chaos. The situation in Ankara is, giving carrots to both the public transport users and private cars. If nothing is done to shift the car users from their cars, the construction of rail systems, particularly through the high income areas, such as Eskisehir Highway, might not be enough to decrease the heavy private automobile traffic volume reaching the city center from those corridors.

The newly elected major of Ankara, also the former major of Ankara, has declared the most important problem of Ankara as the traffic congestion and the solution as the grade separated intersections in an interview just before the recent elections. He stated that 48 grade-separated intersections were constructed in his period, and if finance for new investments would be available, new grade-separated intersections would be constructed for solving the transportation problem of Ankara. Besides these, he also confirmed that there exists metro constructions throughout the city, and these are planned to be finished and start to serve the city as soon as possible to encourage the inhabitants of Ankara to public transport modes. (Hürriyet, 2004)

There are conflicts between these statements, as one favors car traffic and the other favors public transport. The reduction of automobile traffic in the central parts of the city is possible only by implementing public transport promotion together with car travel restrictions not by promoting both public and private modes.

There exist proposed bus priority routes both in the Master Plan and Parsons Brinkerhoff's report; however none of these have been realized. Especially for the central and southern parts of the city, the existing public transport is not sufficient. The rail systems are not proposed for these regions since these directions are not the priority axis of development and because of topography. The residential areas in these regions are mostly occupied by the higher income inhabitants. Besides these areas are becoming more important in terms of commuter traffic, produced and attracted, day by day because of the rising number of offices. The city center is growing to the southern parts, such as GOP, Esat, Çankaya, etc. and the current situation is leading to higher car use levels. The service quality and speed of service should be increased to favor the public modes. This step is vital particularly for those wealthy regions of the city, since people would not shift to public modes if they do not find the equivalent comfort that they reside in their cars. The service levels in terms of speed and convenience can not be improved if the buses continue to flow in the same traffic with private cars, so the carrots and sticks approach should be implemented properly in this case.

In the Transportation Master Plan, policies supporting public transport investments and consistent land use decisions to restrain car use in the city center were proposed. Policies on the newly developing areas of the city are designed to create opportunities for the further use of the public modes, such as Batikent. However, the same integration of land-use decisions with the urban transport policies cannot be seen in the existing, especially the central parts of the city. (Babalik, 1996)

There are still no car traffic management policies implemented to prevent the adverse effects of car use in the city center. The central areas still continue to suffer from the flow of car traffic; it is a fact that not much progress has been achieved.

CHAPTER 6

SUMMARY AND CONCLUSIONS

During the 20th century, car ownership and use became the dominant method of personal transport, with many benefits to those enjoying the greater mobility, speed, comfort and convenience which cars provided. In turn, these trends led to changes in the structure and functioning of cities (urban sprawl and a more diffuse pattern of origins and destinations) and to commitments of funds as improving the roads to deal with the extra traffic.

However, as the further these trends proceeded, the negative consequences grew; congestion, environmental damage, economic inefficiency, destruction of social equity, etc. As a result an alternative view emerged emphasizing the necessity of automobile travel reduction in urban areas.

Transport planning has been completely transformed from an activity 'predict and provide' to a much more complex approach. Transport planning has to ensure that all people have appropriate levels of accessibility for this purpose the urban transportation policy should give the priority to the accessibility of people, not vehicles.

When people think about transportation improvements they often think about new technologies, improvements in automobile technology and air travel. However, those will not solve the problems of the urban transportation. Then, perhaps the next milestone in the transportation history would be a new way of thinking that consists of innovations that result in more efficient travel of the people.

It is accepted that many people have built their present life standard around their cars, and depend on them for many regular and occasional trips. People are different from each other and these differences become more obvious from country to country. There is a wide variation among people in how dependent they are and what they think about it. The differences must be recognized and treated in different ways. Many people perceive strong advantages of time, being able to make spontaneous journeys. In addition to this the feeling of control, privacy and enjoyment of driving adds up to 'independence' rather than dependence.

There exists a crucial distinction between car dependent *people* and car dependent *trips*. It would be quite difficult to achieve an automobile travel reduction especially in wealthier regions. Improving alternative modes seems a necessary condition, but not a sufficient one. Seeking to change people's behavior is unlikely to be successful unless restrictions on car use are introduced.

The policy sticks -restrictions on private automobile trips- should be implemented with carrots -the improvements in alternative modes-. Policy sticks, unaccompanied by carrots, would generate resistance, because they do not take why people are using their cars into consideration.

Land use policies and transportation supply should work together in order to achieve car travel reduction and a public transport oriented city. The settlement patterns should be transit supportive. The urban planning should be the result of farsighted and pro-active land use planning, to support very intensive rail transit services. Radially expanded rail lines tie planned settlements together while strengthening the central city. A payoff of creating a transit oriented regional form is the sustainable levels of private automobile usage.

There is much that any city can learn about car travel reduction from other cities as regards roles of new technologies, forms of institutional management and the long term consequences of different policies.

Through the review of the cities which have achieved success, it is evident that the major contributor to automobile travel reduction is a well integrated, comfortable and reliable public transport system. The existence of a reliable public transport system is the common feature in the examples of success.

The urban transport indicators put Ankara in a stage between the developed and the developing countries, and the current trends in Ankara indicate that the car ownership and use will continue to increase. Ankara, being at the initial stages of congestion problems, is likely to face the similar problems that the developed countries encountered. However, the public transport use is still relatively high in Ankara. This might be an opportunity to implement public transport favoring policies more easily.

The low level of service observed at the intersections in central Ankara is mainly due to the high level of car use. The percentage of cars in the traffic is 80% in central Ankara while this volume of carries only 25% of the passengers.

It is observed that the urban transport policies and investments in Ankara are in conflict with each other. While rail network investments favor public transport, the grade separated intersections providing uninterrupted vehicle flows through the main corridors favor private car use. While many developed cities implement and others plan pedestrianization of city centers, either totally or partly, Atatürk Boulevard was proposed to serve as a transit road, without letting any pedestrians, acting as a barrier in the heart of the city.

The actions implemented in Ankara towards the problems caused by increasing car use are proved to be incorrect in most of the developed countries. The reduction of car traffic should be achieved, rather than trying to cope with the high traffic volumes by improving the road capacity and constructing grade separated intersections.

The policies favoring car use both conflict the Transportation Master Plan and the development plans proposed by The State Planning Organization (DPT). In The Eighth Five Year Development Plan, proposed by DPT Urban Transportation Commission, the priorities of investments are envisaged to the promotion of public modes. As the car use increases, even the capacities of those grade separated intersections and the provided extra lanes would be exceeded and the problem would appear again, as a result, these would all become useless investments.

The existing taxi operation is poorly organized in Ankara. The taxis are wandering around particularly on the central streets in the search of customers. If a photograph is taken from one of the overpasses in Kizilay, the dominant color would be yellow for sure, which is the color of the taxicabs in Ankara. There exist bus stops along the Atatürk Boulevard and the buses are blamed for the slow flowing traffic. However the right lane, which should be used by the buses along the stops, is usually occupied by the taxis, resulting in a struggling situation. The problem of taxi traffic is now being tried to be solved by diverting the taxis out from the Atatürk Boulevard. An example of this is rerouting of the free taxis to the Mesrutiyet Street; not allowing their flow along the Atatürk Boulevard.

During the period between 1991 and 1994 Kizilay was closed to vehicular traffic because of the Metro and ANKARAY constructions. The scenes from those dates resemble the European cities with city center pedestrianization. This makes the setting for proposing that the inhabitants of Ankara do not have to use the Atatürk Boulevard for their motorized trips.

In this study, car travel reduction options in the central regions of Ankara are proposed. The methods and their applicability are discussed to achieve this aim. However, there will be opposing voices if parking restrictions, congestion pricing, reallocation of roadspace, forming of gates, diverting the car traffic to peripheral routes are implemented in Ankara. The first effects of a new initiative are likely to meet substantial resistance, and it is only after persistent implementation for a longer period that the broader effects can be seen. The longer the delay, before policies are implemented, the more entrenched are the patterns of behavior.

People are getting used to car travel more day by day, and in turn it will be more difficult to obtain a shift from private car to public transport.

Consequently, the following recommendations are made for Ankara:

- TDM and TSM strategies (reducing the need to travel, shifting the mode choice to public modes, managing the use of private car) should be implemented in a comprehensive manner in Ankara.

- While implementing car travel reduction options in Ankara, it should be kept in mind that the attractiveness of a region depends on the counts of people not vehicles. The public opinion and acceptance is at utmost importance regarding the success of such a scheme.

- Ankara is a city in the need of well distributed, comfortable and attractive public transport. The known transportation objectives in Ankara may only be achieved by a network of attractive, comfortable and well distributed public transport. The public transport should not only serve for the captive users but also for the car owners.

- The urban structure is a vital point in automobile travel reduction, as discussed in the examples of success. The decentralization in Ankara will shape the urban structure as a poly-centered city. The proposed decentralization in Ankara can be realized only if proper rail lines are provided. The first priority in investments should be given to the realization of the rail network proposed by the Transportation Master Plan.

- The 'hybrid' form is suitable for Ankara. (Orbiting the dominant center, are secondary and tertiary centers and their surroundings tied to the dominant center by rail transit. The centers, comprising multiple land uses, are connected to each other by a transit network.) A balance between land-use and transit should be achieved, by both concentrating development along transit corridors and adapting transit to pre-existing settlements of the city.

- The city center of Ankara, Kizilay is under a heavy pressure in terms of traffic. All the main corridors intersect there and the majority of transfers are done in Kizilay. Therefore the most important stations of different modes take place in Kizilay. In addition to these, pedestrian movements are in high levels. These all add up to a gridlock in the city center. In the search for solutions, the proposals should not be only city center based. The urban land should be taken into consideration as a whole and single system.

- As the access to and from the distant residential and employment areas are improved by promoting public transport, the city center would be released from the heavy volume of traffic both towards and through the city center. The rail network plays a vital role in this plan, since busses are not efficient and not preferred for the distant locations.

- The percentage of commuter trips is high in Ankara and most of the commuting trips use the city center either as destination or passing through, so reducing the car trips for commuting would definitely effect the city center congestion. Besides this, implementation of flextime may decrease the peak period congestion.

- A better service to passengers by constructing taxi storage areas in central regions is essential in Ankara. Additional taxies would only cause further congestion so the taxi quotas should not be increased.

- Atatürk Boulevard is the key central arterial connecting the traffic volumes from the main corridors of the city. Depending on its key central arterial characteristic, a policy stick on car travel may solve the congestion problem not only in Kizilay, but also in the main corridors releasing traffic to the urban core. The travel behavior of the inhabitants of Ankara may change and a shift to public transport may be achieved, provided that a comfortable and reliable public transport network exists.

- Complete pedestrianization is not suitable for Kizilay, since this might create a conflict with the goal of integrating the public transport modes. The Kizilay station of Ankaray and Metro is the major station of the rail system and it should be integrated with other road public transportation modes, The integration of the public modes is an element of the policy of giving priority to people. There will be passengers who would transfer from rail systems to busses or minibuses, or vice versa, since the rail system does not reach every settlement of the city.

- A suitable action in Kizilay may be creating a congestion pricing zone along the Atatürk Boulevard, allowing and promoting the public transportation modes and reducing the car traffic. London's experience shows that congestion pricing is technically feasible and effective, and that it is possible to overcome the political and institutional resistance to such pricing.

- Congestion pricing should not be misinterpreted as double taxation. It is a way to make the private car users pay for the congestion they create and delays that they impose on the other users. Besides, it is an efficient way to change the travel behavior of the drivers.

- As discussed before, The World Bank is advising the cities in developing countries to use charging to curb exploding traffic growth, raise money for much-needed infrastructure and free up congested buses, which are traditionally the main form of mass transport.

- Parking management is an essential feature of car travel reduction in the city center, as many cities have implemented.

- It is essential that car parks should be available, in the form of park and ride services, around the stations of the rail systems preferably at far distances from the city center. The captive car users who are traveling between their homes, distant residential areas, and the city center might be attracted to the metro system, if they can park their cars safely and easily, near a station and continue their trips by metro. Incentives such combining the rail tickets with parking fees near the stations and disincentives such as high parking fees and scarce parking places in the city center would help to shift the car users from their cars and use the metro.

- Locating shopping and recreation centers near the metro stations or vice versa would be a solution for decreasing the volume of travel towards the city center. The shopping center, Migros, located near the Akköprü Station of metro is a good example of this idea. Many car users would prefer to do their shopping, go to the cinema and join the cultural events at Migros rather than struggling around in the city center, Kizilay, in the traffic jam trying to find a parking place. Migros and the metro seem to form a mutual type of living. The large car park of Migros serves as a park and ride facility, a feeder, for the metro system; while the metro supplies easy, comfortable and quick access for the customers, particularly captive public transport users from several origins of the city.

- The private cars should be encouraged to use the alternative peripheral routes rather than passing through the city center. If the drivers are discouraged to enter the central area, by forming of gates or restricting some of the lanes at certain intersections, the attractiveness of the alternative corridors may be enhanced.

- Where the rail based system construction is essential but needs long time both because of financial reasons and construction phases, more practical short-term solutions should be implemented. Improving the existing public transport modes, busses with higher service levels, might be a temporary solution. Signalization priority and separate or diversable bus lanes might be effective for decreasing the attractiveness of private cars.

- The policies of road network improvement in the inner city should be abandoned. Rather than those, capacity extensions should be supplied by using the road space more efficiently, by the help of a regular traffic and transportation policy. As discussed before, one of the reasons underlying the Copenhagen's success is that the city traffic engineers have held the total capacity of the central city road network constant since 1970. Zurich, having one of the most efficient transport systems in Europe has responded to congestion by redistributing the road space to public transit.

- The effectiveness of new implementations in changing behavior depends to a great extent on drivers' perceived probability of detection which depends on the rule that is implemented, the amount of police surveillance and the punishments imposed in case of violations. The success of the car traffic reduction measures depend on enforcement and continuous monitoring. For example, parking management and congestion pricing cannot be realized without control and enforcement.

- The recent policies favoring the use of cars should be abandoned, and the city center should be designed in a way to favor the pedestrians, public transportation and their integration.

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APPENDIX

Table A.3.1 Selected Travel Characteristics for the Dataset of 46 Cites in 1990 and Corresponding % Growth Relative to 1960, Source: Sinha (2003)

	Persons/ hectare		Cars/ 1000 people		Car-km of travel/capita/year		Transit boardings/cap/yr	
City	1990	Change %	1990	Change %	1990	Change %	1990	Change %
Adelaide	12	-30	537	135	6690	154	76	-47
Amsterdam	49	-50	319	393	3972	4175	325	75
Bangkok	149	-11	199	472	2664	NA	423	NA
Boston	12	-34	521	91	10280	150	114	9
Brisbane	10	-53	463	141	6467	148	69	-70
Brussels	75	-25	428	172	4864	171	260	-22
Calgary	21	-23	620	95	7913	178	94	0
Canberra	10	0	457	89	6744	NA	89	23
Chicago	17	-31	547	78	9525	133	96	-34
Copenhagen	29	-29	283	220	4558	261	164	-15
Denver	13	-31	753	57	10011	70	30	-30
Detroit	13	-32	693	90	11239	NA	24	-50
Edmonton	30	NA	527	96	7062	NA	109	10
Frankfurt	47	-47	478	258	5893	195	217	NA
Hamburg	40	-42	410	329	5061	224	228	-32
Hong Kong	301	NA	43	276	493	NA	570	84
Houston	10	-7	608	57	13016	91	26	-8
Jakarta	171	NA	75	NA	1112	NA	238	NA
Kuala Lumpur	59	NA	170	270	4032	NA	227	NA
London	42	-35	348	122	3892	190	325	-25
Los Angeles	24	7	644	18	11587	57	55	48
Manila	198	NA	66	NA	732	NA	481	NA
Melbourne	15	-27	518	131	6436	117	101	-55
Montreal	34	-41	420	118	4746	NA	222	NA
Munich	54	-5	468	258	4202	177	404	NA
New York	19	-15	484	79	8317	105	155	-23
Ottawa	31	NA	510	82	5883	68	135	17
Paris	46	-33	360	136	3459	175	295	0
Perth	11	-32	523	119	7203	119	54	-60
Phoenix	11	22	644	75	11608	61	15	6
Portland	12	-11	764	57	10114	141	46	21
Sacramento	13	-2	563	36	13178	NA	15	-19
San Diego	13	12	559	45	13026	NA	29	-6
San Francisco	16	-3	604	48	11933	111	112	9
Seoul	245	NA	66	NA	1483	NA	460	NA
Singapore	87	-17	102	164	1864	338	457	NA
Stockholm	53	-19	409	186	4638	157	348	149
Surabaya	177	NA	40	NA	1064	NA	174	NA
Sydney	17	-21	449	109	5886	92	160	-37
Tokyo	75	-17	225	1315	2103	267	461	3
Toronto	42	13	606	103	5019	NA	350	127
Vancouver	21	-16	565	98	8361	NA	117	-15
Vienna	68	-25	363	288	3964	NA	422	36
Washington	14	-33	620	114	11182	NA	106	7
Winnipeg	21	-32	412	51	6871	67	98	-34
Zurich	47	-22	444	253	5197	NA	515	46

Table A.4.1 Recorded Changes in Traffic Levels, Source: Cairns (2003)

Description	Vehicle flows on altered route/area		Vehicle flows on parallel/alternative routes		Traffic Change	
	Before	After	Before	After		
Nurnberg Rathausplatz 1988-1993 (5 years)	24,584	0	67,284	55,824	-146.6	*
Wiesbaden city centre and boundary 1990-92	1,303	366	8,445	7,968	-108.5	*
Southampton city centre 1996-2000	5,316	3,081	26,522	24,104	-87.5	*
Nurnberg Rathausplatz 1988-1989 (1 year)	24,584	0	67,284	70,692	-86.1	*
Tower Bridge closure (1month)	44,242	0	103,262	111,999	-80.3	
Partingdale Lane local area 1997 (6 months)	988	18	2,519	2,735	-76.3	
Rotherhithe Tunnel closure 1998 (1 month)	40,000	0	245,381	260,299	-62.7	
Hobarti tasman Bridge collapse (14 months)	43,930	0			-61.3	
Orpington high street closure 1996 (3 months)	1,105	760	7,084	6,847	-52.7	*
Bologna city centre 1981-1989	177,000	87,000			-50.8	*
Hanshin-Awarji earthquake 1995	252,900	103,300	205,900	233,600	-48.2	
Gothenburg CBD (1970-1980)	150,000	81,000			-46.0	*
New york highway closure 1973 (2 year)	110,000	50,000	540,000	560,000	-45.5	
Edmonton Kinnaird bridge closure	1,300	0	2,130	2,885	-41.9	
New york highway closure 1973 (1 year)	110,000	50,000	540,000	560,000	-36.4	
Hammersmith Bridge 1997 - local area only	36,698	3,000	104,698	122,106	-33.5	
A13 closure, 8 June 1996	56,000	22,800	50,800	65,513	-33.0	
Partingdale Lane local area 1997	988	21	2,519	3,190	-30.0	
A13 closure 1 june 1996	56,000	19,722	50,800	71,463	-27.9	
Oxford Street 1972- I Phase	1,800	950	4,050	4,400	-27.8	*
Ring of Steel " Central core 1992-1994"	160,000	120,000			-25.0	*
A13 closure 15 june 1996	54,200	26,804	52,200	67,347	-22.6	
Aarau 1988-1994	1,444	1,132	2,275	2,301	-19.8	
Oxford Transport Strategy 1999	57,186	46,773			-18.2	*
Hamm 1991	21,500	18,000			-16.3	*
York: Lendal Bridge closure 1978-1979	16,250	0	49,100	62,800	-15.9	
Luneberg 1991-1994	106,002	90,597			-14.5	*
Wolverhampton 1990-1996	81,500	69,750			-14.4	*
Hobart: Tasman bridge restored 1975	43,930				-14.0	
Bologna city centre 1972-1974	213,200	185,500			-13.0	*
Leeds HOV 1998	3,384	2,779	10,824	11,069	-10.6	
Cambridge Bridge street closure 1997	23,411	20,931			-10.6	*
Oxford bus lanes 1974-1975	60,684	54,820			-9.7	#
Cambridge core traffic scheme 1996-2000	76,155	69,792			-8.4	*
Loma-Prieta Earthquake 1989	245,000				-7.5	
A104 Bridge Road bus lane 1994	34,070	31,102	81,609	82,121	-7.2	#
Freiburg ring road 1996-1997	34,200	22,600	64,500	73,700	-7.0	*
Oxford city centre 1974-1984	60,684	56,599			-6.7	
York bus lane (% 50 signal capacity)	681	650	600	594	-5.4	#
York bus lane (% 67 signal capacity)	681	645	600	606	-4.4	#
Cardiff bus lanes 1993-1996	156,299	149,596			-4.3	#
Gotenburg central urban area 1975-1980	320,000	307,200			-4.0	*

Table A.4.1 continued

Leicester ring road 1996	4,575	3,972	6,059	6,511	-3.3	
Edinburgh princess street closure 1997	221,953	215,011			-3.1	*
M4 bus lane 1999	52,800	51,300			-2.8	#
NorthRidge earthquake 1994	698,000	670,000			-1.7	
Nottingham traffic collar 1975-1976	13,380	13,150			-1.7	
Wolverhampton 1990-1996	222,900	220,300			-1.2	*
Cambridge emmanuel road closure 1999	70,030	69,792			-0.3	*
Ring of steel " Square mile 1992-1994"	254,192	253,613			-0.2	*
Edinburgh princess street closure 1997	221,953	221,834			-0.1	*
Munich bridge closure 1988	32,000	0	71,000	103,000	0.0	
Vauxhall cross area 1999	537,543	539,734			0.4	
Orpington high street closure 1996	1,105	744	7,084	7,461	1.4	*
Frankfurt am main bridge closure 1989	29,500	0	162,500	192,500	1.7	
Westminster bridge 1994-1995	41,739	41,284	90,276	91,626	2.1	
M4 bus lane 1999	52,800	54,000			2.3	#
Cambridge Bridge street closure 1997	31,869	28,781	44,286	48,338	3.0	*
Norway street enhancement 1991-1995	15,300	15,800			3.3	*
Leicester ring road 1999	10,935	11,212	7,542	7,918	6.0	
Aarau 1988-1994	18,292	17,244	26,512	30,093	13.8	
Six towns bypass project 1992-1995	38,212	30,968	51,697	66,808	20.6	
Leeds HOV 1998	3,384	34,038	10,824	11,634	25.5	

Where the third and fourth columns are shaded, traffic was counted crossing a cordon around an area-wide scheme (typically a town center) such that there are no alternative routes into the affected area. (Source: Cairns, 2003)

* : town center scheme

\# : bus lane

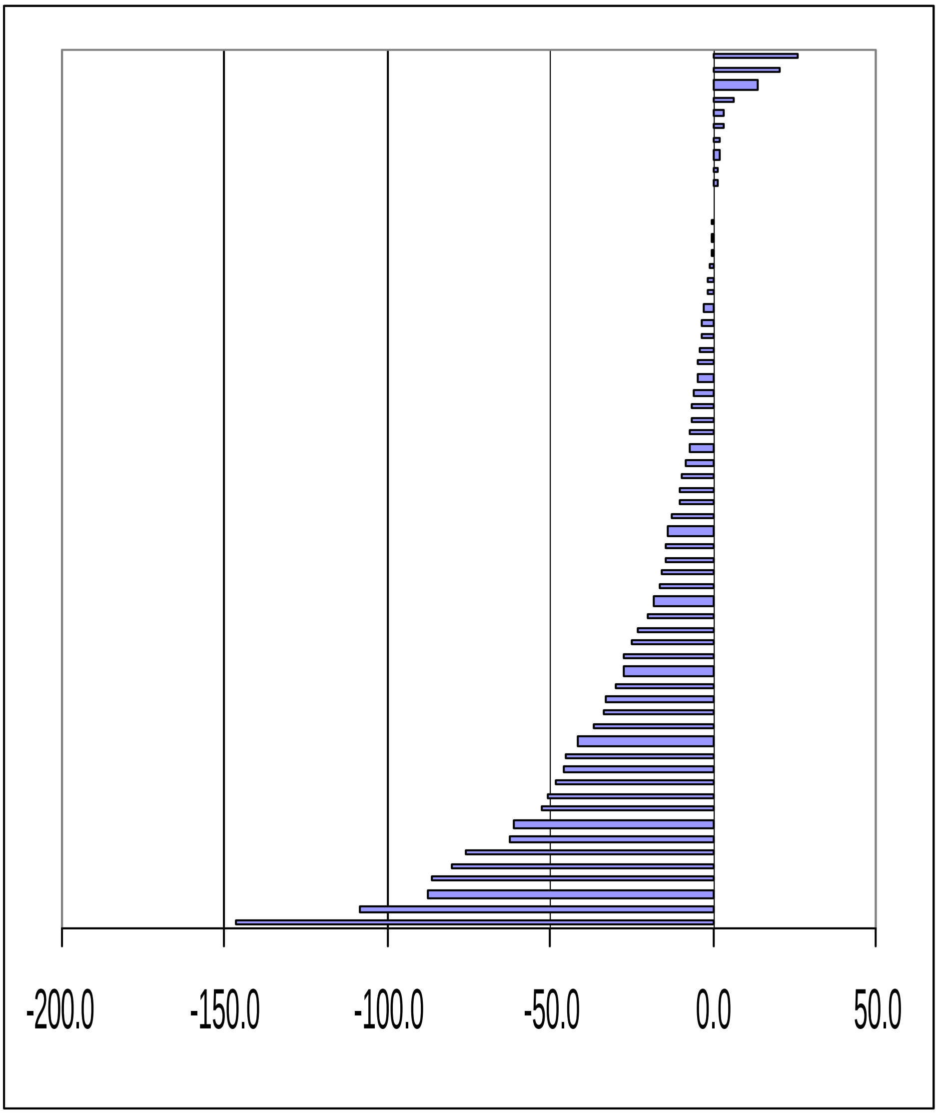
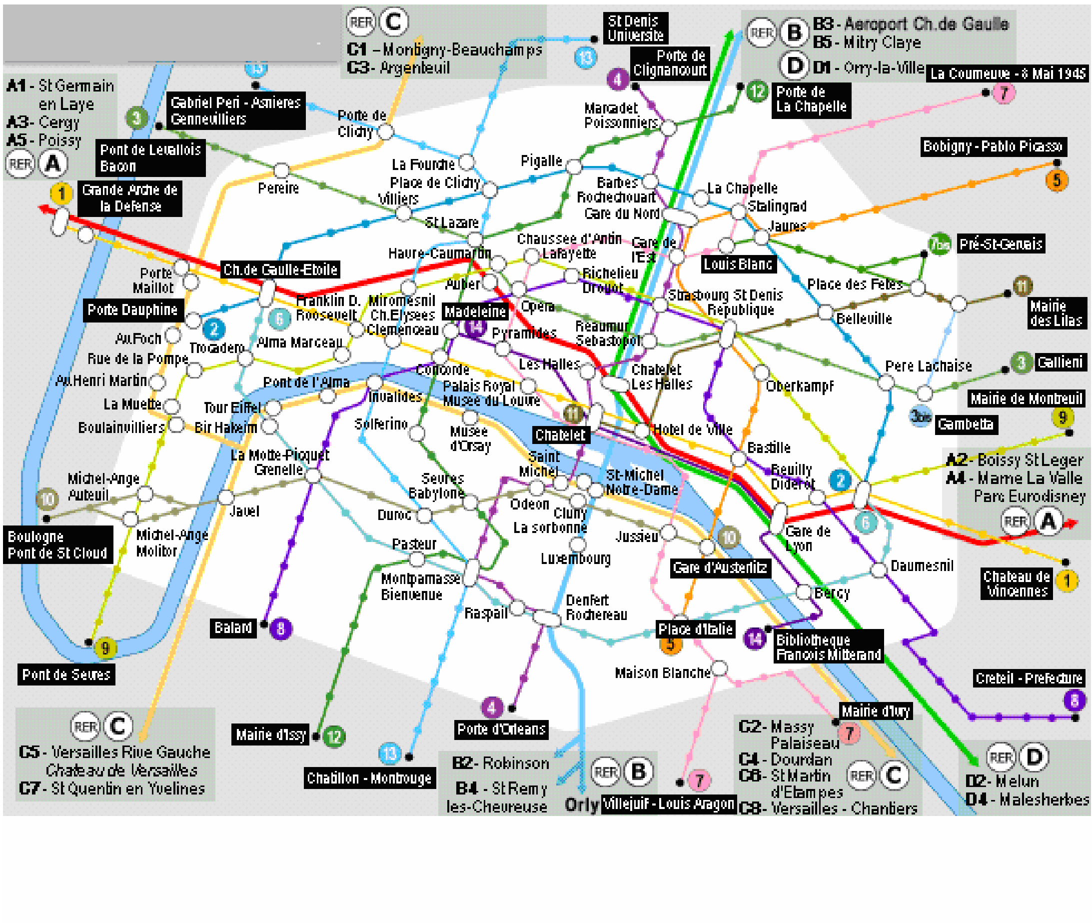


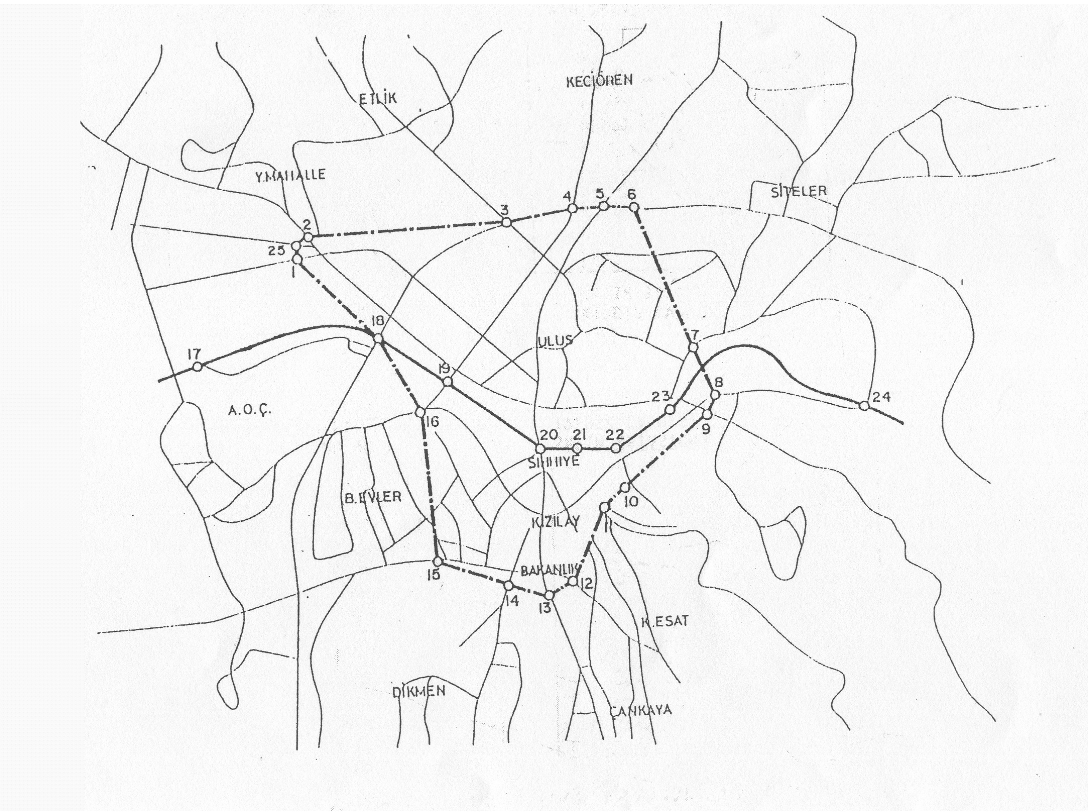
Figure A.4.1 Distribution of Percentage Change in Traffic Levels in Individual Case Studies, Source: Cairns (2003)



Map A.5.1 The routes of the Paris Metro

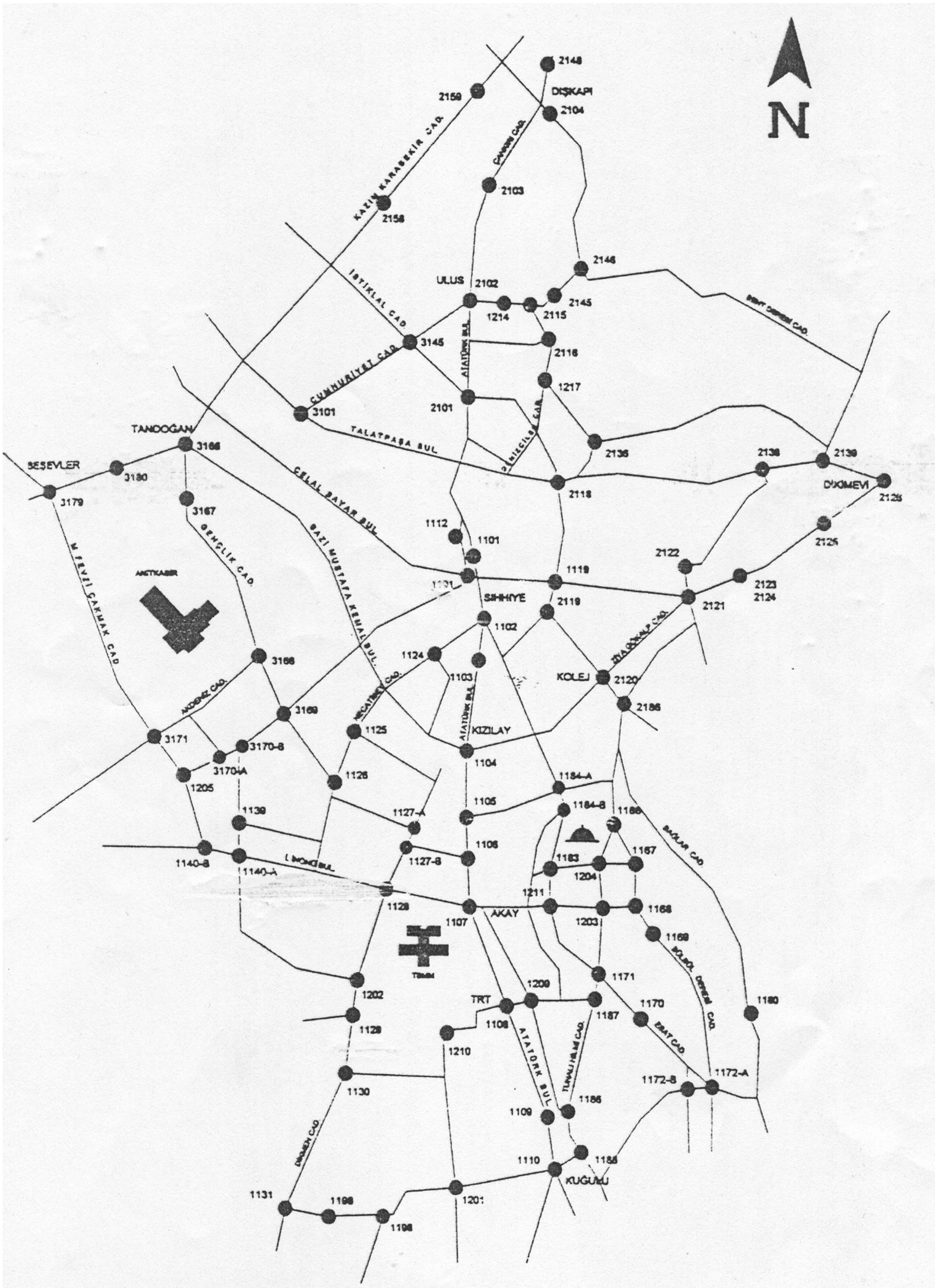
Table A.5.1 Car Ownership Levels in Ankara, Source: EGO (1995)

BOLGE NO	BOLGE ADI	BOLGE NUFUSU	OZEL OTO SAYISI	OZEL OTO BASINA NUFUS	OZEL OTO SAHIPLILIK ORANI (BINDE)
1	ULUS	6.063	449	13	74
2	KULTUR	516	0	0	0
3	KIZILAY	8.525	2.155	4	253
4	DEVLET	2.355	392	6	167
5	KOCATEPE	7.548	982	8	130
6	MALTEPE	30.257	4.923	6	163
7	BAHCELI	37.064	7.288	5	197
8	EMEK	27.144	3.980	7	147
10	KAVAKLIDERE	18.197	3.960	5	218
11	CANKAYA	36.363	7.796	5	214
12	AYRANCI	45.541	10.028	5	220
13	OVECLER	48.260	4.693	10	97
14	BALGAT	26.841	1.526	18	57
15	CUKURAMBAR	35.320	2.233	16	63
16	ODTU	7.025	0	0	0
17	ATA	39.431	2.479	16	63
18	ILKER	38.628	4.381	9	113
19	YILDIZ	38.201	2.840	13	74
20	G.O.P.	31.212	8.323	4	267
21	SEYRAN	62.690	6.561	10	105
22	KUCUKESAT	37.950	5.143	7	136
23	INCESU	20.260	2.597	8	128
24	CEBECI	40.334	4.871	8	121
25	TURKOZU	23.553	240	98	10
26	AKDERE	40.456	2.962	14	73
27	MUTLU	35.226	2.394	15	68
28	TUZLUCAYIR	87.212	2.060	42	24
29	KAYAS	67.223	1.792	38	27
30	BOSTANCIK	24.384	1.242	20	51
31	KECIKIRAN	18.809	2.622	7	139
32	GULVEREN	23.593	641	37	27
33	GULSEREN	18.014	716	25	40
34	DEMIRLIBAHCE	18.071	1.263	14	70
35	HAMAMONU	6.227	333	19	53
36	HISAR	23.468	1.594	15	68
37	YENIDOGAN	36.336	753	48	21
38	ALTINDAG	32.770	953	34	29
39	DISKAPI	13.830	1.456	10	105
40	ISKITLER	13.672	775	18	57
41	HIPODROM	264	44	6	167
42	AYDINLIK	48.592	5.180	9	107
43	SITELER	11.818	215	55	18
44	ONDER	113.743	3.027	38	27
45	GUNESEVLER	56.090	2.372	24	42
46	SOLFASOL	21.173	330	64	16
47	AKTEPE	82.001	4.120	20	50
48	KECIOREN	145.398	10.030	14	69
49	SANATORYUM	93.811	3.931	24	42
50	ASAGIEGLENCE	19.842	1.821	11	92
51	VARLIK	3.246	306	11	94
52	ETLIK	169.250	15.495	11	92
53	YENIMAHALLE	42.120	4.131	10	98
54	KARSIYAKA	116.106	6.475	18	56
55	DEMET	96.310	11.434	8	119
56	GAZI	12.729	4.598	3	361
57	BESTEPE	10.256	1.536	7	150
58	GUVERCINLIK	2.338	195	12	83
59	ETIMESGUT	33.026	1.006	33	30
60	CALISKANLAR	26.164	1.297	20	50
61	SAIMEKADIN	31.511	1.544	20	49
63	BATIKENT	46.213	4.107	11	89
64	ERYAMAN	6.904	618	11	90
65	OSMANIYE	18.624	920	20	49
66	SINCAN	28.096	643	44	23
67	ERLER	144	21	7	143
68	ESKISEHIR YOLU	9.700	2.265	4	234
69	DIKMEN	24.888	5.734	4	230
70	NATOYOLU	114	0	0	0
71	KARAPURCEK	2.870	0	0	0
74	IVEDIK	894	224	4	250
81	SINCANKUZEYI	39.725	2.119	19	53
90	GOLBASI	26.039	2.342	11	90
	TOPLAM	2.468.595	207.476	12	84

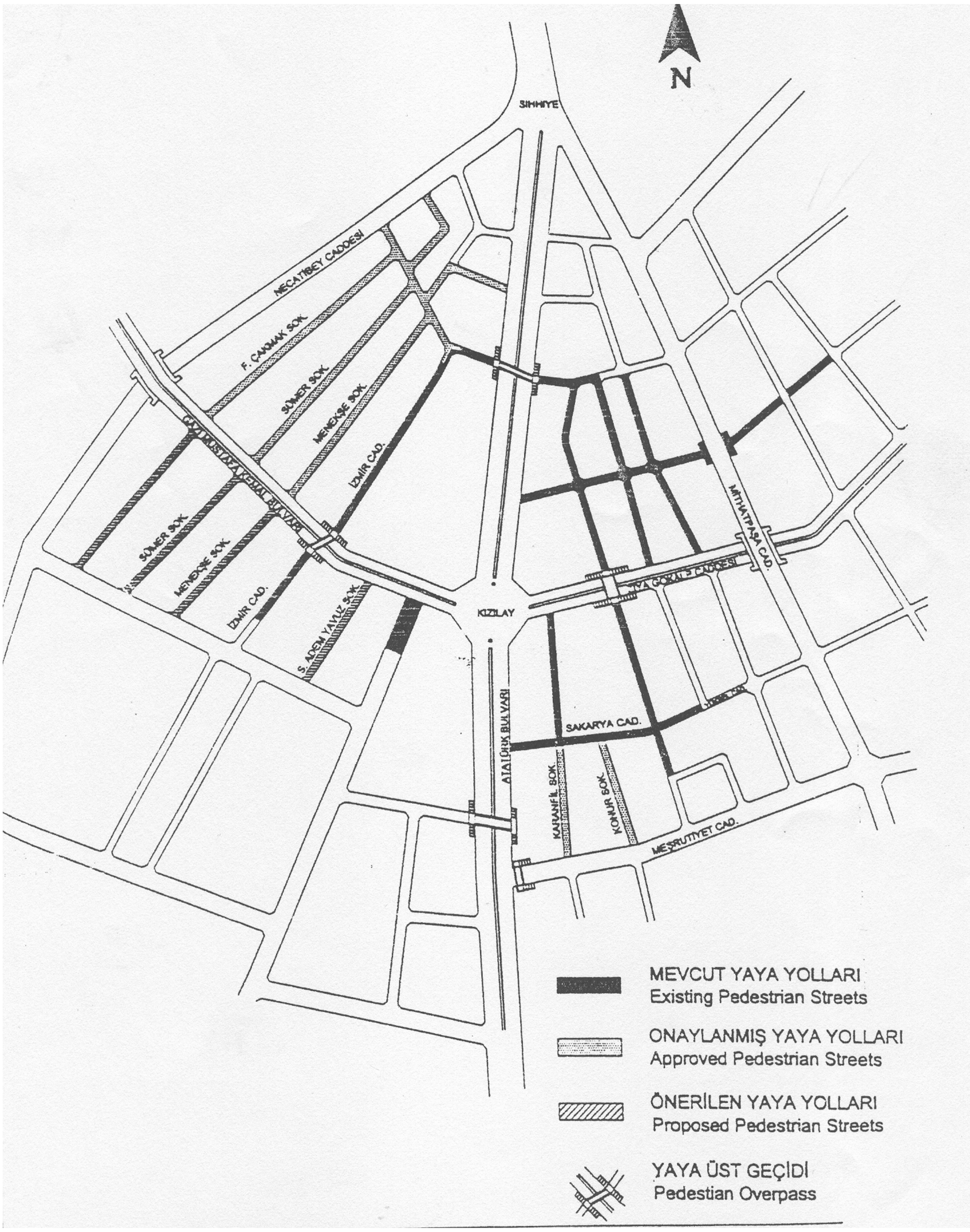


Map A.5.1 Locations of the Count Stations

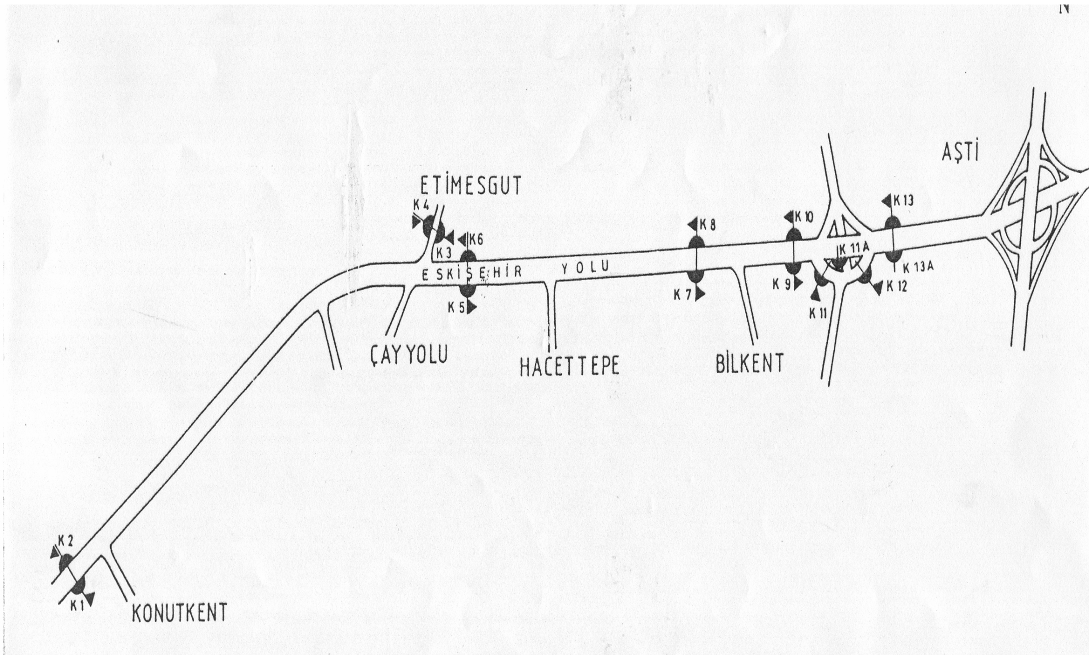
1. ISTANBUL STREET
2. IVEDIK STREET
3. ETLIK STREET
4. FATIH STREET
5. IRFAN BASTUG STREET
6. SAMSUN STREET
7. PLEVNE STREET
8. MAMAK STREET
9. TIP FAKÜLTESI STREET
10. KIBRIS STREET
11. LIBYA STREET
12. ESAT STREET
13. ATATÜRK BOULEVARD
14. DIKMEN STREET
15. INÖNÜ BOULEVARD
16. FEN FAKÜLTESI STREET
17. ÇIFTLIK STREET
18. BAHÇELERARASI STREET
19. DEGOL STREET
20. SIHHIYE STREET
21. HASIRCILAR STREET
22. DUMLUPINAR STRDEET
23. TALATPASA STREET
24. SAIMEKADIN STREET
25. FAHRI KORUTÜRK STREET



Map A.5.2 Locations of Intersections



Map A.5.3 Pedestrian Regions in Ankara



Map A.5.4 Location of Count Stations along Eskisehir Highway