A GIS BASED ANALYSIS OF THE EFFECTS OF NEIGHBOURING LAND USE ON THE TRAFFIC CONGESTION ON CONNECTOR ROADS: THE CASE OF THE HADIMKOY- BEYLIKDUZU CONNECTOR ROAD

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by

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June 2007

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AUTHOR DECLARATIONS

1. The material included in this thesis has not been submitted wholly or in part for any academic award or qualification other than that for which it is now submitted.
2. The program of advanced study of which this thesis is part has consisted of:

i. Examination of relationship between transportation and land use

ii. Making use of vehicle counting, traffic survey and GIS based analysis

Arif KEÇELİ

June, 2007

A GIS BASED ANALYSIS OF THE EFFECTS OF NEIGHBOURING LAND USE ON THE TRAFFIC CONGESTION ON CONNECTOR ROADS: THE CASE OF THE HADIMKOY- BEYLIKDUZU CONNECTOR ROAD

ARİF KEÇELİ **JUNE 2007**

ABSTRACT

Transportation is the most important and most current problem of Istanbul, like other entire metropolitan cities. People lose lots of money and time because of transportation and related congestions. Rapid development and unplanned urbanized area have reduced mobility of the people on the existing roads. Another point that should be stated here are roads which have been built without thinking about today's population and future situation. However, building roads was just part of the problem because rapid and unplanned creation of the industrial and residential sites have caused transportation problems, along with many environmental problems.

The aim of this study is to determine the relationship between traffic congestion on the Hadimkoy-Beylikduzu connector road, which is one of the important parts of Istanbul, and the surrounding land use types; then produce some solutions for the problem. The road carries import and export materials, industrial products, raw materials, industrial tools and of course services for people and private cars. Many types of vehicles have to use this road at the same time and because of this the road exceeds its capacity. Also, the distribution of the parking lots for lorries and warehouses is the reason of the problem of the road. The other negative effect is the lack of alternative route if there is an accident or a traffic jam on any part of the road. The HBW trips are playing important roles on the traffic condition of this road.

In this study, vehicles have been counted during three different times of the day: in morning, in noon and in the evening peak hours. There were three different classifications while counting, type of the vehicle, directions and time. Also, there were 250 surveys that drivers took on 3 different control points along the road with the help of the police officers. One of the other important steps of this study is to create a land map of the Beylikduzu, Kirac and Hadimkoy region, by 1963, 1987, 1996 and 2004 aerial photos and satellites images. The traffic attraction and generation potential of the close surrounding area of connecting road, have been counted by TransCAD software program.

86,4 percent of the drivers think that there is a problem on the road due to survey data. So, decision makers have to be careful when using the results from the surveys. According to counted survey results, Hadimkoy and Kirac intersections need immediate renewing and reconstructing. Most effective solution is to have an alternative gate to connect Hadimkoy to TEM motorway. On the Kirac intersection, an underpass or overpass could solve the existing queues, because the transit passing is dominant on this point all day.

Key Words: Land use, Transportation, Traffic Congestion, Planning, GIS

BAĞLANTI YOLLARI ÜZERİNDEKİ TRAFİK YOĞUNLUĞUNDA YAKIN ÇEVRE ARAZİ KULLANIMI ETKİSİNİN CBS TABANLI ANALİZİ: HADIMKÖY-BEYLİKDÜZÜ BAĞLANTI YOLU ÖRNEĞİ

ARİF KEÇELİ **HAZİRAN 2007**

ÖZET

Ulaşım, bütün metropol kentlerde olduğu gibi İstanbul'un da en önemli, en güncel ve en fazla para ve zaman kaybının yaşandığı sorun olarak karşımıza çıkmaktadır. Hızlı gelişim ve bunun sonucu olarak ortaya çıkan plansız yerleşim, hızla artan nüfusun mevcut yollarda hareket kabiliyetinin düşmesine sebep olmaktadır. Mevcut yolların, günümüz nüfusu ve yakın gelecekteki nüfus tahminlerine bağlı trafik üretimi göz önünde bulundurulmadan inşa edilmesi de vurgulanması gereken diğer bir husustur. Bununla birlikte sadece yolların inşası değil sanayi ve yerleşim alanlarının son derece hızlı ve uzun vadeli düşünülmeden oluşturulması bazı çevre problemlerine sebep olduğu gibi, ulaşımı da olumsuz yönde etkilemektedir.

Çalışmanın amacı, ulaşım probleminin yoğun olarak yaşandığı noktalardan biri olan Hadımköy-Beylikdüzü bağlantı yolu üzerindeki trafik yoğunluğunun yakın çevredeki arazi kullanımı ile ilişkisini incelemek, problem kaynaklarını belirleyip çözüm yollarını ortaya koymaktır. Mevcut yol, ithalat ve ihracat ürünleri, endüstriyel malzeme, hammadde, sanayi araç-gereçleri ve tabiki insan ulaşımını sağlayan servis ve bireysel otomobilleri içeren çok sayıda aracı taşımaktadır. Çok sayıda ve farklı karakterlerde aracın aynı anda ulaşımını bu yol üzerinden sağlamaya çalışması yol kapasitesinin üzerinde bir yüklenme olması ciddi trafik yoğunluğuna neden olmaktadır. Bölgedeki tır antrepoları ve konteynır depoları da bu yol üzerindeki trafiği olumsuz yönde etkileyen nedenlerdendir. Diğer bir negatif etken ise, trafiğin tıkandığı noktalarda alternatif yolların yetersizliğidir. Beylikdüzü bölgesindeki yoğun yerleşim alanlarından ev-iş amaçlı seyahat eden otomobiller de buradaki hali hazır durumda oldukça büyük paya sahiptirler.

Çalışmada, yol boyunca belirlenen noktalarda, sabah, öğle ve akşam zirve saatlerde gerçekleştirilen kamera kayıtları aracılığı ile araç tipi, yön ve zamana göre araç sayımları yapılmıştır. Bununla birlikte bölge trafik ekiplerinin yardımı ile 3 kontrol noktasında sürücülere yönelik 250 anket düzenlenmiştir. Beylikdüzü, Kıraç ve Hadımköy bölgesinin 1963, 1987, 1996, ve 2004 yılları hava fotoğrafları ve uydu görüntülerinden yararlanılarak arazi kullanım haritaları oluşturulmuştur. TransCAD programı ile de bağlantı yolu yakın çevresinin trafik üretimi ve çekimi oranları elde edilmiştir.

Yolu kullanan sürücülerin %86,4'ünün bu güzergahta ciddi trafik probleminin olduğunu düşünmesi karar vericilerin dikkate alması gereken bir orandır. Anket ve sayım sonuçlarına göre Hadımköy ve Kıraç kavşaklarında revizyona ve yeni düzenlemelere ihtiyaç duyulmaktadır. Bölgenin gelişim trendi göz önünde bulundurulursa en etkili çözümlerin başında Hadımköy bölgesinin kullanımına açılacak yeni bir TEM kavşağı gelmektedir. Transit kullanımın çok yoğun olduğu Kıraç kavşağı için ise altgeçit yada üstgeçit ile ışıklarda oluşan kuyruklanmalara engel olunabilir.

Anahtar Kelimeler: Ulaşım, Arazi Kullanımı, Trafik Tıkanıklığı, Planlama, CBS

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LIST OF ABBREVIATIONS

IBB	Istanbul Metropolitan Municipality
GIS	Geographic Information System
YÖK	Yüksek Öğretim Kurulu (Higher Education Council)
ISO	Istanbul Sanayiciler Odası (Association of Istanbul Industrialist)
CBD	Central Business District
IETT	İstanbul Elektrik Tramvay ve Tünel İşletmeleri Genel Müdürlüğü (General Management of Istanbul Electirical Tramway and Tunnel Operations)
INT	Intersection
ALT	Alternative
TEM	Transit European Motorway
TURKSTAT	Turkish Statistical Institute
PT	Public Transportation

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CHAPTER 1

INTRODUCTION

It is known that every metropolitan area has some type of transportation problem because of both high population density and the intensity of daily life. In other words, people's lives are as mobile in a metropolitan area as to reach somewhere for something every single day. Thus, there are high densities of traffic throughout—every time of day, at every locale—these big areas. Public buildings like schools and hospitals, as well as government, commercial, and recreational areas, are not close each other. For this reason, people have to move from place to place throughout the day, causing traffic problems as well as costing time and money. Also, poorly managed public transportation systems bring more trouble to such situations, lacking customer comfort and security. The other unavoidable thing is that developing personal income and increasing purchasing power inevitably increase the number of automobiles in the city. It doubles the problem of traffic day by day. Yet another factor concerns the short-term planning of new settlement and industrial areas. Decision makers have to think about (at least) the next 15 years in terms of its economic and demographical development, mainly where to locate and place city functions. Unplanned regions thus often have problems, such as transportation, infrastructure, deteriorated environmental quality, and security.

The relationship between land use and transportation is bilateral. Judgments made without assessments from both will cause irrecoverable troubles. The new applications should prepare for extra traffic load during the duration of any land-use decision, which occurs by new city functions. On the other hand, new transportation facilities increase the accessibility of places and affect the land-use types of the regions for both the middle- and long-term. Those effects should examine very carefully and new structure of the region design in integrity with other parts of the city features by exact guidance and applications. It creates, thus, some livable urban areas (Atış, 2003).

The aim of this research is to find out the effects on traffic congestion brought about by adjacent environment land-use types on the Beylikduzu – Hadimkoy connector road, using the criteria about relationships between land use and transportation systems. Also, this study will make clear the main source of that congestion. The study has divided some sections as written below:

Introduction includes the research problem and information about the connector road present situation. Also, there will be transportation through Istanbul its own capacity, close historical trend, general hierarchy, occasions and threat.

Research Design contains research questions and their definitions, the

study area with its demographical and economical situation. Finally, practical research design processes will be explained.

Literature review of this study includes land use and transportation relationships, land use planning, connector road principles, traffic counting systems and examples of some applications, survey techniques and GIS application about transportation.

Methodology determines the system and techniques that used for this study, like field studies, technological tools usage, survey data collection and analysis, creating maps and GIS integration.

Under the title of **Relationship between Land Use and Traffic Congestion on the Connector Road,** interactions of transportation and land use in general and in study area have placed here. This section is the body of study, the importance of the way in Istanbul, general consideration of the region, physical environment, effects of demography and economy will be discussed here.

Conclusions and Recommendations have all the research results finalized for further study. Survey and counting results will compare and contrast in this section. Also, GIS based analysis will report in this part. All of them will contribute with a geographical view. Recommendations are going to be designed and preparing to present to decision makers. Some direction for future research will be in this part, too.

1.1 Statement of Research Problem

The kind of development and land uses that occur make a difference in how easily people and goods can get to where they need to go. In fast-growing regions of the city, traffic congestion is a frustrating transportation problem. Moving freight and industrial products is often difficult in slower-growing regions. Everywhere, communities want to maintain or improve ways of getting around.

Today, through the Kirac-Hadimkoy connector road, vast numbers of transports are carried out including industrial products, raw materials, necessary instruments, and people. Large numbers of transport results in high traffic density which obviously affects people who need to use this route to reach their work or home, depending on the time of the day. Local environments in the present situation are also creating negative effects in finding the alternative route for vehicles, especially for heavy trucks and lorries. Before and at the end of the work-time period, the road has to carry out different types of transport simultaneously because service buses, trucks, lorries and private cars start to move in the same time-span direct to home or work (figure 1). The situation is worse if there is an accident or another emergency condition. Besides all of them, the locations of the industrial establishments, settlement area and warehouses are playing important roles in this problem.

FIGURE 1: RESIDENTIAL AND INDUSTRIAL AREA

As a thesis study, the main problem and its main reason should be defined properly and then produce some solution alternatives by some filed works, prepare vehicle counting result and survey data, meeting with the local managers, and analyzing them with GIS tools.

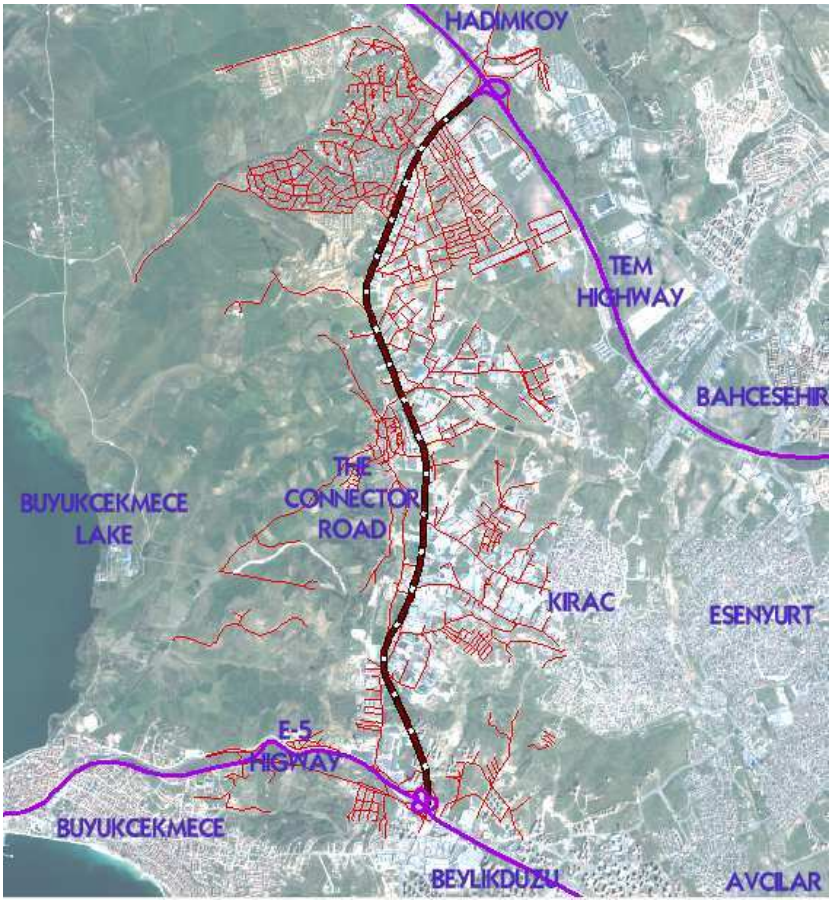
1.2 The Study Area

The road, which this study focuses on, starts from Beylikduzu intersection on E-5 highway to Hadimkoy gates of TEM motorway, approximately eight km in length. This is one of the important connector roads between those two main transportation corridors of Istanbul. There are seven intersections through the road. Three of them - Hadimkoy, Kirac and Beylikduzu - are

more important than the others because they determine the source of the road's traffic capacity. Because of the discussion point of the study is that relationship between land use and transportation, surrounding places should be examined as part of the study area (figure 2).

The study area is completely connected to Buyukcekmece district, which is lies through the western part of the European section of Istanbul. Buyukcekmece lies through the east coast of the gulf, by the same name, and also through the east and southeast coast of the Buyukcekmece lagoon lake.

FIGURE 2: STUDY AREA AND TRANSPORTATION SYSTEM



Buyukcekmece was established as a municipality and one of the sub-districts of the Catalca, on February 19, 1958. It was just an agriculture and recreational center before its rapid urbanization during the 1980s. Thus, the population of Buyukcekmece started to increase in same period of time. It became a center of district on July 4, 1987. The urbanism movement began in 1994, and so, now Buyukcekmece is a kind of modern residential area with its own city functions and infrastructures.

It has nine sub-districts, named Kırac, Beylikduzu, Gurpinar, Mimarsinan, Bahcesehir, Esenyurt, Yakuplu, Kumburgaz and Tepecik. All of them have different types of urban landscape due to individual functions. Real estate, industrial areas and recreational places are cover all around the area.

If there should be a broad explanation about sub-district, Kırac would be the first place because of the study road passes over this place. It is thus directly related to the study area. Kirac Municipality is 35 km from Istanbul (Topkapi). It is surrounded by Buyukcekmece to the south, Beylikduzu to the southeast, Yakuplu to the east, Esenyurt to the north, Hadimkoy to the northwest and Karaagac village to the west. One of the important features of Kirac is that there is a pipeline of natural gases to reach Europe. The geographic situation of Kirac is quite interesting considering its neighboring areas. Because of the valley shape and many riverbeds, there are more buildings on the slopes. Industrial buildings dominate the flat places. A high

percentage of the residential areas is covered by shanties. There are lots of Turkish immigrants who came from Georgia, Greece and Yugoslavia during the exchange in early republic. Also, there are more people from East Anatolian and Black Sea Regions of Turkey. Rapidly increased population and being without financial support caused to not enough infrastructure and unplanned development all over the Kirac. Besides them, there is an industrial complex which is the biggest in Istanbul and third in all of Turkey.

Beylikduzu is another important sub-district of Buyukcekmece. It is divided from Kırac by E-5 highway, lying up to the Marmara Sea in south. Gurpinar and Yakuplu have border with Beylikduzu. As in general history of this place, Rums used to live around Beylikduzu, until 1924. After the Salvation War had ended, there was an exchange between Turkish people who live in Greece and the Rums who live in Turkey. The first migrants' economic activities included agriculture, husbandry and fishery. It was bound to Catalca until 1988, when Buyukcekmece got it in its own borders. Today, the Beylikduzu region is one of the attractive residential areas of Istanbul, with its fresh air, real estate, malls and close recreational functions. There are lots of projects planned by both municipality and the private sector surrounding urban landscape planning, constructions, art and culture and education.

One of the other sub-districts is Gurpinar, located in the southern part of Beylikduzu. This was an old Rom village, too. After Beylikduzu began to

develop as an attractive residential area, Gurpinar absorbed more migration too. It was such a small village only 15 to 20 years ago; but now it is a city with its own seven km long cost line, real estate, summer houses, malls and other city functions.

Mimarsinan is new face of the Buyukcekmece district. After Beylikduzu and its surrounding area came close to its own residential capacity, Mimarsinan became another attractive place. It is located in the western part of the center of Buyukcekmece district, lying across the Marmara Sea coastline. There are also some mixed land uses currently seen. Fabrics, real estate, shopping centers and some agricultural fields are located close to each other.

Bahcesehir is an interesting sub-district of Buyukcekmece. It has a long history up to its current position as a satellite town, since 1926. This is one of the successful satellite town projects accomplished in Bahcesehir which started in 1990. Today, there are over 16,000 dwelling-units up there. Bahcesehir is such an example to modernize municipality system and management. It is the unique municipality of Turkey which has taken from "Europe Honor Flag Award" for local management.

Esenyurt, Yakuplu, Kumburgaz and Tepecik cover the rest of Buyukcekmece. Yakuplu is an alternative place to Beylikduzu. Esenyurt is more close to Avcilar than Buyukcekmece, but it is bound here. All of these places seem more shanty-like than the others, except Kumburgaz.

Kumburgaz is one of the famous summerhouse locations in Istanbul. It used to host primarily summer activities and houses, but today there are lots of people who live in Kumburgaz in all seasons.

The last sub-district is Hadimkoy, which is bound to Catalca district. Hadimkoy is one of the other important places for our study because of its hosting to developing industrial area. There is high traffic flow to Hadimkoy, as both origin and destination. This is why it is the focus in our preliminary thinking about the source of and reason for congestion.

There is a big mismatch between the land-use types all around the region, and it is hard to explain how they are located so close to each other. At a glance, it looks like a planning mistake.

1.2.1 Economy

The last twenty years, the importance of the location decisions of the industrial institutions is critically increasing. Because of the number of this kind of establishments are ascending day by day, the traditional city is losing its environmental values. Industrial establishments have lots of input and countable elements; location decision-makers have lots of studies about industrial places. One of the past survey results about location decision of some industrial places are listed below:

- Connection with a highway 83%
- Closeness to manpower 71%

- Closeness to market 64%
- Closeness to center of raw materials 58%
- Facilities about repairing services 44%
- Contributory industry 43%
- Connection with seaway 29% (Colgan, 2000)

Buyukcekmece district is responsible for the adjacent parcel north of Kirac, related to the connector road. These are covered by the industrial establishments, warehouses, production centers and import and export trade. Because of its location, this place is preferable for the businessmen and decision-makers. By a superficial view, this place appears far away from the city center and city crowd; furthermore, it is the nearest place to one of the biggest harbors of Istanbul, Ambarlı, and it is also in reach of the TEM motorway. Thus, this region is the biggest industrial area in Istanbul and the third-largest in Turkey. According to SAN_BIR union member database, there are 398 official industrial factories in the region; informal counts say there are actually more than 500 industrial establishments here. According to a list of the "Association of Istanbul's Industrialist" (Istanbul Sanayiciler Odası), there are more than 500 companies and nearly 50,000 employees in this region (Table 1).

TABLE 1: CLASSIFICATION OF INDUSTRIAL TYPES AND DISTRIBUTION OF THE TOTAL EMPLOYEMENT OF BUYUKCEKMECE

Sector No	Type of Industry	Employee
Sector 1	Industry of Grinding Food	1102
Sector 2	Industry of Food with Cacao and Sugar	657
Sector 3	Industry of Mixed Food	132
Sector 4	Industry of Canned Food	127
Sector 5	Cotton Thread and Combine Cotton Industry	322
Sector 6	Construction Industry	114
Sector 7	Industry of Woolen Thread	45
Sector 8	Sea Vehicles Industry	20
Sector 9	Weaving Industry with Silk and Artificial Fibres	292
Sector 10	Bending and Wrapping Thread Industry	47
Sector 11	Industry of Tricot	382
Sector 12	Industry of Socks	2169
Sector 13	Knitting Cloth and Ready-Made Cloth Industry	1506
Sector 14	Cold Iron, Nail and Civata Industry	331
Sector 15	Mechanic Products Industry	191
Sector 16	Machine, Tools and Spare Part Industry	1064
Sector 17	Electrical Tools, Accumulator and Illumination Industry	630
Sector 18	Land Vehicles Industry	1800
Sector 19	Industry of Copper and Its Alloy	761
Sector 20	Industry of Metals and Their Alloy Except Iron-Copper	890
Sector 21	Miscellaneous Chemistry Industry	273
Sector 22	Medical Industry	10
Sector 23	Industry of Soap, Cleansing Matters and Cosmetic	387
Sector 24	Textile Industry	1554
Sector 25	Industry of Paint-Resin and Printing Inks	411
Sector 26	Industry of Thermoplastic and Galalit Things	409
Sector 27	Leather Industry	330
Sector 28	Rubber Industry	189
Sector 29	Printing Industry	1104
Sector 30	Industry of Paper and Cardboard Products	931
Sector 31	Forest Products and Wooden Furniture Industry	457
Sector 32	Marble and Mining Industry	344
Sector 33	Industry of Glass and Glass Object	261
Sector 34	Soil Industry	180
Sector 35	Industry of Steal and Pressure Works	1485
Sector 36	Industry of Iron Materials	242
Sector 37	Moulding Industry	217
Sector 38	Basic Chemistry Industry	214
Sector 39	Industry of Plastic Materials Producing with Injection	1449
Sector 40	Industry of Electric Production, Motor and Cable	1764
Sector 41	Industry of Electronic	1947
Sector 42	Industry of Plastic Materials Producing with Vacuum	1774
Sector 43	Industry of Cauldron, Pressures Pots, Heating and Cooling	370
Sector 44	Home Device Industry	1510
Sector 45	Industry of Shoes, Artificial Leather and Shoes Product	2775
Sector 46	Industry of Male and Children Ready-Cloth	2361
Sector 47	Sport Clothing Industry	6344
Sector 48	Industry of Female and Other Ready-Cloth	5822
Total Employees Number		**47696**

1.3 Summary of Existing Road Network

Transportation projects and decisions are an inseparable part of city life, so they should develop in collaboration with city planning. The city's land use and transportation systems define the transport demand that will occur in this system with the effects of demography, employment, industry, commercial, schooling, settlement and CBD.

Taking a cursory glance at the severe congestion problems at the Kirac-Hadimkoy intersection, it is apparent that the root cause of the congestion at the intersection is that the TEM/Hadimkoy interchange is a partial interchange that does not allow traffic from the industrial areas north of the TEM to have direct TEM access. All the traffic from this developing industrial area is being fed into the Kirac and subsequently into the Kirac intersection. The situation will only get worse as the land to the north of the interchange has a large amount of vacant land suitable for development, particularly industrial land-uses.

The whole area shows that development occurred without any kind of impact assessment on the existing network. It is affecting the area industries as loss of productivity due to trucks being delayed. It is causing delay to private transportation which wastes energy and causes additional pollution.

It should also be noted that the land east of the intersection, which is

presently low-income residential and marginal service commercial, is more valuable as high-end residential, commercial or industrial.

There is also significant development (particularly residential developments) occurring along the Hadimkoy, which will increase the traffic along the road. This increase in traffic will cause further congestion at both the interchange and intersection. The increase in traffic will further exacerbate the Kirac and Beylikduzu intersections.

The following seven intersections are through the road:

- **Hadimkoy TEM Entrance:** Intersection is distorted and signalization is not performing well. Long lines occur, especially at peak hours. There are two irregular entrance points to the intersection, increasing the problem. Average speed is lower than normal values because the road superstructure is deformed and the high number of heavy trucks. There is over-demand on the connector road – TEM entrance, connector road - Hadimkoy road and Hadimkoy road – TEM entrance. Figure 3 shows the Hadimkoy intersection and Alkent entrance.

- **Intersection of Connector Road with 11th street:** In general, this intersection is not so busy all along the day. There is no traffic congestion and much number of vehicle entrances from here (figure 4).

- **Intersection of Connector Road with 9th street**: This is also an important intersection for the industrial area and lots of factory, but

according to field observations and results of the previous project this intersection has no overload. There is no need for reconstruction (figure 4).

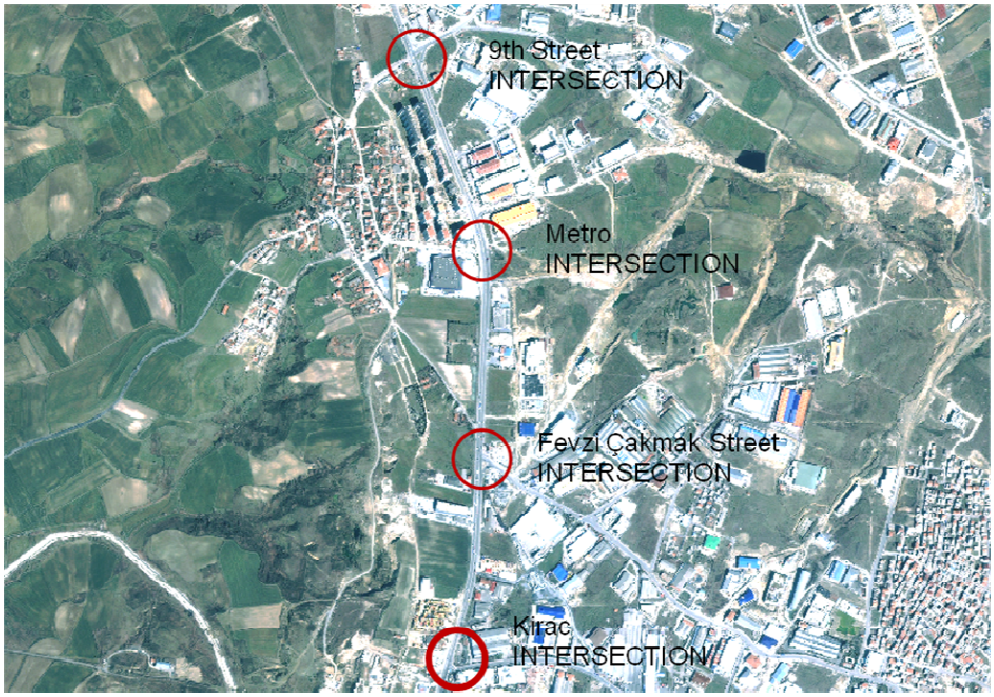
FIGURE 3: HADIMKOY AND ALKENT INTERSECTIONS

FIGURE 4: 11th AND 9th STRETTS INTERSECTIONS

- **Metro Market Intersection**: This is more important than the last two intersections, but there is no traffic congestion here either. Furthermore, the market would be an attractive center in the near-future, and so might be a cause of traffic jams on this intersection (figure 5).

- **Fevzi Cakmak Street Intersection:** This intersection is busier because of the high number of factories and commercial establishment locations surrounding. In particular, the left turn can cause detention on the connector road (figure 5).

FIGURE 5: METRO, FEVZI CAKMAK STRETT AND KIRAC INTERSECTIONS

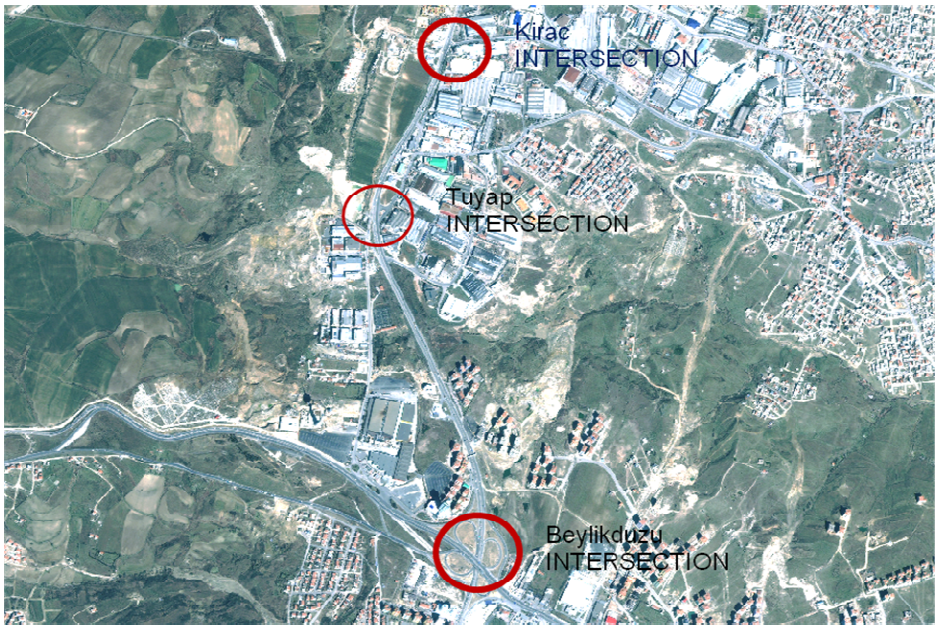


- **Kirac Intersection:** This is the busiest intersection along the connector road. Car lines occur, and detention time gets longest at peak hours. This intersection has a lesser level of service-quality in its present

condition. The vehicles cannot complete their turn during the green light, causing causes lines at the middle of the intersection. This intersection is fed by the Kirac settlement area—different types of vehicles of neighbouring fabrics and commercial institutions (figure 6).

- **TUYAP Exit Intersection:** The road carries out the existing work place's traffic load, except for fair-time. There are frequent U-turns sighted here because of the wrong way entrance, showing us the deficiency of current signboards. Besides them, when drivers miss the Hadimkoy exit over the E-5 highway, they use the fair entrance in front of TUYAP and come to this intersection by following this way (figure 6).

FIGURE 6: TUYAP AND BEYLIKDUZU INTERSECTIONS



1.4 Transports through Istanbul

Istanbul has some problems with land use and transportation systems, like

many of the metropolitan cities all around the world. There were many projects developed and recipes based on the vehicle movement for the traffic and transportation problem of Istanbul until the 1990s. Many new roads were constructed as alternatives for the roads which had traffic congestion. Existing roads have been widened and intersections have been built or reconstructed.

There are too many institutions for planning, management, operation and control to highway, railway, seaway, private and public transportation systems. Also, there are several companies for people- and freight- carrying. They can be classified as central management, local management / municipalities and private institutions.

There are some difficulties and organization problems about transportation planning and the operation of different kinds of transport alternatives because more than one institution enforces transportation functions throughout Istanbul. However, in recent years, managers have developed some policy towards integration of the different transportation types. So coordination is becoming gradually generalized between the public and private operating transport system.

The rate of car ownership in Istanbul is still under the standard of developed countries, in spite of an increased rate of car ownership per person day by day (table 2). This rate averages 350-400 automobile per

1000 people in many European cities, but is still around 150 automobiles in Istanbul (strategic plan, 2007-2011). Public transportation demand is increasing accordingly. Thus, Istanbul's public transportation system's proportion in total city traffic is more than other developed metropolitan cities (table 3). High demand for public transportation (depending on the low rate of car ownership) causes investments in public transportation, forming sustainable transportation policies. More than 50 percent of Istanbul Metropolitan Municipality's budget is expended for transportation investments (Strategic Plan, 2007-2011).

TABLE 2: CAR OWNERSHIP RATES PER A PERSON IN ISTANBUL

YEAR	NUMBER (1000)	AUTOMOBILE PER 1000 PEOPLE
1950	3900	19
1960	21300	30
1970	55400	47
1980	201400	49
1990	559400	76

Source: İstanbul 1. Kentiçi Ulaşım Şurası Raporu (2002)

Istanbul holds 2500 years of historical and cultural heritage, besides its geographic and natural beauties. Roughly and piece formed of the Istanbul create a chance for applications of unusual transportation system alternatives, even while it causes troubles about the solution of the traffic problem. The obligation of preserving historical and cultural heritages gives rise to basic qualification of transportation applications. All of this shows the necessity of integration between the railroad (subway, tramway, etc.) and

other transportation systems throughout Istanbul. If the railway system of Istanbul is compared to some other metropolitan cities, we see a lower level of present railroad line, as in table 3.

Stimulation of linear development of Istanbul's Metropolitan area along an east – west axis had been a spotlight during the regional planning works in the 1960s. Forests and water basins located along the northern part of the city limit possible growth.

TABLE 3: EXAMPLES FOR DENSITY AND PUBLIC TRANSPORTATION RELATIONSHIP

CITY	POPULATION DENSITY	RATE OF PUBLIC TRANSPORTATION PER PASSANGER -KM	RATE OF RAILROADS PER PASSANGER - KM	RATE OF PUBLIC TRANSPORTATION FOR HOME TO WORK TRIPS
NEW YORK	19,2	10,8	76,0	26,6
PARIS	46,1	30,5	82,8	36,2
LONDRA	42,3	29,9	74,2	40,0
TORONTO	41,5	23,6	55,1	30,1
TOKYO	71,0	63,6	96,1	48,9
SYDNEY	16,8	15,8	62,6	25,2
HONG KONG	300,5	82,3	43,4	74,0
BANGKOK	149,3	33,3	0,4	30,0
MANILA	198,0	66,7	6,2	54,2
ISTANBUL	101,2	73,9	5,7	50,4

Source: İstanbul 1. Kentiçi Ulaşım Şurası Raporu (2002)

The density of central business districts, the policy of decentralization and the development of sub-regions play important roles in the city and regional planning processes. Home-to-work trips are having a bigger impact day by day, due to the policy of decentralization and expansion of the transportation lines. Common transportation facilities of Istanbul are IETT, minibus, railway

and seaway. The distance between central points and endpoints of those systems are shown on the table 4.

Highway lines cover to 90,54 percent of total transportation systems in Istanbul. Seaway systems and facilities comprise only 3,33 percent despite the fact that the city is surrounded by the sea. Also, the railway system is deficient with its 6,13 percent rate in total (strategic plan, 2007-2011). The rate of the transportation systems in city and the distribution of the trips are shown in the table 5. There is a decrease in usage of the suburb railway line, which connects east to west. In the highway transportation systems, 32,66 percent of the trips occur by private car. Following the private car usage rate are minibuses with 21,07 percent and IETT with 14,75 percent. The public transportation rate is 59,5 percent of total highway transportation and 70,43 percent of total transport (strategic plan, 2007-2011). The rapidly increasing rate of car ownership in Istanbul also presses the highways to capacity. Thus, these factors point to the need of new transportation investments. After all, Istanbul's topography is not really suitable to have new wide transportation investment. Also, local management should have to pay high price for expropriation, if they try to do some construction around dense residential areas and CBD. So in recent years, Istanbul Metropolitan Municipality tries to solve some local problems with intersection and tunnels where traffic congestion stops to life.

TABLE 4: DISTANCES BETWEEN THE CENTRAL AND END POINTS OF THE TRANSPORTATION SYSTEMS OF ISTANBUL

IETT Line	Central and End Point	Distance (km)
European Part	East-West (Eminonu-Mimarsinan)	46,7
	East-Northwest (Eminonu-Gaziosmanpasa-Tasoluk)	43,5
	North-South (Eminonu-Rumeli Feneri)	38,9
	North-South (Eminonu - Kısırkaya)	35
Anatolian Part	Uskudar-Tuzla	44,2
	Uskudar-Kurtdoğmuş	46
	Uskudar-Cumhuriyet	36
	Uskudar-Halayıkdere	34
East-West (Istanbul)	Tuzla-Mimarsinan	100
Suburb Line	**Central and End Point**	**Distance (km)**
European Part	Sirkeci-Halkalı	27,6
Anatolian Part	Haydarpasa-Gebze	43,8
Minibus Line	**Central and End Point**	**Distance (km)**
European Part	Eminonu	-
Anatolian Part	Harem-Gebze	58
IDO Seaway (ship)	**Line**	**Distance (mile)**
	Kartal-Yalova	14,5
	Bogazici	6,5
	Marmara Line	17
IDO Seaway (sea bus)	**Line**	**Distance (mile)**
European Part	Yenikapı-Yalova	52
	Yenikapı-Mudanya	90,2
	Boğaz hattı	32,4
Anatolian Part	Eminönü-Bostancı	18,8
	Bostancı- Bakırköy	27
	Kartal-Yalova	29
	İstanbul-Bandırma	126

Source: Strategic Plan of Istanbul, 2007-2011

1.5 Occasions and Threats of Istanbul through Transportation

There are some occasions and threats of Istanbul's transportation listed below:

Occasions:

- Creating a database of transportation systems
- Existence of the seaway transportation opportunities
- Coordination of municipality and private sector
- Minimize traffic jams by supplying most effective usage of road and decreasing breach of rules with effective traffic control and management.
- Supply an alternative and high capacity Bosphorus passing with Marmaray railway.

Threats:

- The existence of several kinds of hazard risk
- Local managements lack the budget for new transportation investment to solve problems
- Lack of chance to construct a new road throughout Istanbul
- Increasing the car ownership by increase of personal income during the process of EU.
- Increasing the average transport distance and time
- Illegal land use
- Unplanned green area or residential area
- Irregular distribution of population between counties
- Divided transportation systems develop because of the geographical feature of the city.
- Emergency roads cannot be free because of the deficient control
- There is not enough qualified worker and technical instruments to have effective traffic control.
- Close residential, commercial and recreational area create heavy traffic. (Strategic Plan, 2007-2011)

TABLE 5: DISTRIBUTION OF THE TRIPS ACCORDING TO THEIR TYPES

	Type of Transport	Number of Vehicle	Daily Average of Transport	The rate in its own kind (%)	The rate in general (%)
HIGHWAY TRANSPORTATION	IETT	2463	1.400.000	14,75	13,35
	ÖHO	2046	1.121.000	11,81	10,69
	Automobile	1.522.521	3.100.000	32,66	29,57
	Minibus (registered)	5860	2.000.000	21,07	19,08
	Minibus	590	70.000	0,74	0,67
	Taxi (registered)	17.416	750.000	7,90	7,15
	Service Bus (registered)	32.000	1.050.000	11,06	10,02
	Sum	1.582.896	9.491.000	100,00	90,54
RAILWAY TRANSPORTATION	Suburb(TCDD)	58	102.888	16,01	0,98
	Subway	32	140.000	21,78	1,34
	Light Subway	76	200.000	31,12	1,91
	Tramway	55	185.000	28,78	1,76
	Nostalgic Tramway (Tunnel-Taksim)	2	1550	0,24	0,01
	Nostalgic Tramway (Kadıköy-Moda)	4	1800	0,28	0,02
	Tunnel (finüküler)	2	10.800	1,68	0,10
	Cable Car (cabin)	4	700	0,11	0,01
	Sum	233	642.738	100,00	6,13
SEAWAY TRANS.	IDO	83	254.307	72,80	2,42
	Motorboats	100	95.000	27,20	0,91
	Sum	183	349.307	100,00	3,33
	Principle Sum	1.583.312	10.483.045		100,00

Source: Strategic Plan of Istanbul for 2007-2011

Sometime in the next thirty years Istanbul will approximately more than double in population, if the population increase continues along the same trend. The Statistical Institute of Turkey has estimated a population of 35.366.122 by 2040 according to 2000 census (TURKSTAT). This means the addition of ten million more people. For every person and building now in the state, space will be needed for another. There will be enough people for

another Istanbul. All which now exists will have to be duplicated in some way to accommodate this growth. Shortly, the growth of the state means that a second Istanbul will be created to sit beside the present one.

The doubling of Istanbul assumes that growth will continue at a rate close to that of the past. Istanbul has been the fastest growing city in Turkey. During the last forty years the population of Istanbul has increased by 33,09 percent, from 7.195.773 million people in 1990 to over 10.018.735 million people by the year 2000 census (TURKSTAT). This was around 1,5 million during 1960s. Most of this growth has increased by migration. This has been primarily from the northern and eastern parts of the Turkey, and also from some other countries, especially the Balkans and Africa. The population of Istanbul is not only much larger, but it is also far more diverse than it has been in the past.

People move to Istanbul for a variety of reasons. It is a state of extraordinary natural and historical beauty that draws people from all over the world as tourists and as permanent residents. But the most important reason is that Istanbul is a state of great opportunity as a place to get a job or start a business. Growth leads to growth, as more people arrive and need more services, in turn providing jobs for the next round of arrivals.

1.6 Discussion

Planning is forecasting for future of somewhere or something in general definition (Atış, 2003).

One of three basic elements that affects the formation of urban areas is transportation priorities / preferences with the economic and cultural priorities. Automobile- and public transport-based transportation models cause development of new sub-regions or renovation of the existing urban area. Both of them needs to be have new land use preference, causing modification of cultural approach with regard to the living area. By this way, the cities are formed to current conditions (Atış, 2003).

The studies about relationship between land use and transportation try to explain the factors for location decision for activities and also try to find out their susceptibility, interaction and collaboration. Transportation includes movement of people and property, so the factor in location decision of human activity is strongly important for transportation planning (Baycan, 1993).

There are lots of activities to traffic demand but transportation studies just care about the most important ones. Eighty to ninety percent of total trips are home to work and home. Thus, the first place to observe for transportation planning is residential areas. Traffic generations from residential areas usually flow to commercial, shopping and recreational places. Also, we can arrange two main groups of transportation as public and private (Ruth, 2006).

Trip generation and common transportation types are really different from

each other according to land use types. There are several main categories as attraction center for trip generation (Atış, 2003):

a. Residential area

b. Commercial and Industrial area

c. Terminals or stations

d. Public Buildings

e. Public Open Spaces

f. Manufacture area

Business- or work- based trips are the most common types throughout developing cities. In general, these types of trips begin from home. It could be by vehicle (and even by walking), but transportation studies focus on trips by a kind of vehicle. Preference of transportation type is not stable. It changes depending on the public transportation facilities and car ownership rate. Automobile usage is reduced when public transportation systems are practical and functional by accessibility, security, cost and comfort. But if we glance at Istanbul's situation, we see there is high automobile usage in spite of a low general income. The reason for this unusual behavior is the poor public transportation system.

1.7 Research Design

1.7.1 Introduction

In this chapter, the research questions at the heart of this study are stated. The research activities and all the techniques that will be used to answer them are also explained. Then the main aims of the study are defined based on the questions. After that, certain research boundaries and scopes are explained, and the study area is controlled in order to be able to work on it in detail. Following this starting-point, the practical research design is provided in order to define the function of the study. After this one, each step of the research activities is clarified and elaborated. Finally, the case study approach is addressed. To be able to be studied as a case study, a place needs to demonstrate uniqueness. In this chapter, the uniqueness of E-5 - TEM connector road is explored.

1.7.2 Research Questions:

There should be many different points to observe and examine regarding this road and its relations with the surrounding environment. Upon the completion of this study, comparison of the results to identify:

1.7.2.1 Which arterials and main roads fed this connector mostly?

This question has been asked to determine the main source of the traffic volume along this road. There are really complex usages, and the main directions should be found as origin and destination.

1.7.2.2 What type of trip is common on this road?

The main purpose of the trip that passes over this road every day is absolutely necessary to know relationship between land use and transportation interaction. It is going to help us to find out how much trip generate by residential area to commercial or industrial place. How much volume do the heavy lorries create? Besides of them, the traffic flow is still in high volume during the day not just in peak hours.

1.7.2.3 What kind of land use effect to this road's traffic and being reason to congestion?

This question related to the previous one. In fact, the aim of the trip would show to dominant land use type. When some one have a superficial glance on the area, residential field cover more than the industrial field. But there should be some scientific number to determine both the main source and the type of land use with the most effective roles on the road.

1.7.2.4 Are there any problems with present road condition and its lighting system or driver characteristic?

This question is asked to determine what the actual problem is. Actually, there is more than one reason to cause congestion on the road, but some of them are dominant. So the roles of traffic lights, road conditions and intersection geometry have been examined to determine its effect on the problem. Driver behavior also plays a role in the problem.

1.7.2.5 Do drivers have some alternative to reach their destination around this region?

This is another question to aid our understanding of the source of the problem. Also, this question will help to constitute the result and recommendation of this study.

All of those questions have been used for field study, record and survey. Based upon those analyses, several kinds of land use – transportation scenarios developed to show what the region would look like and modeled.

1.7.3 Practical Research Design:

The practical research design is a useful application of the well design for research that would be undertaken if unlimited time, money and effort were available (Ackoff, 1953). In this section, a flowchart of the study's practical research design (figure 7) shows the main directions of the research process and activities. The following include the step of the process:

1.7.3.1 Problem Statement:

In this step, some field observations and public discussions have given direction to this problem. Of course, there are so many places to have traffic problem all around the Istanbul, but this place have some specifications. This is connecting two main transportation vital lines. Also, it is locating so close to residential area that have rapidly increasing population and most attractive place of Istanbul since 10 years.

1.7.3.2 Literature Search and Review:

In this step, transportation and land use interactions have chosen the first topic to search on. Then, traffic survey application and vehicle counting system have searched. During the searching, several university libraries, municipality publications, and surely internet libraries and online book have looked. Also, many internet sites and online journal's site have visited and some of useful studies have downloaded in this way. Another way that have used for collecting literature and data about study area and topic is, demand something from local managers and public institutions. The best place to find the best study, especially thesis that has been done in Turkey, is The Department of Publication and Documentation Center of the Turkish Council of Higher Education (Tez kataloğu, www.yok.gov.tr).

1.7.3.3 Development of Research Questions:

Actually, the questions are naturally developed after some limited observation on the study area. In this step, circumstance condition has tried to clarify by basic research question. Each question's answer will be determining the different blind spot of the research.

1.7.3.4 Selection of Appropriate Research Methods and Techniques:

In this study, the common techniques applied for the processes. Vehicle count information have to placed in every transportation studies because of

known about the actual capacity the traffic volume in different day of the week and also different time of the day. Traffic survey is also too necessary data for decision process of the study because of this one is like a public opinion poll, so, researchers and decision makers have to care about the public thinking and feeling about the problem, they are the actual user of the road. Also, there should not be a quality research unless library research and field works. Finally, GIS tools and technologies have used for the clarified all the data and determine the relations between each other.

1.7.3.5 Study Implementation:

Actually, this part should work on the study area and the area has visited many times during the study period and video recording. While visiting of the site, the driver behaviors, breaking rules, intersections and traffic lights, road conditions and mixed usage of the road have been observed and recorded. Also, there are so many talks with the people who live or work around the region and have got their personal observation and thinking.

1.7.3.6 Data Analysis:

There are mixed analysis in this study. For the analysis of the survey results, MS excel and SPSS software programs have been used. Also, some of the typed into GIS environment and shown on the existing study area map by some different symbology to make easy to understand. The vehicle recording results have designed in MS excel with its total, percentages and

graphics. Another thing is land use maps of the area. This map has created by 2 different aerial photographs and 2 satellite images which taken in four different years -1963, 1987, 1996, 2004-. The one that have created by using 2004 satellite image of IKONOS include population and employment data in its own database. It made easy to designation to interaction. 3D and spatial analyst tools have used to create analysis maps.

1.7.3.7 Data Interpretation and Explanation:

After finishing the data analysis, the information will be evaluated in detail in order to determine the extent to which land use represents a threat to this connector road.

1.7.3.8 Identification of Secondary Research Results:

This part has located in the conclusion and recommendation part of the study, to give some clue for future studies and shows the missing point of the study. In fact, this study intended to show interaction between land use and transportation, so, it doesn't include any transportation planning result. Also, four step models should be applicable for this road as a future study.

1.7.3.9 Dissemination of Research Result:

The publishing in academic journals and informing the decision makers are two main aims of the result of the study. There are some sub-topic could be basic of some another paper for academic conference and related meetings. Also, local management will have the copy of the research.

FIGURE 7: PARTS OF PRACTICAL RESEARCH DESIGNE

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this section, some of the example applications and papers about relationship between transportation and land use will be shown. There are many studies that worth investigating for this research. The papers have several definitions for both of those terms. However, some of them have several criteria for varied applications and places. Also, this section focused on examining the techniques that used for the study. There are many models for vehicle counting, traffic survey, connector road systems and GIS based transportation studies.

2.2 Land Use and Transportation

One of the studies that have done in Turkey is about relationship between transportation and urban sprawl - industrial dynamics, case study of Beylikduzu industrial region. This one is the closest previous study to current one, as its own topic and techniques. The author have mentioned about the developing stage of the industrial regions and its own role on the current sprawl's development; and also, all of those interactions with the transportation. He has formed his general thought as industry has extra charge to current traffic capacity of the region. At the present time, there is

no problem but in future, some clues have shown that it would be (Atış, 2003).

There is another study that includes the examining of industrial regions by transportation planning. It has compared two different industrial areas, called İkitelli and Gebze. Both of them have less activity than it had expected. Even the current condition like this, there is some congestion around both of that region, especially on the intersections. As result of the study, the author has mentioned that transportation planning is the most important thing when decision makers try to place some commercial or industrial function in somewhere in the city (Uslu, 2001).

Another study is about relationship between land use – transportation and accessibility, case study of Istanbul. This is also stated that relationship of transportation and land use is basic need to explain past and present condition and to forecasting for future. The author said that, transportation has a priority for the planning studies because of its own effect on the city dynamics in different scale and expensive investment cost. The author has phrased accessibility and economic-behavioral approaches, and how did they work on Istanbul Metropolitan area (Baycan, 1993).

One of the other studies has included that some assessments about the solutions of Istanbul's transportation problems. There are many studies about Istanbul's transportation problem but applications could not develop as much as same trend with the papers. The reason of this situation had been

studied by the M. Yeni. His most important result is disagreeable applications with the planning decisions (Yeni, 2001).

Land use and Transportation are interrelated. This means, in part, that land use affects the level of transportation service that is needed. For example, where land is used in a low-density pattern, frequent transit service is usually not cost-effective. Similarly, it means that the level of transportation service affects the kind of land use that will be suitable for an area. For example, an established truck route will make it easier for adjacent land to be used for industry. A multi-modal, high quality transportation system can help attract or retain intended land uses.

Relationship between land use and transportation became a spotlight topic by Robert Mitchell and Chester Rapkin studies in Philadelphia. They detected that different kinds of land use create to several traffic flow by using information about land use and urbanize movements. They observed qualitative and quantitative changes on traffic flows changes depends on the land use types. This approach became a kind of starting point for many changing about transportation studies. Information about the distribution of activities all along the urbanize area, densities of activity places, demographical and socio-economic situation of the existing population had collected and determinate to interaction between settlements and city movement, then finally, the idea of organizing to city movements by land use planning had developed.

The connection between transportation and land use is a fundamental concept in transportation. Everything that happens to land use has transportation implications and every transportation action affects land use. Actions by transportation agencies shape land use by providing infrastructure to improve accessibility and mobility. This increases the utility of land and leads to more intensive land use. Land development generates travel, and travel generates the need for new facilities, which in turn increases accessibility and attracts further development. The question of whether transportation influences development or whether land use dictates transportation has been a matter of ongoing concern among transportation professionals since the beginning of transportation planning. There is no simple answer to this question, both happen together and there is a need to consider both simultaneously.

Recently, concerns about urban sprawl have arisen in many areas of the nation. Many diverse groups have common concerns about the role transportation plays in exacerbating or combating the problems associated with urban sprawl, suburban congestion, and jobs/housing mismatches. Some people have argued that efforts to expand the highway system contribute to urban sprawl by decreasing travel times from urban to exurban/rural areas and making undeveloped areas attractive for residential and commercial uses. Often new highway facilities in urban areas have driving times and levels of congestion that exceed that of the highways they

replace, suggesting that new or expanded facilities may be unable to solve long-term congestion problems. 3 Several factors can be identified as contributing to sprawl, including the movement of jobs to suburbs, lower transportation costs versus lower housing costs, preference of many people to live in remote areas away from the problems of the city, and the desire for larger residential lots and units.

Downs stated the relationship between land use planning strategies and congestion. The economic and social costs of sprawl reduce our quality of life. Several tactics for fighting sprawl are discussed. These include growth boundaries, regional coordination of local land use planning, regional tax-base sharing, and region wide development of housing for low-income households. Although potentially effective at addressing many of the negative impacts of sprawl, Downs argues these strategies are not effective at curbing traffic congestion (Downs, 1998).

"Land Use" title of this work includes a critical summary of transportation–land use theory and simulation models and examines intercity and intracity comparative policy studies. The authors conclude that the role of transportation in determining land use patterns has been exaggerated by some. Factors such as rising incomes and changes in production technology have contributed greatly to decentralization. Attempts to use transportation policy to shape land use patterns run the risk of being undermined by these

other factors. For those cases in which transportation does affect land use, the impact is limited and usually is local. Policies designed to control development could conflict with policies that are designed to reduce fuel consumption or air pollution. Housing policies, (e.g., zoning and tax policies) may be more appropriate for alleviating the negative social or economic impacts of sprawl (Meyer, 1981).

Ross's study measures the interaction of land use and travel behavior. The data for the study were provided by the National Personal Transportation Survey (NPTS) conducted in 1995. To access the detail available in the data, population densities have been grouped into five classes: urban, second city, suburban, town, and rural. Other key variables include residential density and work-tract employment density. The scope of this study goes beyond the intent of this land use and transportation awareness program, including statistics on age, gender, race, and income (Ross, 1997).

Another report examines whether density affects the amount of household automobile travel in the United States. The study concluded a 10 percent increase in density leads to only a 0.7 percent reduction in household automobile travel. In other words, most current automobile travel would occur even if residential densities were greatly increased (Schimek, 1996).

Comparing various predictive models stated in another international study. Among the conclusions is that the greatest effect of highway improvement is upon retail employment location, density, and peripheral residential values.

Webster warns that "Planners should take note that if particular policies do not offer people what they want, they will seek more attractive alternatives elsewhere, even if present constraints prevent them from taking up these alternatives immediately. The non-interactive type of land-use model or the conventional transport model tends to ignore all but the first-round effects of a policy. As a result, many of the important adaptive responses of both people and firms are excluded" (Webster, 1990).

The other paper explores the problems associated with the movement of people within the urban form, suggesting that the planning and management of urban growth can lead to the resolution of such traffic issues as congestion through the coordination of land use and transportation. Because transportation is a necessary component of growth, it is vital to any smart growth strategy. Traffic congestion is considered a result of unplanned sprawl and the major reason growth management strategies are politically accepted. The authors call for growth management programs that can withstand the changes in political compositions of state legislatures and the cycles of economies to allow these programs to become fully effective. Examples of growth management programs in Washington State, New Jersey, and California's Contra Costa County, in addition to excerpts from papers of transportation professionals, are provided (Frank, 2002).

Land use decisions are the result of complex interaction of many forces

involving individuals and organizations in both the public and private sectors. There are many factors in the land development process. These include overall population and economic growth, market conditions, individual preferences and life style choices, other infrastructure, changing technology, local planning and zoning polices and geographic and topographic conditions (Brinckerhoff, 1999).

2.3 Connector Road

One of the studies suggests that urban sprawl could be linked to the separation of powers between state and local governments. Often, the state has authority over transportation and the local governments have land use planning authority. This study asks, does it have to be this way? Eleven cases across the United States (where institutional, implementation and planning mechanisms are either in place or being contemplated) are examined. The research found few institutional models but concluded there are several approaches that may prove beneficial. Essentially, each locality would need to develop a corridor management framework that fits its characteristics (Carlson, 1996).

The study about The Cross Bronx Expressway (CBE) reconstructing and priliminary working is a good example of counting and survey applications for the connector. There are limited opportunities to cross between the eastern and western sections of the Bronx due, to a large extent, to the topography

and geography. The CBE and a limited number of through streets provide for east-west mobility. This study shows how the connector road system could be configured given the geographic characteristics of the borough and the current arrangement of local streets, arterial highways, and transit services. The opportunities thus created for the neighborhoods, transit users, motorists, pedestrians, and bicyclists would significantly benefit the quality of life for Bronx residents (Gluck, et. Al.).

One of the other report presents the findings and analysis of the proposed system of connector roads between Edgartown-Vineyard Haven Road and Upper State Road using the results of an origin destination study. The primary focus of the study is to evaluate the existing conditions and future conditions with and without the connector roads (Ford, 2003).

2.4 Vehicle Counting and Traffic Survey

The Department of Conservation and Recreation (DCR) has determined that the Storrow Drive Tunnels between Clarendon and Arlington Streets have deteriorated after 55 years of use and are in need of repair. Several options for bridge repair and associated staging and traffic management are being considered. Critical to making decisions about traffic management schemes and final conditions will be input regarding driver choices. DCR recognized the importance of gathering information required to answer variety of questions. As such, they authorized a comprehensive

Origin/Destination survey to extract this information from the most direct source – the motorists currently using Storrow Drive (BETA, 2006).

One of the other study includes a procedure that author has produced for random location desicion to vehicle counting application. This procedure has resulted in median traffic count volumes on local streets that more realistically represent the variety of local streets that exist. These median volumes, derived from randomly selected sites, are considerably lower than the median volumes derived from historical count locations that are not randomly selected. In addition, the use of randomly selected traffic count locations has made it possible for TxDOT to reduce by thousands the number of counts it performs across the state (Frawley, 2002).

Another example to traffic count application is from Orlando. This report contains 24-hour bi-directional traffic counts for various locations in Orange, Seminole, and Osceola Counties from 2000 through 2004. The counts are listed alphabetically and are grouped according to the county in which they are located. A set of maps showing the traffic count locations is also provided. FDOT's traffic counts are averaged for each year and most are rounded to the nearest five hundred. The maps and figures also presented in the report (Orlando, 2000-2004).

The traffic count program for the West Palm Beach Urban Study Area (Palm Beach County) consists of the collection of traffic count information at

a number of specific locations on the highway network on a regular basis. This information is used in evaluating growth characteristics, determining highway capacity demand and need for improvement to meet growth. It forms the foundation for transportation computer model validation for the study area (PBMPO, 2003).

CHAPTER 3

METHODOLOGY

3.1 Introduction

The methodology of this study was formed by interdisciplinary techniques involving geography, planning and traffic engineering. The geographical view posits that people are directly affected by something. As we know that geography informs everything involving people. Planning is another discipline with a strong influence on daily life because people organize their activities and movements according to their environment and facilities. This study does not include methods directly related to traffic engineering, but rather methods of vehicle counting and classifying

A step-by-step explanation of the methodology is not so easy because more than one application was conducted at the same time. At the beginning, the needs of the study were determined. According to that work chart, budget for instruments and task force was counted and also the draft time table arranged. Then the things below were done one by one, in order.

3.2 Literature and Administrative Review

First of all, the national literature was searched by libraries of the Universities and YÖK's thesis catalogue. Six available studies were found, but none of them in direct interest to our study area. There was just a single

project done by a private firm for IBB's transportation planning department. Besides these, there are lots of international studies and reports on this topic all around world. Actually, the sheer amount of studies shows the importance of topic.

While collecting information from the literature, a list of related local managers and departments was devised with designations. Unfortunately, it was not possible to meet every one of them because their time schedule did not coincidence with ours and also because some were not interested in the study. Also, some were hesitant to give information, in even talking about the present condition. Thus, we did not have any more chances to have meetings and suggestions by local managers and decision makers. However, it was clear that, at the time, there was limited activity (possibly none) regarding the planning around this road by local departments.

3.3 Traffic Records and Vehicle Counting

One of the important things is camera recording for vehicle counting by classification and directions. This part of the study is one of the important steps that formed the body of the study. There was no counting information for this road except the project done in August 2005. But this one also did not have the numbers we desired to have. At first, we met with the responsible people at the IBB's traffic control center. Two of our important intersections could be monitored by their own city camera. One is located

over the Hadimkoy entrance of the TEM highway, while the other one is looking over the Beylikduzu intersection on E-5 highway (figure 9). The permission was received by a petition to the management of this department. It provided us remote access in observing that area. By this way, weekly recording of two intersections was completed. Recording was arranged to record during peak hours, divided to three parts of the day: morning, noon and evening. Each period is 2.30 hours long (7.00-9.30 in the morning, 12.00-14.30 in the noon, and 16.00-18.30 in the evening). Also, the counting of the records was divided into 15 minutes to have more detail about the capacity of those hours. The Kirac intersection has no city camera, and was thus observed by field work and recorded by our own video camera (figure 8). Vehicles were classified as automobile, minibus, pickup, truck, lorry, bus and public transportation.

FIGURE 8: CAMERA RECORDING ON KIRAC INTERSECTION

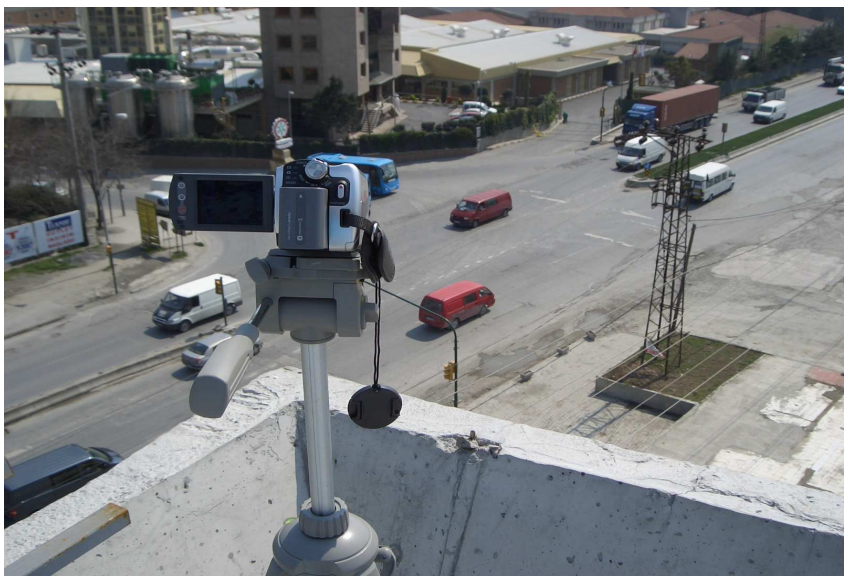


FIGURE 9: LOCATIONS OF CAMERAS FOR RECORDING

Every direction on the intersections was numbered, and flow was presented accordingly (figure 10). For example, for roads x, y, and z, direction of the vehicles which come from "x" and continue to "y", it present as "x to y" in the tables and the text.

FIGURE 10A: NAME OF THE DIRECTIONS OF THE HADIMKOY INTERSECTION

FIGURE 10B: NAME OF THE DIRECTIONS OF THE KIRAC INTERSECTION

FIGURE 10C: NAME OF THE DIRECTIONS OF THE BEYLIKDUZU INTERSECTION

A team was organized by the project director, and after the recording process completed for a point and for a single time. The team received short training about the study and importance of the work. Project purposes, general methodologies and expected results were explained. To have successful results, they should know what they do and have some experience. During their trial sessions or experimentations, some possible errors were corrected and the classification of vehicles became more understandable. Then the team filled out the form, according to time and classification (figure 11). All the data were collected and typed into Excel file in order (the form is in appendix C).

FIGURE 11: VEHICLE COUNTING BY CLASSES AND DIRECTIONS

3.4 Traffic Survey

One of the other important applications is traffic survey. Its form is shown in appendix B. The aim of the survey is to find out the actual reason of the following questions. What is the main source of the traffic volume on this road? What are the common purposes of the trips? What do drivers think about the problem's source? The survey was done by the help of traffic officers (figure 12). They stopped vehicles, and the survey team asked the questions to the drivers; otherwise, it would not have been possible to stop vehicles. This method was applied to 250 drivers.

In fact, survey application was originally planned for morning and evening

peak hours and in two direction of the way at least eight times. But it was not possible because the police officers' time schedules conflicted with the possible times for application. Thus, there were just three applications that could be done. Two of them were in the direction from Hadimkoy to Beylikduzu, and one of them was in the opposite direction. Every application was done between 1.00 to 4.00 p.m. Thus, origin-destination questions gave results involving just work-hour trips. At first it seems like a gap of the survey but, actually, peak hour traffic-counts and road-volume close that gap in the survey.

FIGURE 12: TRAFFIC SURVEY WITH POLICEMEN

3.4.1 Development of Survey:

The development of the planning survey was accomplished with the following tasks:

A. Needs Identification: The first step in planning the survey was to define the issues related to the impacts of the traffic jam on this connector road and to develop an understanding of the problem and needs of drivers who usually use this road. It is necessary to understand the current source of the problem. Besides trading vehicles, commuter characteristics were examined during this survey. The questions included on the survey form would be designed to glean information that can lead to a meaningful evaluation of these strategies.

B. Survey Questionnaire: With consideration to the discussion above, a survey questionnaire was designed to facilitate the drivers' ability to answer questions necessary to develop effective congestion management measures. This form will be developed in draft format and be distributed to supervisors of the study and the people who know about the best statistical value from survey data for review. After incorporation of significant comments, the form was finalized. The form is shown as appendix B.

C. Field Review: Survey locations should review for optimum placement of surveyors. The direction and the time of the survey was designed for getting optimum results.

D. Surveyor Training: A training session was held before going to the field to discuss expectations for the survey. The survey team had to know about the study, purposes and application prior. The following was presented to team members:

- The purpose of the survey
- Safety, including where to stand and how to approach a vehicle
- Proper attire
- Proper conduct
- Procedures for restocking survey forms
- Duration of the survey
- Response to extraordinary situation

The short summary of survey questions are as following:

1. Where did you start this trip?: This question was included because the survey was located somewhere on the connector road and on different directions. To reach approximate origin destination information this question was placed in the survey.

2. Do you use this road in the morning / evening? If so, where does that trip start from?: There were limited chances to do this survey on the road because the survey team needed police help. Thus, the survey

was designed to be as short as possible and cover all the information about road usage. This question was placed in survey for the information of usage for the opposite time of the time that the survey was done. One more thing that this question includes is the aim of the other trip.

3. **Where will you leave this connector road?:** There are 7 main intersections all along the study road and approximately 10 arterials connected here. Thus, this question was placed to examine the capacity or potential of the intersections. Also, its answer gave us information about the attraction of the environmental land use types.

4. **Where is your destination?:** This question was designed to find out the destination of the trips and get some clue about the purpose. There will be some figure that creates this question's impact on the rest of the study.

5. **What is your main purpose of this trip?:** Trip purpose is one of the most important things to know about the relationship between land use and transportation.

6. **How often do you use this connector road?:** This question was asked to drivers to know about the possible volume of the road.

7. **How many people are there in the vehicle? Is everybody going to the same place? If not, where is the passenger's destination?:** This question was prepared to show the other problem of Istanbul's traffic

condition. There are not enough people who share their vehicles even if they go to the same place.

8. Which intersection do you think has the worst congestion? Why?: This question will convey public thinking to decision makers, and also it will help with recommendations for reconstruction or reorganization of the existing system.

9. Do you have any other alternative way to do this trip? If so, what is it?: This question shows us the incurability of the people who have to use this road constantly. There are only two roads as alternatives to this connector, but none is available for every origin or destination.

10. Do you really think there is traffic congestion on this connector road?: It is like a public opinion poll, and as expected, everybody has answered this question with "yes," except those who use this road very rarely or for the first time.

11. Do you arrange your travel time according to the traffic conditions of this road?: The last question also shows another problem of Istanbul; usually, people do not arrange their travel time due to the existing traffic condition. In other words, they do not keep in mind the peak hours before they start their trip.

Survey results and discussions are in chapter 6.

3.5 GIS Based Analysis

GIS tools are very useful in city planning and transportation modeling, like it is in a variety of studies. It is really easy to analyze and show something in this environment. The user can easily create more than one statistic and synthesis by using a basic map and its attribute table. Also, relations and interactions of different types of data can be created smoothly using this technology.

In this study, GIS was used for creating a land-use map of the study area. There are two different aerial photographs and satellite images taken in order: 1963, 1987, 1996 and 2004. Land use was classified as residential area, with high, medium and low density; industrial area; and agricultural area, with open fields and garrison. Besides these, the roads and existing building maps of the area were created.

Land-use maps were informed by the population, employment, dwelling units and traffic generation capacity, road capacity and existing volume, average speed; all of them were used to analyze their collective interaction.

All the analysis, results and discussions are presented in chapter 5.

CHAPTER 4

RELATIONSHIP BETWEEN LAND USE AND TRAFFIC CONGESTION ON THE CONNECTOR ROAD

4.1 Introduction

At first, general interaction between transportation and land use will present here and then according to that discipline study area will examine. Also, results and discussion of the land use analysis will be present. Survey data, vehicle counting results that shows the interactions with GIS tools are going to be locating in next chapter with all of those results, recommendation and conclusion.

4.2 General Transportation-Land Use and Interactions

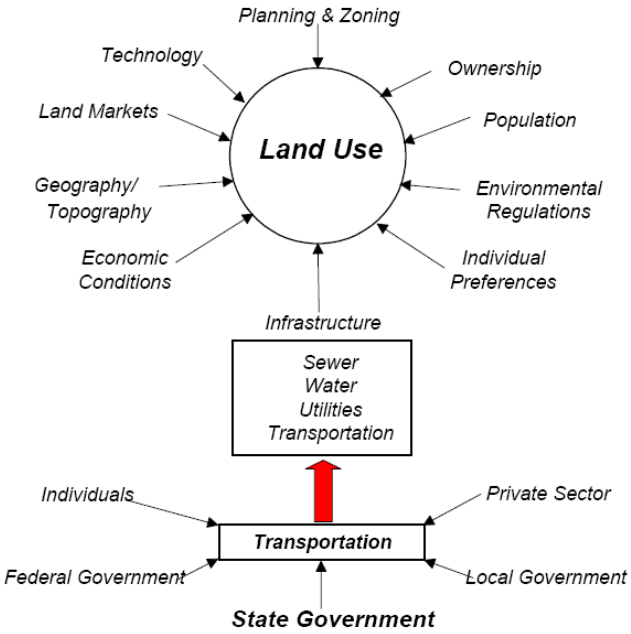
Some points about relationship between transportation and land use should state here. On the one hand, land uses affect transportation by physically arranging the activities that people want to access. Some changes in the location, type, and density of land uses change people's travel choices, thereby changing transportation patterns. On the other hand, transportation affects land uses by providing a means of moving goods, people, and information from one place to another (www.friends.org/goods/transguide)

Transportation systems play a very important role in affecting urban structure. The debate over the "chicken and the egg" issue of whether transportation influences land use development or whether land use dictates

transportation continues. The effect of past transportation decisions and investments are evident in today's development patterns with less than 10% of the total population working in the central business districts of traditional cities (Lowry, 1988). Thus, the transportation – land use connection is one that cannot be ignored and must be addressed for effective planning by local agencies.

Land development is influenced by a large number of forces as shown on the figure 13. Infrastructure, which is comprised of sewer, water, utilities and transportation play an important role in influencing land use patterns. Transportation in turn is affected by individuals, private sector, federal government, state and local governments. As mentioned earlier, the most significant role that transportation plays in land development is affecting access to land. Transportation systems have the potential to indirectly affect land development by either inducing new development or altering the pattern of development. Even through transportation improvement may not bring growth to a region in terms of number of households or square feet of developed area, it may affect the location pattern of land uses. However, due the large number of factors affecting land use patterns, transportation may be considered just part of a complicated process of land development.

FIGURE 13: RELATIONSHIP BETWEEN TRANSPORTATION AND LAND USE



Source: WisDOt, 1996

Land use plans can adapt to different kinds of land usage in different places. Various types of land use plans have been created, and applied to lots number of project. If we should state their official name here, they ordered as Regional Land use Plans, County Development Plans, County Park and Open Space Plans, County Farmland Preservation Plans, Local Land Use Master Plans, Sewer Service Area Plans, Cooperative Plan for Boundary Change, Transportation Corridor Land Use Plans, Federal, Tribal or State-Owned Property Master Plans, Local Park and Open Space Plans, Neighborhood Plans, Local Area Development and Redevelopment Plans, Private Sector Plans (WisDOT, 2002). In fact, every one of them has interaction each other. In other words, planning process could not be reaching the success point as much as expected.

4.3 Land Use of the Study Area:

According to the Public Improvements Plan Report of Istanbul Metropolitan Area Sub-Regions with 1:50000 scales, which is prepared by IBB, the study area is in the Upper Section of Europe Part of Istanbul. Table 6 shows daily trip distribution by type of transportation and table 7 shows the 1996 values of daily travel demand and forecasts of 2010 were created.

TABLE 6: DAILY TRIP DISTRIBUTION AS TYPE OF TRANSPORTATION

	1996		2010	
	Daily Pass. (million)	Ratio (%)	Daily Pass. (million)	Ratio (%)
Private	2,5	26,9	4,5	26,9
Service	1,0	10,8	2,0	12,0
Public	5,8	62,4	10,8	61,1
Total	9,3	100,0	16,7	100,0

TABLE 7A: TOTAL DAILY TRIP DATA OF 1996

SECTION	1	2	3	4	5	6	TOTAL
1	685160	391650	46575	75650	105855	53590	1358480
2	391650	436030	151175	48805	110725	56285	1194670
3	46575	151175	94610	12275	55890	27655	388180
4	75650	48805	12275	254240	122075	541790	1054835
5	**105855**	**110725**	**55590**	**122075**	**850600**	**303300**	**1548445**
6	53590	56285	27655	541790	303300	2749200	3731820
TOTAL	1358480	1194670	388180	1054835	1548445	3731820	9276430

TABLE 7B: TOTAL DAILY TRIP PLANNING DATA OF 2010

SECTION	1	2	3	4	5	6	TOTAL
1	1657080	868620	72615	88280	121620	102340	2910555
2	868620	894050	254435	66250	138125	109850	2331330
3	72615	254435	131950	15995	66935	47285	589215
4	88280	66250	15995	283810	170120	757930	1382385
5	**121620**	**138125**	**66935**	**170120**	**1405750**	**505875**	**2408425**
6	102340	109850	47285	757930	505875	5359780	6883060
TOTAL	2910555	2331330	589215	1382385	2408425	6883060	16504970

Source: Mescioğlu Mühendislik, 2006

SECTION 1: Southern part of the E-5 highway on Asian Side

SECTION 2: Between E-5 and TEM motorways on Asian Side

SECTION 3: Northern part of TEM on Asian Side

SECTION 4: Historical Peninsula on European Side

SECTION **5: Northern part of European Side**

SECTION 6: Southern part of European Side

As stated before, the region is a rapidly developing part of Istanbul, especially for the last ten years. Like the total trip expectation for 2010, population data shows this trend. Table 8 shows the demographic situation and development of the area since 1955. Also, figure 14 shows the rapidly developing trend of the Buyukcekmece population.

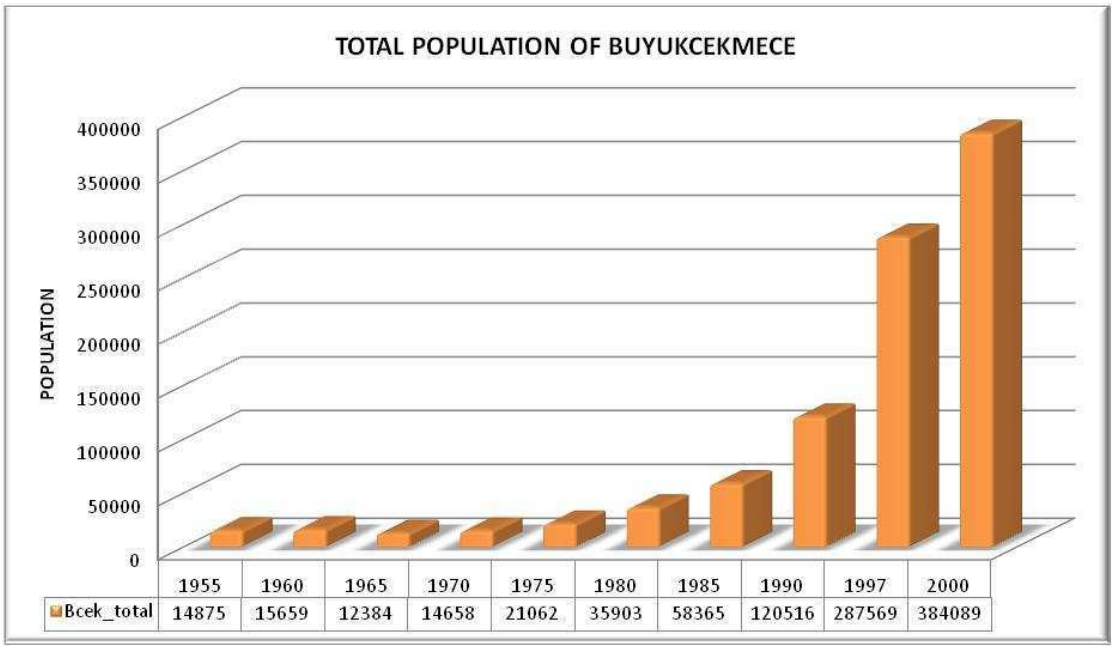
Thus, there should be an immediate intervention to the existing condition to prevent a worse situation in the future. In fact, there seems to be no transportation problem in most parts of the region except in some of the important points. As the area continues to grow, and industrial activities continue to develop, the result is that the current road will not be able to absorb total demand.

The urban movements towards the western part of Istanbul since the 1980s, Kucukcekmece and Avcilar have been affected first, and then Buyukcekmece has become an attractive place to live. Main summer houses and recreational place of the past have been converted the modern livable city and new face

TABLE 8: POPULATION OF THE DISTRICTS AND SUB-PROVINCES (1955-2000)

Population Distribution of Districts and Sub-Provinces of the Region										
	1955	**1960**	**1965**	**1970**	**1975**	**1980**	**1985**	**1990**	**1997**	**2000**
Bcek_center	1846	2125	2269	3913	5204	8121	11.310	22394	36873	35860
Beylikduzu	414	460	486	501	628	866	1021	2170	26786	39884
Yakuplu	584	884	771	974	1045	1252	1664	2841	23510	24960
Gurpinar	1108	1110	1207	1305	1578	2812	3584	10191	22037	25479
Kirac	315	664	365	371	435	544	826	2239	10566	24217
Esenyurt	531	981	1410	923	1631	6636	21290	70280	100565	148981
Bahcesehir	1642	1811	583	613	802	864	924	1538	14356	19018
Mimarsinan	3035	2006	1637	2296	2232	3138	4083	7690	16606	25858
Tepecik	921	1065	1200	1607	3134	4805	7382	21240	14736	18798
Kumburgaz	444	518	693	928	1270	2750	2569	7118	9533	10352
Hadimkoy	8814	4689	8279	10806	4963	4976	6060	6486	7363	10253
Bcek_total	14875	15659	12384	14658	21062	35903	58365	120516	287569	384089
Avcılar_total	1362	3109	3295	9854	14953	30486	106521	126493	214621	233749

FIGURE 14: TOTAL POPULATION OF BUYUKCEKMECE SUB-PROVINCES



of Istanbul. The common problem of the rapidly developing areas is generation of unplanned urban areas. One of these examples can easily distinguish around Buyukcekmece region. The life and environmental quality

are reducing in this way. There are some mistakes and mismatches with regard to land use; this situation especially affects schools, hospitals or health centers. Open fields like playgrounds and some social activity space could not be established wherever they should be (Türkoğlu, 1997). Also, the industrial area which was established in this region before now stays inside or very close to the residential area. Besides them, this rapidly and unplanned developing has spoiled the natural environment of the region.

Some of the other problems of the area are spatial culture and social status differences because of the different residential types located together as well as the social exclusion because of the time and cost of transportation. The last one is poor environmental quality, due to the proximity of industrial area.

Figure 15 shows how land use has developed and changed in the study area since 1963, and figure 16 shows the amount of land cover as percentages over years.

FIGURE 15: LAND USE CHANGE OF THE STUDY AREA

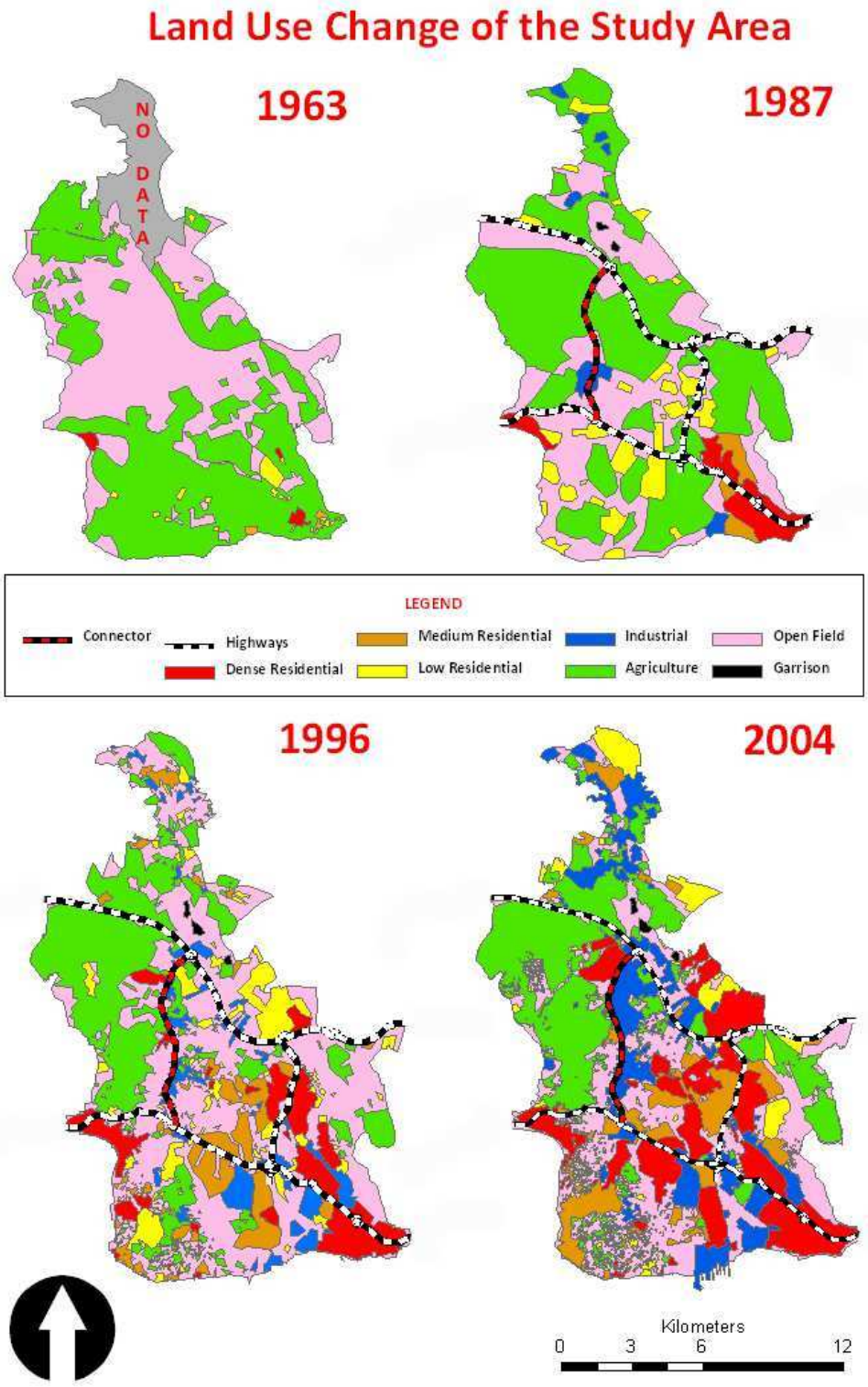
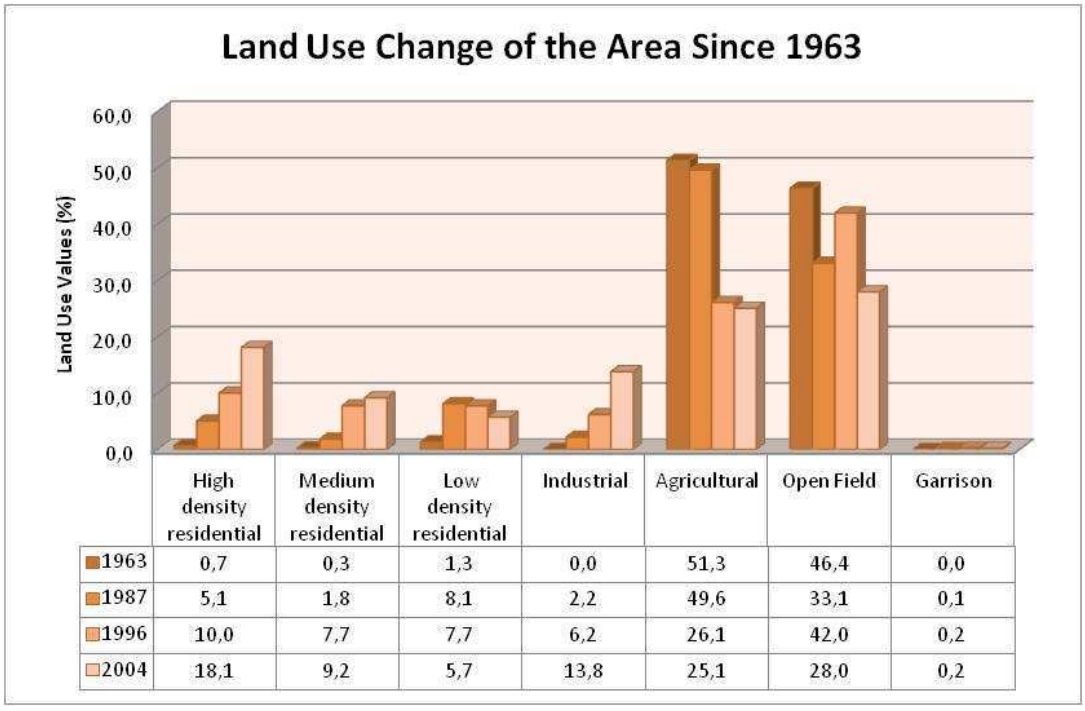


FIGURE 16: LAND USE CHANGES BY PERCENTAGES



	High density residential	Medium density residential	Low density residential	Industrial	Agricultural	Open Field	Garrison
1963	0,7	0,3	1,3	0,0	51,3	46,4	0,0
1987	5,1	1,8	8,1	2,2	49,6	33,1	0,1
1996	10,0	7,7	7,7	6,2	26,1	42,0	0,2
2004	18,1	9,2	5,7	13,8	25,1	28,0	0,2

As it seems on the map, there was no industrial activity around the region. Hadimkoy and its surrounding environment was not available to digitize because of the aerial map used for creating this was not included in that part of the area. Also, there was a garrison field in the area in that time, which could not be presented here because the photo was not enough clear to distinguish as much as that separation. So that part is shown as open field. This garrison has been moved to Hadimkoy in the late 1960s. At this time 51,3 percent of the area was covered by agricultural field. Especially around Gurpinar, Yakuplu and Kavakli there were many agricultural activities, because in that time there was little economic activity except agriculture and fishing. The open space in the middle of the map was the second biggest

land use type in that time, but some of that area was bound by the garrison until the early 1970s. Also, residential area covered just 2,3 percent of the area, and low density residential area was much more than the others.

When we look at the 1987 images, we can easily recognize the changes of the agricultural field places and increasing the residential areas. Actually, the total percentages of the agricultural field was not decreasing so much, it lost just 1,7 percent and still covered 49,6 of the total area. It slid down to the northern part because the southern part started to convert to residential. When we look at the residential area's percentages, it had covered 15 percent of the area. Low residential was still dominating during construction, but high and medium residential potential rapidly increased. This is the first butterfly effect to this area in urbanization and development. Avcilar (south-east part of the map) is the second place to get full after Kucukcekmece because of the migration rate to Istanbul during the 1970s. At this time, industrial activities were started in this region, 2,2 percent of the area to accommodate industrial establishments.

Economic activities, socio-cultural structure and lifestyle are directly affected by land use. In 1996, the area getting more complex and the type of land use locates one within the other. Agricultural activities have moved to the northwestern part of the area, inside the Buyukcekmece Lake watershed. There is no permission to build anything in that part of the area. It reduced half of the last 10 years with its own field that cover 26,1 percentages of the

total. However, 25,4 percentages of the area have been covered by residence. While high and medium density residential area were increased, low residential area was continuing to develop, around Bahcesehir and Gurpinar. By the way, industrial establishments had 6,2 percent of the total.

When we look at the map of 2004, the scenery is really terrible to explain. Every type of land use opens into another. This mixed usage causes the problem of the region. Constructions were already completed and residential areas were getting dominated with its 33 percent covering land. New buildings are continuing construction on open fields around Hadimkoy and Bahcesehir. Because there is very limited available space south of the region. 13,8 percent of the region is bound to industrial activity. Their distributions are very scattered. The Hadimkoy and Kirac regions have the biggest industrial site inside their borders. The Kirac industrial and commercial site is the third one in Turkey and the first in Istanbul of its capacity. Haramidere and Firuzkoy (both are near Avcilar) contain auto-repair industrial sites, but there are factories around Esenyurt and some parts of the Firuzkoy region. Also, the biggest harbor lies in the western part of the Avcilar in the same place a gas warehouse of Aygaz Company is located. None of those estates are located far away from the city's center. Besides these, there are still 25,1 percent agricultural area and 28 percent open fields. Actually, in 1996 and 2004, open fields formed from slopes and abandoned agricultural fields were unsuitable places to build. Still, there are some limited agricultural activities

which continue in some parts of the region; in general, agricultural fields are closely pressed into watersheds of the Buyukcekmece and Kucukcekmece lakes. Hopefully there are two watersheds in the region to stop construction; otherwise, there is enough potential to fill the region with houses and commercial buildings.

4.4 Interaction between Transportation and Land Use of the Area

This section of the study helps to understand actual condition of the area and transportation links. By using some different layer of maps and upload their database, analysis have been available to have some solutions. ArcGIS and TransCAD software program have been used for this step of the study.

The basic GIS step was creating land use maps of the area using two different aerial photos and two different satellite images. The rates of them have given on figure 16.

The surrounded area of the connector road has divided some section due to the homogeneous of the area and using main and arterial roads. Then, population, car ownership per house, average population per house, retail and nonretail employment, dwelling units information have uploaded the program. Production and attraction value of the area have been got in this way. Another table that is includes length, speed, capacity and volume of the road. By this attribute table volume and capacity of arterials and main connector have been created. This step didn't examine very deeply, just

getting some value to clarify the existing condition because of this process mainly interacts with transportation planning works. So, land use values have given absolute clue for the traffic attraction factor and generation points all around the region. In other words, observing the developing of the area and recognizing the main usage at the present time, make so easy to understand transportation condition for the connector.

The steps that have done for getting production and attraction values and also for determine the capacity and volume of the road are following:

First Step: First step is to define a study area which is small enough to operate without problems and which covers the critical area. The area have chosen around the connector road including parts of Buyukcekmece Lake, Buyukcekmece center, Kirac, Esenyurt, Beylikduzu and Bahcesehir. These zones have defined in ArcGIS by clipping it from the original map.

Second Step: It is necessary to divide this study area in small traffic-zones that cover homogenous parts of the land. Usually the borders of these zones are big streets or other existing borders to make the modeling easier. Study area was divided into 12 zones with homogenous settlements and land use and we tried to set the borders either on connector road or the other big streets and one zone is the whole Kirac (5). Three of the 12 zones are part of the Buyukcekmece watershed which means there are no more houses or other buildings (2,7,8). This part was also done in ArcGIS.

Third Step: As the street network in study area contains all kinds of streets from arterials, collectors to small local streets, it is necessary to cut out some of the streets that are not needed. As concentrating mainly on connector road, some of the collectors and all minor streets that are not essential for this study were cut out in ArcGIS. So then, three base maps were being available. One of them is a satellite image of whole Buyukcekmece which is important to have the overview of our study area and additionally to that was used a digitized map of whole Istanbul with the shapes of all buildings. The other two maps are one shape file which only contains our study area and our defined zones and one shape file that only contains our defined major roads within the study area. These will be the three basic maps for all the next steps.

Fourth Step: For trip generation it is necessary to find out the number of employees in the non-retail businesses we used the information of all fabrics in the whole Büyükçekmece district. These numbers supplied us with helpful hints about how many employees there might be in the defined zones. Out of these numbers and the number of fabric buildings of the digitized map of Istanbul, whole numbers of non-retail employees have estimated to add them to the attribute table of zones in ArcGIS next to the average number of people per household and average number of cars per household. The non-retail employee number is officially almost 50.000 people according to ISO.

The last data that was needed is the number of dwelling units on study area. For this, the number of buildings have counted by using digitized map of Istanbul and studied the average number of floors in each zone. With this average number and the assumption that in average there are two flats per floor, so the total number of dwelling units could calculate in defined zones. Three zones of study are parts of the Buyukcekmece Lake watershed, so it was possible to define the number of dwelling units, employees etc. as zero, which makes the modeling easier. All these data were added to the attribute table of the shape file with our zones.

For attractions, the default model is a regression equation that estimates the number of person trips attracted to a zone, based on the retail and non-retail levels of employment in the zone and on the number of dwelling units in the zone. You must have the following information in the zone-layer: retail employment, non-retail employment and dwelling units in the zone.

Fifth Step: To be able to use the Minimum Path Method later in the assignment part in TransCAD it is necessary to define the length of all streets that can be used. The measuring was possible to do in ArcGIS with the measuring tool and all 670 segments of the streets were measured and added to the attribute table. Also the travel time for each segment of the street is required which is possible to calculate from the speed limit and the length. Streets that should not be considered by the program got very low speed and very high travel time values.

But the attempt to run the Minimum Path method there were faced an unexpected problem. The maps and attribute tables so far were done in ArcGIS and later imported to TransCAD. The import was no problem and it was possible to run different methods with these maps. But for the Minimum Path Method there is a "line layer" required on which it is possible to define nodes and links in the street network. Each node and link would have a unique number about length of the segment, type of facility, number of lanes, speed and travel time. Without this layer which somehow has to be done in TransCAD, it is possible to estimate the most probable trip of the people. The decision criteria for selecting a route are distance, travel time and some others.

Besides of this, it is possible to display on the streets network map, on which street the traffic volume is the highest, if there is a column with "traffic volume" in the attribute table.

Sixth Step: At this point it was possible to run the model for the Trip Generation with the Quick Response Method. Classification by autos per household was used and for this, the household size (4 people per household) and the amount of cars per household (0.6) were required for the production side. On the attraction side the number of dwelling units in the different zones and the number of retail and non-retail employees were required. To balance the trips the favorite method was "hold productions".

Finally the population of the whole area has to be estimated, which have guessed were about 75 000 and then Quick Response Method could run.

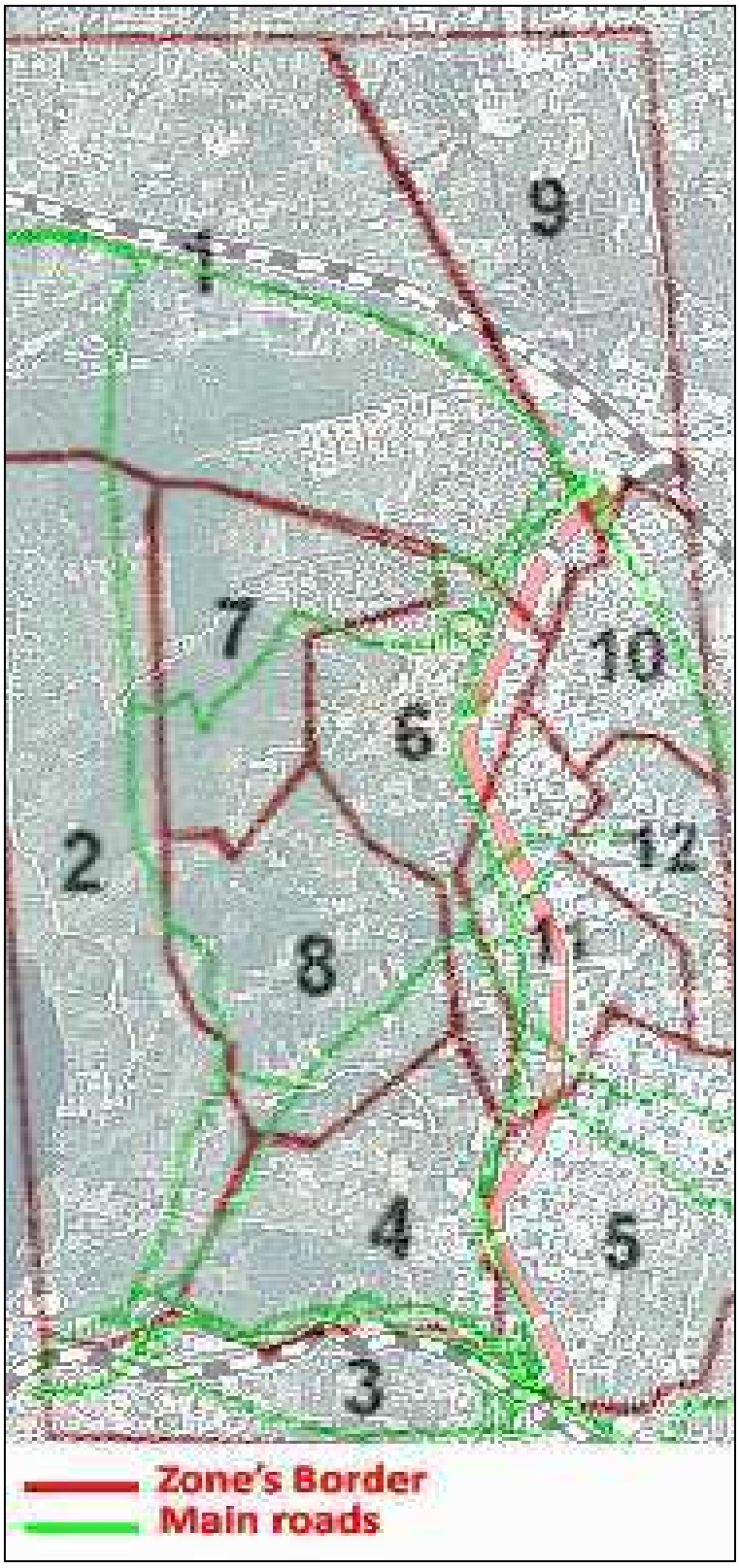
The layers of this process show on figure 17 and result values show on table 9.

TABLE 9: RESULTS OF QUICK RESPONSE METHOD

Dataview1 - QRM_ALL_real numbers_2

ID1	HBW_P	HBW_A	HBNW_P	HBNW_A	HBO_P	HBO_A	NHB_P	NHB_A
1	5.71	76.50	15.50	370.00	0.00	0.00	5.98	260.00
2	5.71	0.00	15.50	520.00	0.00	0.00	5.98	260.00
3	5.71	1708.50	15.50	46002.50	0.00	0.00	5.98	20012.50
4	5.71	161.50	15.50	2988.50	0.00	0.00	5.98	1445.50
5	5.71	12789.10	15.50	12661.50	0.00	0.00	5.98	21682.50
6	5.71	1096.50	15.50	12262.50	0.00	0.00	5.98	4432.50
7	5.71	0.00	15.50	130.00	0.00	0.00	5.98	65.00
8	5.71	0.00	15.50	160.00	0.00	0.00	5.98	80.00
9	5.71	1436.50	15.50	5700.00	0.00	0.00	5.98	2940.00
10	5.71	1317.50	15.50	1636.00	0.00	0.00	5.98	2430.50
11	5.71	4930.00	15.50	8015.00	0.00	0.00	5.98	10007.50
12	5.71	2150.50	15.50	1555.00	0.00	0.00	5.98	3545.00

FIGURE 17: ZONES AND MAIN ROADS OF THE STUDY AREA



CHAPTER 5

RESULTS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

In this chapter, all results of the application will be discussed. Calculations of vehicle counting, survey results and their interactions with land use values will be ranked. Also, the expected reasons of the results are located with those. Present conditions of the road and its insufficiencies will be presented, and a recommendation will be placed for renewal. Also, integration of the study with geography will be proposed.

5.2 Survey Results

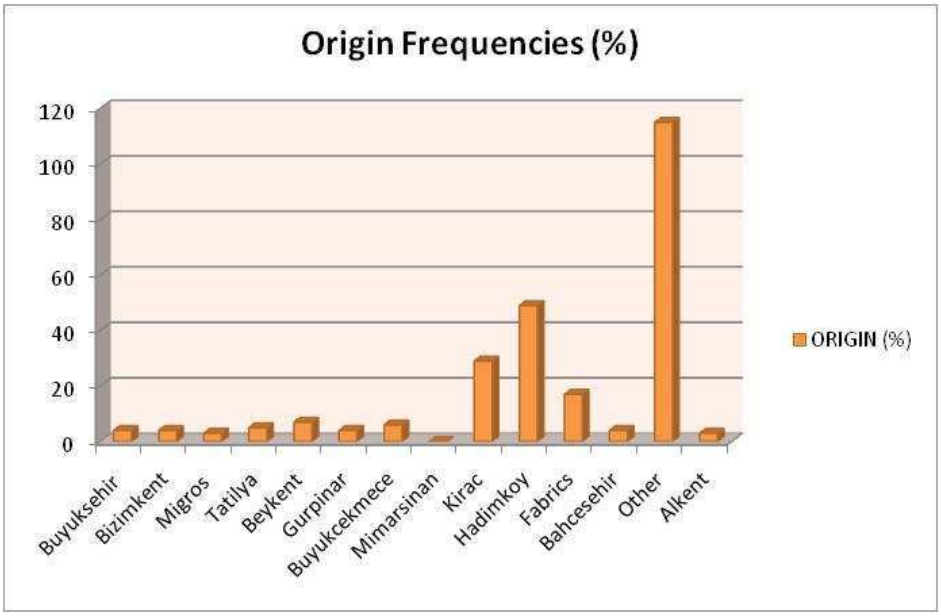
At the beginning of the survey design, origin-destination information had been planned to get at the primary questions. However, there are more things than this one, like purpose of the trips, public opinions about the road, etc. Those are stated in Chapter 3.

The first question regards the origin of the trip, and 46 percent of the participants answered this question as "other" places. There are 13 different sub-regions that surrounded the study road; if the driver came from some place out of this region, surveyors check it as "other". It is hard to classify this part of the result because this region attracts many trips from every part of Istanbul, but İkitelli is the most frequent answer in this part. Industrial

regions' characteristics and interactions are mentioned directly; 11,6 of the answer is "Kirac" and 19,6 was "Hadimkoy". The last 22,8 percent of the answer divided in other alternative in the region because the area is covered by residence except most parts of Kirac and Hadimkoy. So this result of the first question is as expected for our work hour survey. Origin frequencies are located in figure 18.

The restrictive reason of the first question is also affected to the second question too. Because of the vehicles that have stopped for survey are generally commercial, they usually use this road in work hours to freight transport, meeting, marketing and smoothing related with works. Thus, 54,4 percent of the answers were "no". Daily trip generation of the surrounding area is low, but this industrial estate attracts more traffic from another part of the city.

FIGURE 18: ORIGIN FREQUNECIES

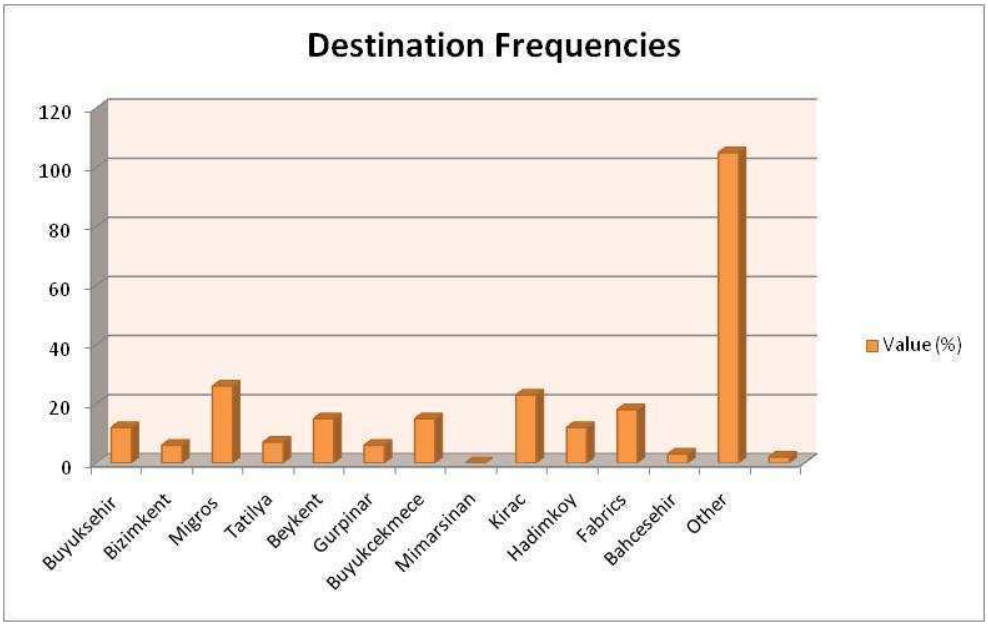


Beylikduzu, Hadimkoy and Kirac are common points to leave this connector road, as their percentage 60% leave from Beylikduzu, 13,6% leave from the Hadimkoy intersection to TEM or the Hadimkoy district and 12,8% leave from Kirac. The time and direction of the survey application directly affected the answer of this question, but there is nothing to do to change the place where police officers assisted.

Work-hour destinations are also related to work-based trips. In turn, the "other" choice has 42 percent of the total destination answers. İkitelli, Corlu, Gebze, Eminonu and some of the other commercial centers of Istanbul have stated as other destination out of the region. Again, because two of the survey applications were in the opposite direction to Hadimkoy, it had a lower percentage than expected, with 12 percent. Kirac and Migros have more than 20 percent, and the other destination-centers share the remainder, with lower than 20 percentage of the total (figure 19).

These survey results are directly related to work hours and work based trips, as 83,2 percent of the purpose were answered as "work based". Also, this answer supported the high percentages of the origin-destination from outside of the region. Besides them, it shows the attraction capacity of the existing industrial region.

FIGURE 19: DESTINATION FREQUNECIES



Some part of the survey was designed as a public opinion poll. One of these parts includes the jam point analysis according to driver thinking. Forty-eight percent of participants think that most the important jam point is Hadimkoy intersection; 14,4 percent think Kirac intersection has the most frequent congestion and 16 percent of the participants predicted more than one point. Also, 12,4 percent of the answer expressed that there is no problem anywhere along the road, but most of them rarely use the road or had their first trip down this road.

Another result as public opinions regards perceived reasons for the congestion. The dominant answer to this question is traffic lights with its 35,6 percent. The reason that people think this will be discussed in the rest of this chapter. The secondary reason is driver behaviors, especially those of

the drivers of heavy trucks, lorries and minibuses. Twenty percent of the total answers include more than one reason.

There are three alternative routes to use for the driver who aims to arrive somewhere around this area. One of them is the Avcilar-TEM connector, second one passes through inside of Kirac and connect to Avcilar connector again, and the last one lies in the western part of the road towards Buyukcekmece, but this one is narrow and road condition is not good. Many participants did not use these alternatives; 94,8 percent of drivers said "no" to the answer of the question about alternative roads that they used to use.

Another point of the survey was to get information about what people did to prevent their time and cost from congestion, so a timing question was asked. But, unfortunately, 93,2 percent stated that they have no time arrangement before they start their trip due to peak hours or possible jam time. This may be one reason for the congestion too. Furthermore, survey data shows that people usually prefer to make the trip with their own car even if alone in the car; 48,8 percent of the driver had made their trips alone. The cars with one or two passengers are usually commercial, and they are the people who work together all along the day, comprising 44,8 percent of the total. This is also a potential explanation of high traffic volume all around the city, not just on this road. Surely, if there were a possibility to have some morning and evening survey application, this rate would not be so drastic.

Public thinking is the most important thing that managers should care about; 86,4 percent of the participant accepted congestion and problems on this connector road. The rest do not use this road very frequently or were conducting their first trip on the road. Actually, this one is enough to do something for this road. This percentage shows there is something wrong.

5.3 Vehicle Counting Results

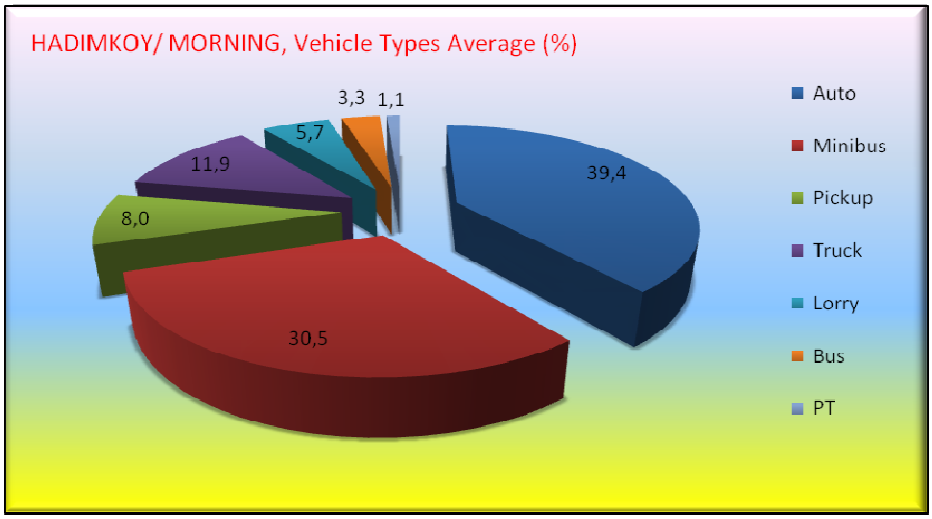
As said before, there are three main intersections recorded: Hadimkoy, Beylikduzu and Kirac. There was no recording of the other four intersections because of the observations of field studies; also, one of the previous project reports shows that there is not as much a problem to the extent something new must be done.

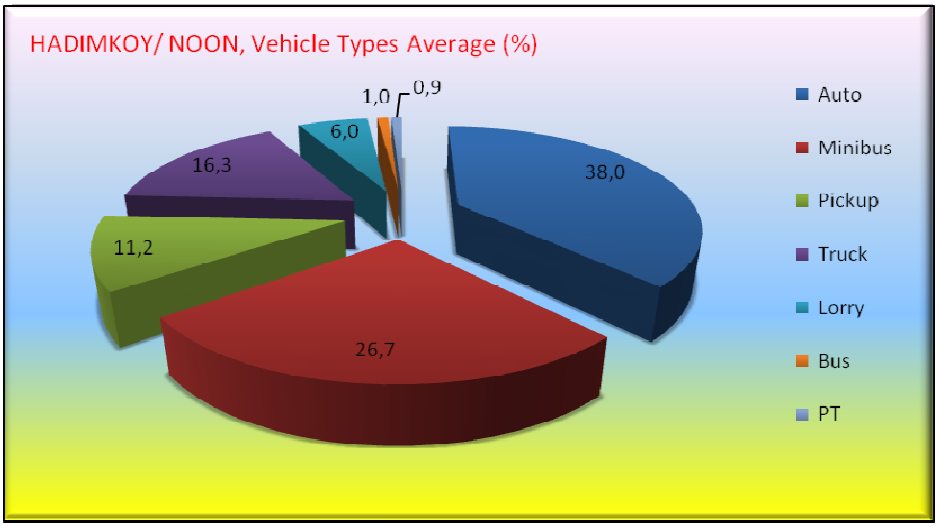
Hadimkoy intersection has 12 main directions on its four-leg intersection. The figure 10A shows the directions and their name of Hadimkoy intersection. According to the survey result, the most problematic part of the road is this part. When we look at the general capacity of the road, the directions of 1 to 2, 1 to 3, 2 to 3, and 2 to 1 have the most frequent usage in the morning, at noon and evening 3 to 2 and 3 to 1 also have high capacity with the other. At a surface glance, the automobile has the highest volume as classes' average. But when trucks, lorries, busses and pickups were considered as a single class, they covered one-third of the total average. The minibuses, used for people and freight transportation as well as

marketing, have approximately 33 percent of the total average. Actually, average percentages of the vehicle classes are not as different as time, but the average percentages of the directions are changing due to time of day. Averages and percentages of the Hadimkoy intersection are shown in figure 20.

Beylikduzu is the biggest intersection of the study area, but just three of its legs were recorded and counted. The vehicles which come from Beykent, Buyukcekmece and Beylikduzu and go to Hadimkoy direction have been examined to get information about the source of the actual road. The rate of the average of vehicle classes is nearly same here. Most frequent usage is seems on 4 to 1, especially in the morning; 2 to 1 capacity is increasing in the near-future because the southern part of Beykent has been rapidly constructed and attracts more people to the area. This means more traffic generation will be occurring at this point. Averages and percentages of the Beylikduzu intersection are shown in figure 21.

FIGURE 20A: VEHICLE TYPES AVERAGES IN TOTAL FOR HADIMKOY INTERSECTION





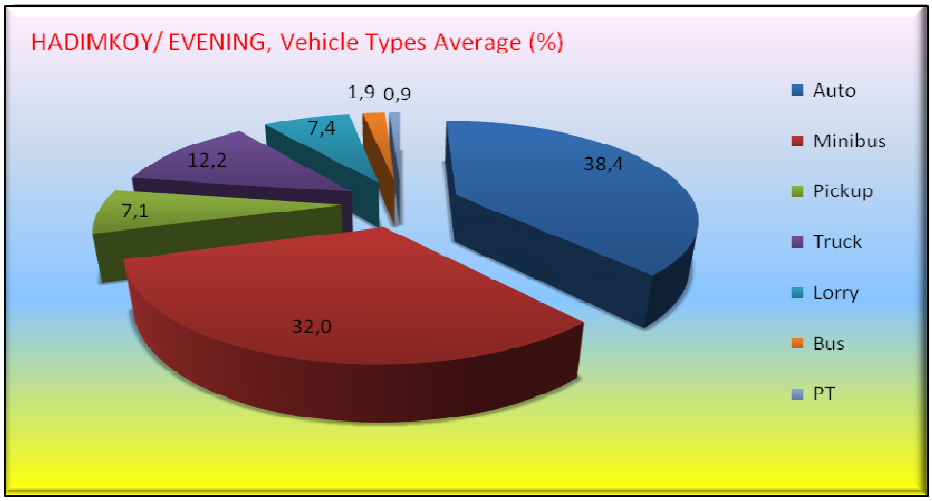
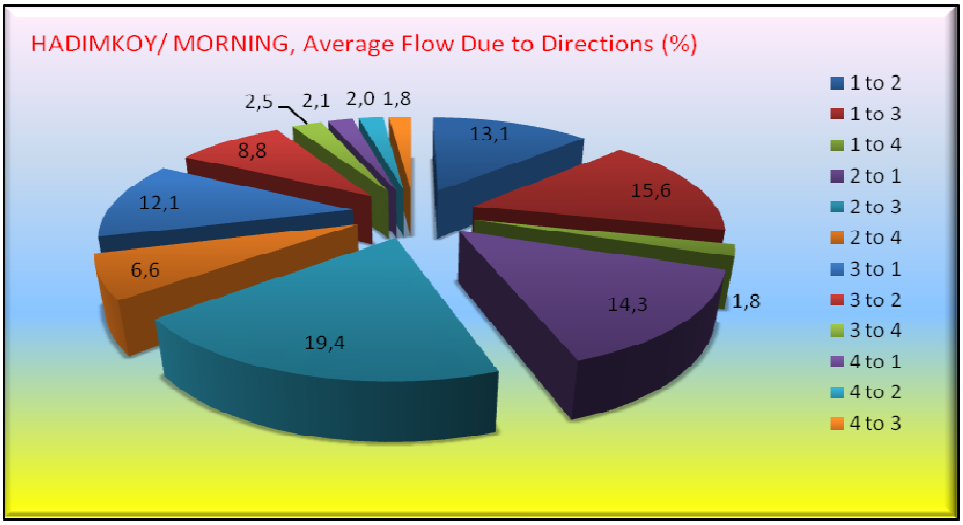
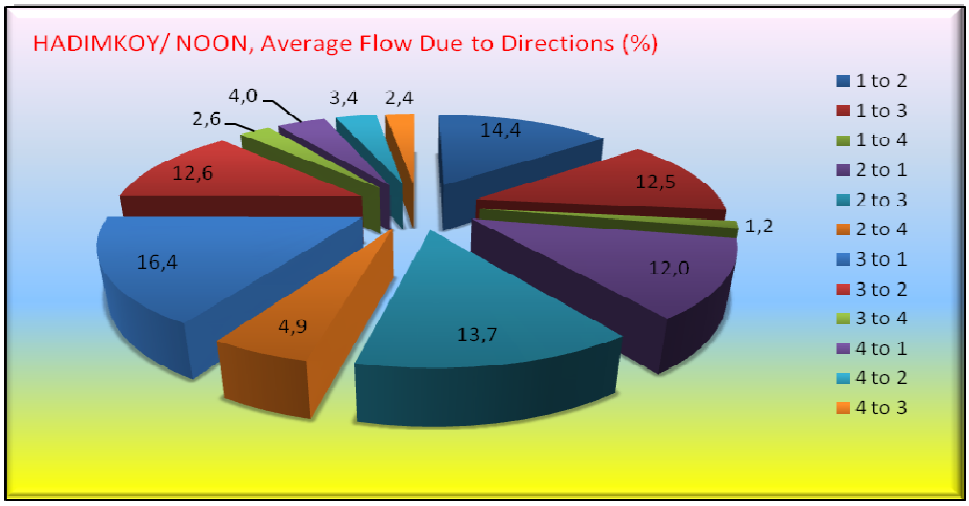


FIGURE 20B: DIRECTIONS AVERAGES IN TOTAL FOR HADIMKOY INTERSECTION





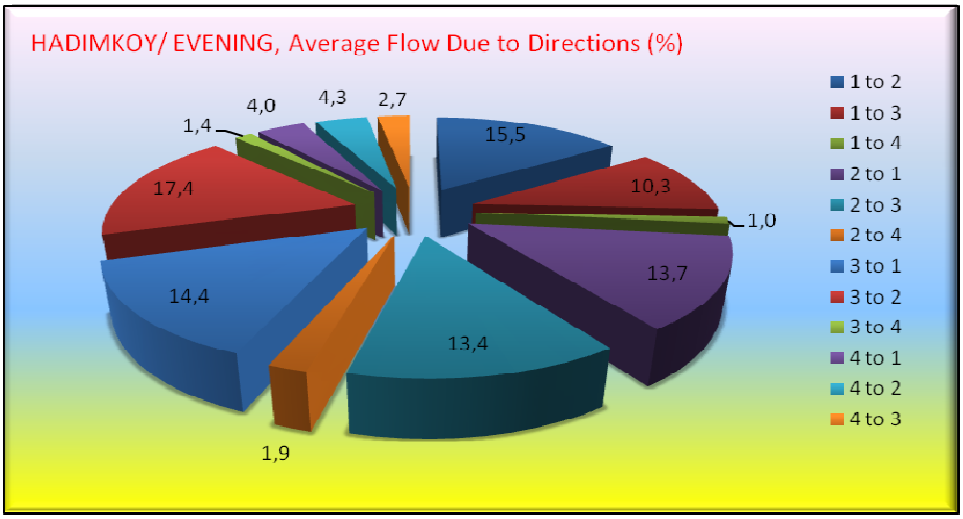
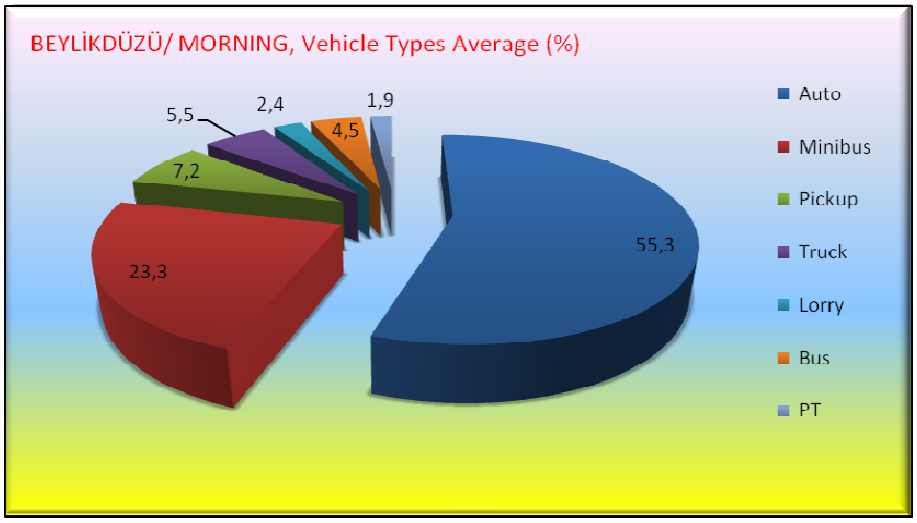
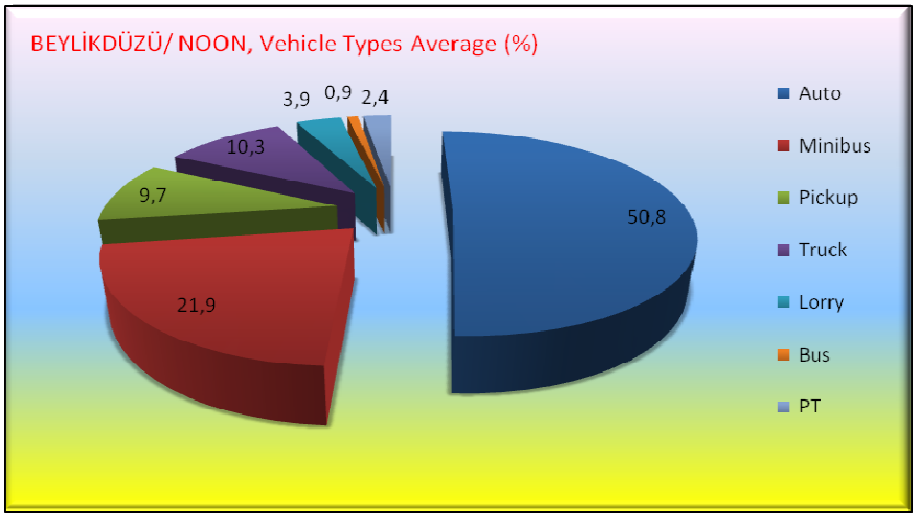


FIGURE 21A: VEHICLE TYPES AVERAGES IN TOTAL FOR BEYLIKDUZU INTERSECTION





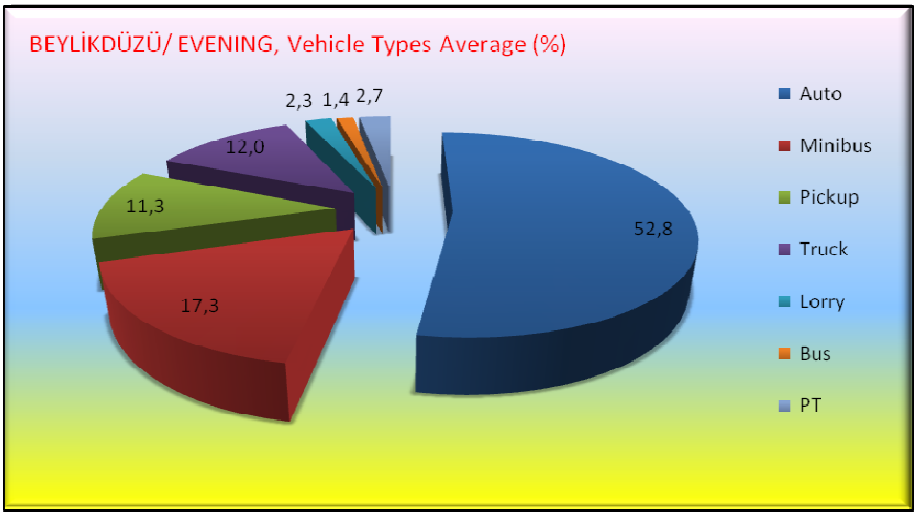
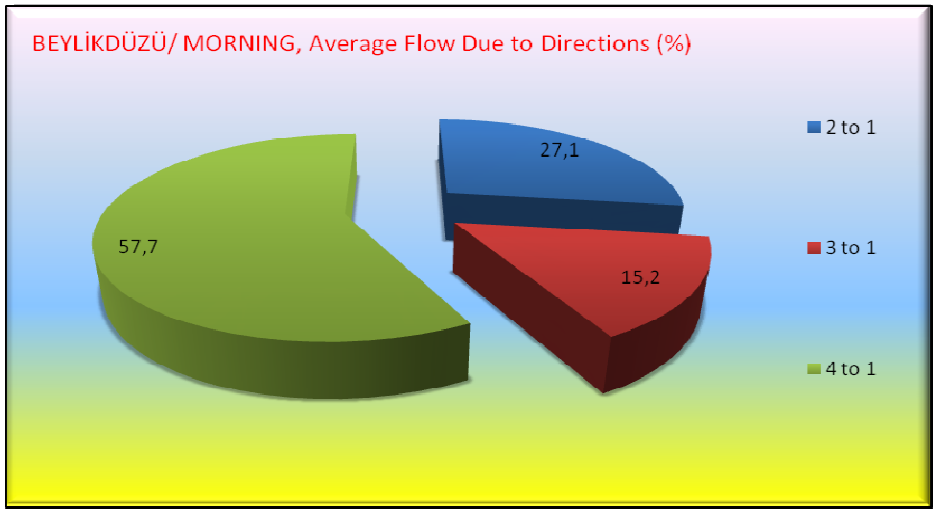
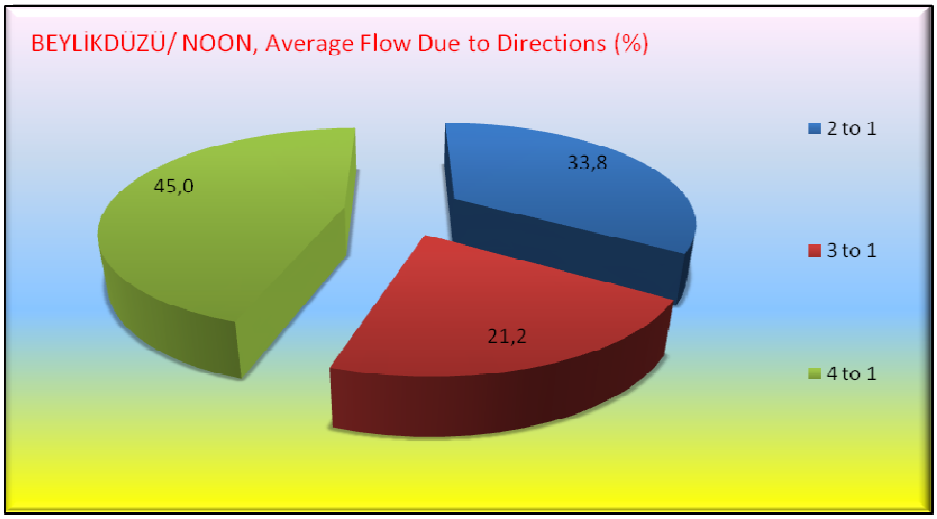
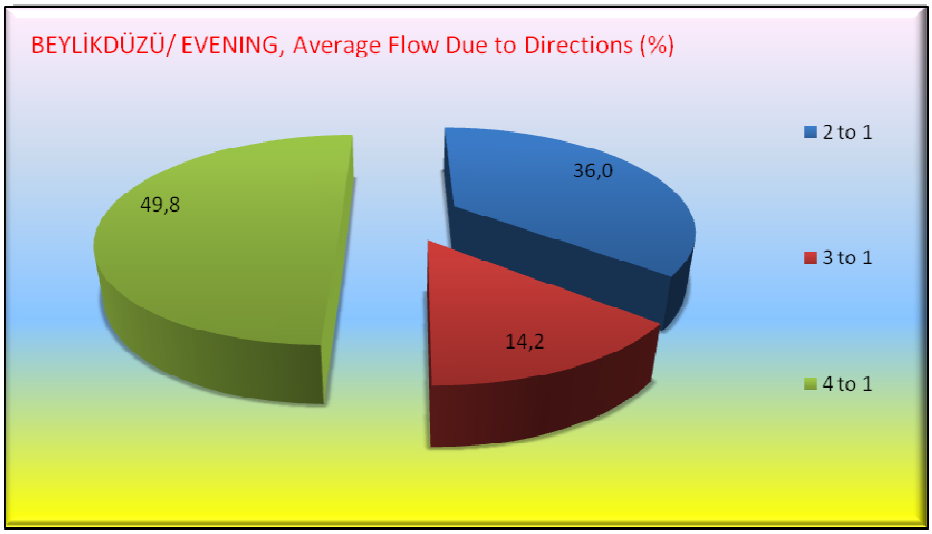


FIGURE 21B: DIRECTIONS AVERAGES IN TOTAL FOR BEYLIKDUZU INTERSECTION



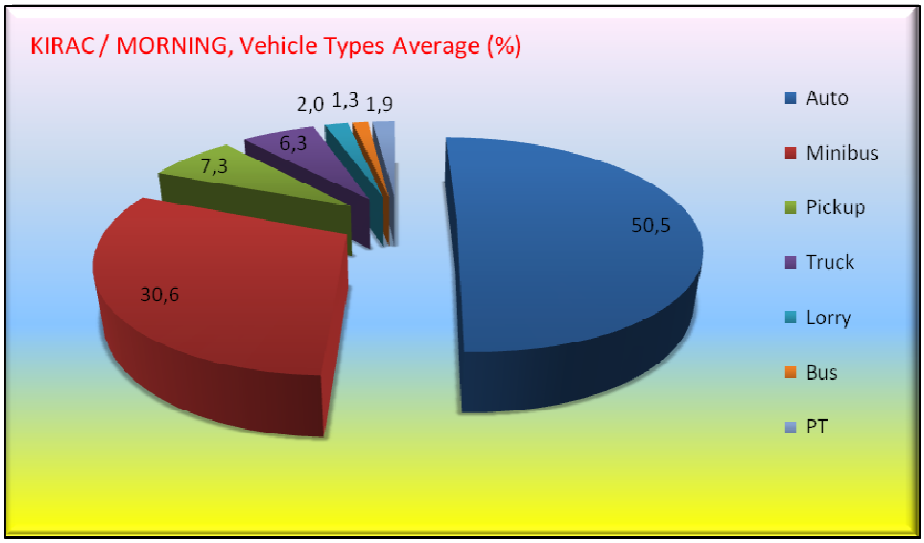


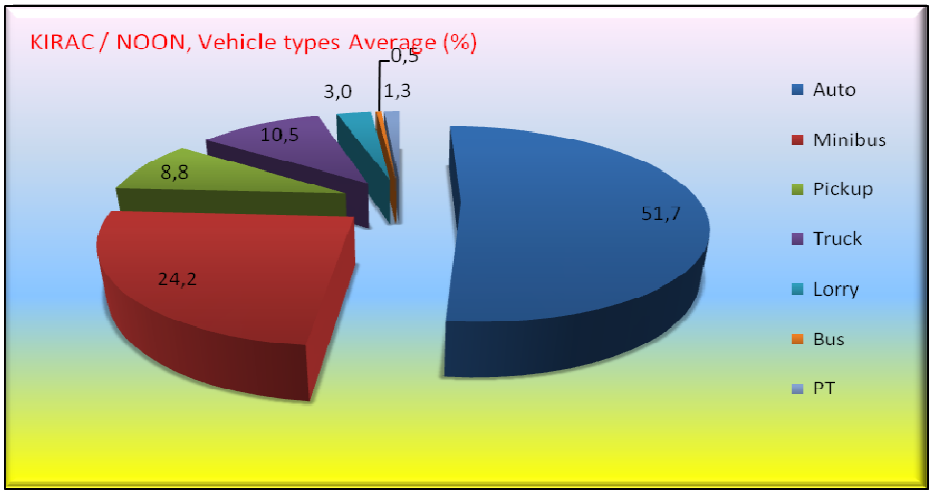


Kırac intersection is the second most important point after a vehicle enters the road from the Beylikduzu intersection. There are two arterials, between Beylikduzu and Kırac, lying through to Kırac city center and fabrics. Those are the alternative to drivers for escape from the queue on the traffic lights; if the condition of these roads were better, most probably more people would prefer to use it. In every time of the day, transit passing has the highest frequency. In other words, 1 to 3 and 3 to 1 passing has the biggest average in total traffic flow of this intersection. Their rates are changing from morning to evening. Depends on the time of the day, 15-17 percents of the total traffic flow are using the 1 to 2 and 3 to 2. Also, 13-16 percents of the total traffic come from inside of Kirac. Averages and percentages of the Kirac intersection are shown in figure 22.

Percentages of the total counting results are shown as appendix A.

FIGURE 22A: VEHICLE TYPES AVERAGES IN TOTAL FOR KIRAC INTERSECTION





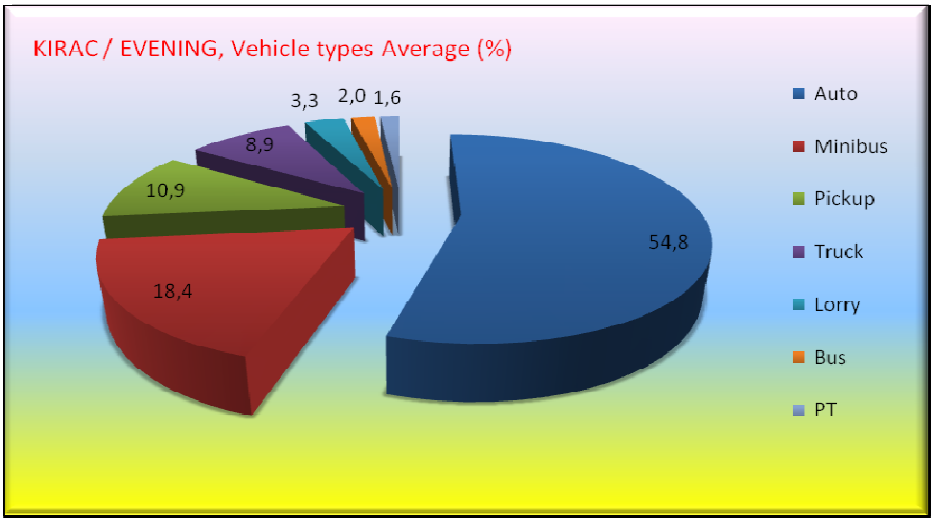
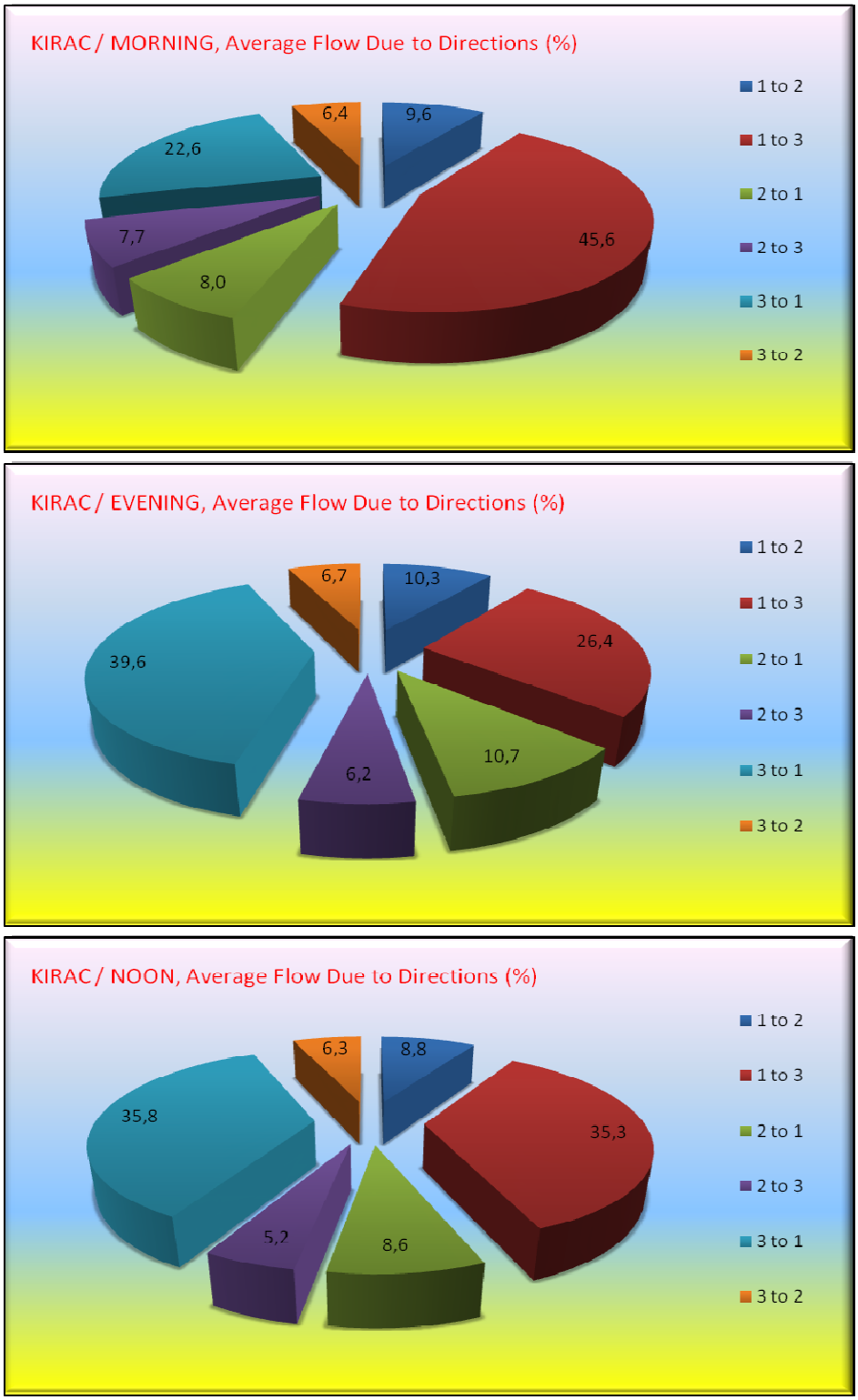


FIGURE 22B: DIRECTIONS AVERAGES IN TOTAL FOR KIRAC INTERSECTION



5.4 Future research directions

First of all, transportation plans of the road should be realize as its own capacity and volume by responsible department of the local management. Also, transportation demands forecasting for next 10 or 20 years of the area depends on the actual trends of residential and industrial developing of the area, provided some clue for future investment. During this process, may be monthly and 12 day-hours long vehicle counting results should be more useful to determine the usage of the road as time, direction and vehicle classes. Another insufficient thing in this study is comparing the expense or cost of the renewing works. By a serious calculation of the reconstruction alternatives, the best one could be chosen. Besides them, this connector should be examining as accessibility and mobility concepts. Accessibility refers to number of opportunities, also called activity sites, available within a certain distance or travel time. Actually, this is really dependent on the mobility, and their integration can be deal with each other all along the region, based on this connector. The last thing that should be considered is that the quality of this road depends on the hierarchy of connector road systems and principles. In other words, its sufficiency with its own advantages and disadvantages due to international connector road disciplines. Finally, the recommendation of this study could be projected by transportation planners or traffic engineering experts.

5.5 Conclusion and Recommendations

The first thing that should be stated before the recommendation and conclusion is that 86,4 percent of people surveyed think there is some problem with the road. That is a single justification to renewing or reconstructing immediately. Another main indicator is the vehicle counting results on the intersections. There are high dense loading on the road, especially on some main directions. These points can easily determine by counting and survey results. One of the other important things is that developing trend is continuing on surrounding area of the region, mainly around Hadimkoy, Gurpinar and south of Beylikduzu. This situation is a warning for close future condition of the region as its transportation system and also environmental quality. Besides of them, industrial area and its capacity are continuing to growing too. It will also be cause of the extra traffic loading in future.

Recommendations have presented by three separate titles:

- Short term operations
- Long term operations
- Determining of alternative roads

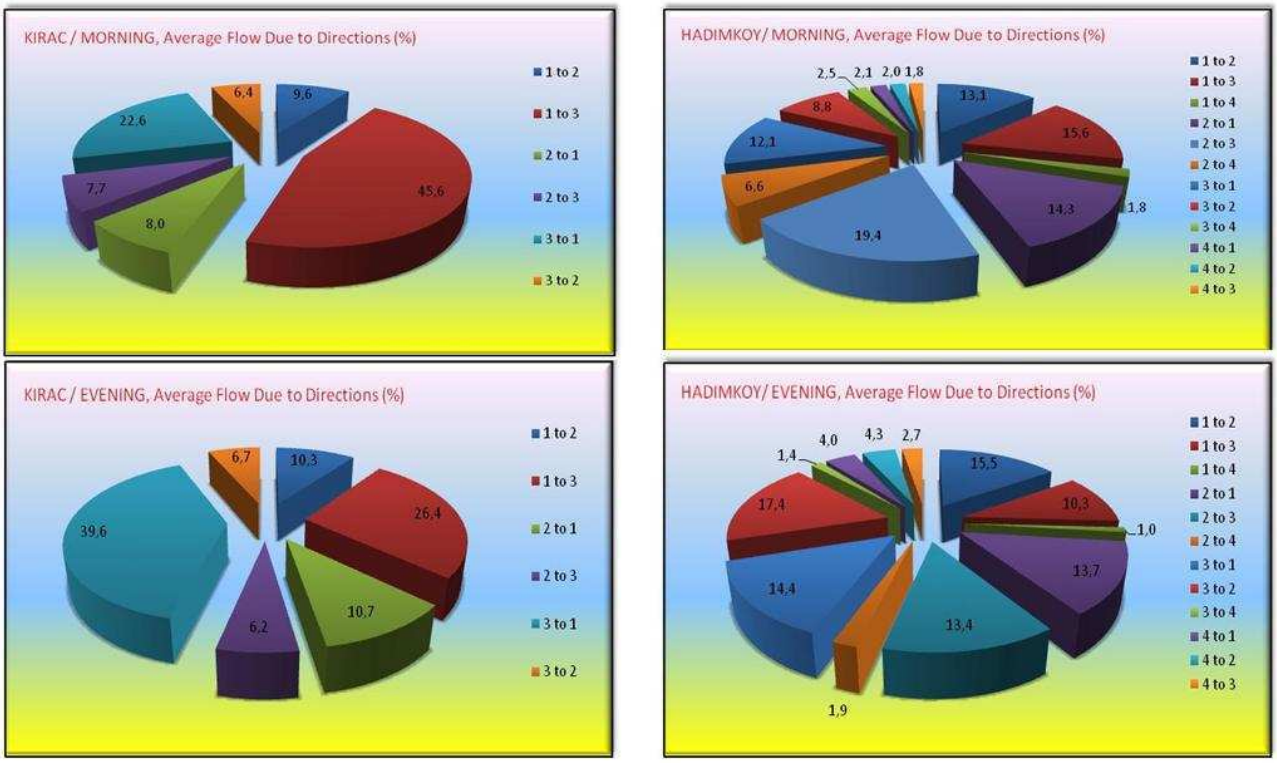
5.5.1 Short Term Operations

According to our survey results, two main problems with the road are traffic lights and road condition. There is so much difference between morning and evening volume of the road depends on the directions. Lighting system must be arranged depends on to volume of the road. So, peak hours traffic and its flow should easily manage by a well lighting system. It is not enough to solve this road's problem by itself but one of the important precautions to preventing of congestion. For example, on the Kirac intersection there are 45,6 percent vehicle move from Beylikduzu through Hadimkoy in the morning, whereas 39,6 percent of vehicle have trip on opposite direction in the evening. If these percentages compare with the traffic light's timing, disorder situation can easily distinguish. There should be an immediately arrangement on the green light times between two times. Also, we can say same situation for Hadimkoy intersection. Actually, the responsible people are claiming that existing traffic lights have arranged and set due to volume of the road and day time, but it doesn't seem so (table 10, figure 23). Maybe, there should be some revise and rearrange the system.

TABLE 10: TRAFFIC LIGHTS TIMES

[redacted]

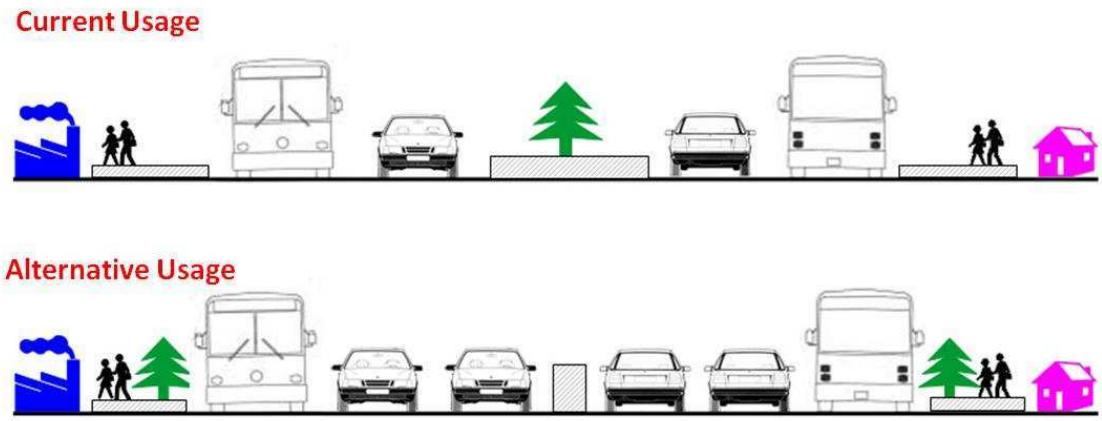
FIGURE 23: TRAFFIC FLOW PERCENTAGE FOR KIRAC AND HADIMKOY INTERSECTION



When we look at the road condition, asphalt cover of the road is less quality because of the high percentage of heavy trucks and lorries usage. It decreases to speed of the vehicles and causes the wrong line usage. Cover of the road should be better first. In fact, two line is not enough for this road's capacity and there is opportunity to get widen of the road. There are average 2,5 meters wide pedestrian way on both side of all along the way

except some short part. It is not really necessary to have that width for pedestrian on this way, because there are very limited usages by pedestrian. Also, there are almost 2,5 meters block between two direction. It is just for landscape but it doesn't really work while people wait for queues in traffic. This part can convert narrower a steel refuge and pedestrian ways could be narrow and afforestation could be done near by pedestrian way. So, there could be some separation between fabrics, new residential units, pedestrian way and the road. Also, the trees could play a role as a block or prevention to inside part of the region from air, noise and sight pollutions of the road. That is one of the city and landscape planning concepts. At the end of this works, there could be construct one more line on the road (figure 24).

FIGURE 24: RENEWING OF THE ROAD



One of other problems of the Hadimkoy intersection is the arterial road that connect to intersection without lighting system is another reason to congestion. When there is a queue occurs on the direction from Beylikduzu,

drivers use this part of the road and enter the intersection. This arterials entrance should be close and this flow orientate to direction 4, for put this extra volume in order.

Time arrangement for the freight transport vehicles, especially trucks and lorries, may be another possible application. These vehicles are covering a space as at least three cars can do. Also, the security space between the cars and these kinds of vehicles are more than it could be between two small cars. If they don't use the road during the peak hours, it may be another relieve factor for the drivers; especially 7.00 – 9.00 a.m. and 5.00 – 7.00 p.m. It is a kind of preventing method that is currently use for TEM and E-5. Also, if their route is suitable, they may use the Avcilar-TEM connector to reach factories around Kirac, but the internal roads should get widen and road conditions should be better for realize this opportunity, otherwise they automatically prefer to use Hadimkoy connector.

Driver behaviors are also being cause to congestion, depends on the survey results with 21,2 percent. Actually, it is dependent on to other situation. People usually don't break to rules if they really don't need it. Another point is that some point of the roads people don't allow to U-turn or do not have to passes across to road. In that point, people create their short cut or break rules for save some little time and cost. It's directly affected to traffic flow. The best examples of this kind of congestions seem on to Kirac intersection many times during the day (figure 25).

FIGURE 25: RULE BREAKS ON KIRAC INTERSECTION

The last things for short term operations are bus stops locations and parking along the road. Local management have built bus stop throughout the road but some of them have not enough spaces to stop without lacking the road. At this point, public transportation vehicles drivers do not really careful about the traffic flowing while get in or get off the passenger. Bus stop spaces may be widened and police officers should warn and care to public transportation drivers about usage of this stops. At the nearly end of the road, some banks and office buildings locating near the roads and because of lack of the parking lot, people can leave their car just near by the road. At this point, parking lot facilities should increase and responsible administrative department should apply some punishment to obstruct to people to park here.

5.5.2 Long Term Operations

When we look at closely on to the intersections, reconstruction is absolutely necessary for Kirac and Hadimkoy. Hadimkoy intersection carries to traffic load both from Hadimkoy and Beylikduzu direction to the TEM. Also, the volume of TEM exit should pass over here too. The first thing that may solve the jam on this point is the extra gate for Hadimkoy. There are three alternatives have been determined for extra gates. One of them may construct on the space that locates almost 1 km west from the existing entrance from the TEM; and secondary alternative can build for just a single direction from TEM to Hadimkoy (figure 26). It absolutely reduces to total traffic volume as 23 percent in the morning, 30 percent in the noon and 33

FIGURE 26: FIRST AND SECOND ALTERNATIVE PLACES TO CONSTRUCT NEW HADIMKOY ENTRANCE

percent in the evening. These are just percentages of the vehicles which come from Hadimkoy and enter to different directions road. Besides of them, the amount of vehicles are 19,4 percent in the morning, 13,7 percent in the noon and 13,4 percent in the evening which come from TEM and follow the Hadimkoy direction. These volumes can also decrease and it really relieves this intersection. Thirdly alternative have shown on figure 27. If this one could construct on this point, almost 1,5 km west from the existing Avcilar entrance, it reduce traffic as much as amount of first alternative can do.

FIGURE 27: THIRD ALTERNATIVE PLACE TO CONSTRUCT NEW HADIMKOY ENTRANCE

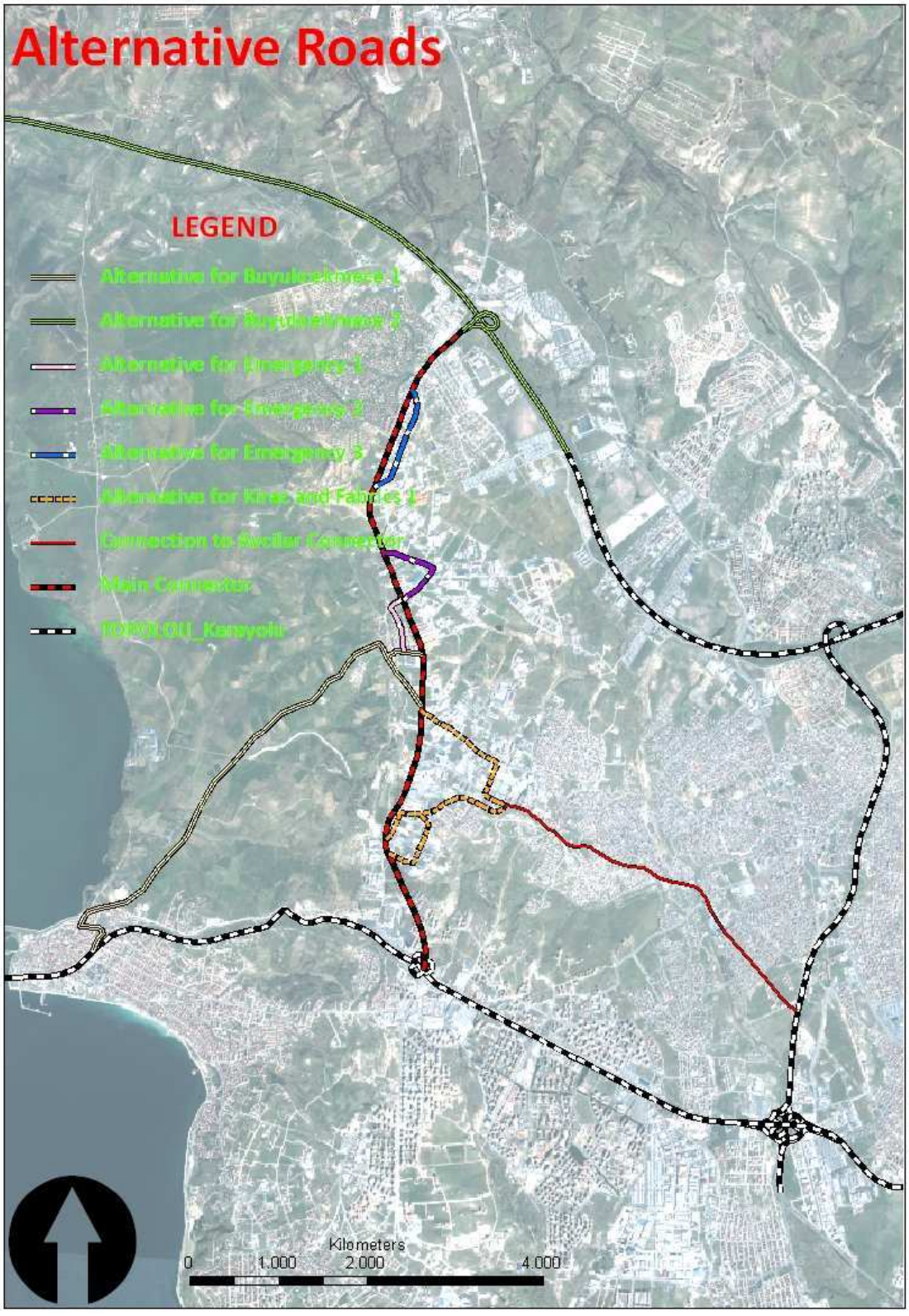
Another possible solution can be realized by an underpass or overpass towards to TEM direction. The same alternative could apply for the direction of Beylikduzu to TEM and Beylikduzu to Hadimkoy on this intersection, because there are also high volumes at those points.

In Kirac intersection, direct flows are dominated which from Beylikduzu to Hadimkoy and Hadimkoy to Beylikduzu (figure 22B). This intersection is not the single one to reach fabrics, so the turns of the vehicles are less than expectations. The traffic flow percentages of the direction from Beylikduzu to Hadimkoy are 45,6 percent in the morning, 35,3 in the noon and 26,4 in the evening. Values for opposite direction are 22,6 in the morning, 35,8 in the noon and 39,6 in the evening. So, to proving a transit passing opportunity for this flow could do everything on this point. Because, over half of the traffic just pass on this intersection and an underpass or overpass could manage the problem here.

5.5.3 Determining of Alternative Roads

According to survey result, 94,8 percent of the driver have stated that there is no alternative roads or they don't use them. In fact, there are some different opportunity to reach some surrounding area by using other routes. Mainly, Avcilar connector to TEM highway, Catalca connection to reach Buyukcekmece, secondary road which locates on west of the existing connector to reach Buyukcekmece and internal roads of Kirac. All of those road have shown on figure 28.

FIGURE 28: ALTERNATIVE ROADS AROUND THE CONNECTOR



Finally, the transit road has suggested by previous project results to local decision makers but it didn't except because commercial sector representatives desire a boulevard for the future of the region. So, some of the alternatives that have stated above should apply to this connector road in time, depends on the attraction and production capacity of the surrounded residential and industrial area.

Possible advantages and issues of the connector road system are following and this road should be redesigned depend on those factors as much as possible:

The connector road system is expected to offer the following advantages:

- Incorporates existing streets and constructs new streets
- Improves north-south mobility for local traffic
- Provides opportunities for new and improved transit services
- Improve neighborhood connectivity
- Could construct connector roads in multiple stages

The connector road system is expected to have the following issues that would need to be addressed:

- Requires major capital investment
- Would involve preparation of environment impact studies
- Could temporarily affect travel adversely during construction
- May be used as an alternate route for the CBD if an accident/incident occurs on the mainline.

APPENDIX A-1

KIRAC / MORNING							
	Vehicle Types	Average	Per %		Directions	Total Average	Per %
Due to Vehicle Types	Auto	3271,2	50,5	Due to Directions	1 to 2	623,3	9,6
	Minibus	1981,7	30,6		1 to 3	2954,8	45,6
	Pickup	473,2	7,3		2 to 1	520,7	8,0
	Truck	409,3	6,3		2 to 3	498,3	7,7
	Lorry	129,2	2,0		3 to 1	1462,5	22,6
	Bus	85,7	1,3		3 to 2	415,5	6,4
	PT	125,0	1,9				
	Total Vehicle Rate	6475,2	100,0				

KIRAC / NOON							
	Vehicle Types	Average	Per %		Directions	Total Average	Per %
Due to Vehicle Types	Auto	3572,5	51,7	Directions	1 to 2	608,3	8,8
	Minibus	1675,3	24,2		1 to 3	2439,8	35,3
	Pickup	610,5	8,8		2 to 1	592,8	8,6
	Truck	724,2	10,5		2 to 3	356,0	5,2
	Lorry	204,5	3,0		3 to 1	2477,3	35,8
	Bus	32,7	0,5		3 to 2	436,3	6,3
	PT	91,0	1,3				
	Total Vehicle Rate	6910,7	100,0				

KIRAC / EVENING							
	Vehicle Types	Average	Per %		Directions	Total Average	Per %
Due to Vehicle Types	Auto	4597,7	54,8	Directions	1 to 2	864,0	10,3
	Minibus	1545,5	18,4		1 to 3	2214,7	26,4
	Pickup	913,3	10,9		2 to 1	898,7	10,7
	Truck	745,2	8,9		2 to 3	522,2	6,2
	Lorry	280,2	3,3		3 to 1	3322,7	39,6
	Bus	168,8	2,0		3 to 2	566,0	6,7
	PT	137,5	1,6				
	Total Vehicle Rate	8388,2	100,0				

APPENDIX A-2

	BEYLIKDUZU / MORNING						
	Vehicle Types	Average	Per %		Directions	Total Average	Per %
Due to Vehicle Types	Auto	2465,5	55,3	Due to Directions	2 to 1	1208,7	27,1
	Minibus	1038,2	23,3		3 to 1	679,8	15,2
	Pickup	322,0	7,2		4 to 1	2571,5	57,7
	Truck	244,2	5,5				
	Lorry	108,3	2,4				
	Bus	198,5	4,5				
	PT	83,3	1,9				
	Total Vehicle Rate	4460,0					

	BEYLIKDUZU / NOON						
	Vehicle Types	Average	Per %		Noon	Total Average	Per %
Due to Vehicle Types	Auto	1810,3	50,8	Due to Directions	2 to 1	1204,7	33,8
	Minibus	778,7	21,9		3 to 1	755,2	21,2
	Pickup	346,2	9,7		4 to 1	1600,8	45,0
	Truck	365,8	10,3				
	Lorry	139,0	3,9				
	Bus	33,7	0,9				
	PT	87,0	2,4				
	Total Vehicle Rate	3560,7					

	BEYLIKDUZU / EVENING						
	Vehicle Types	Average	Per %		Evening	Total Average	Per %
Due to Vehicle Types	Auto	1722,8	52,8	Due to Directions	2 to 1	1173,7	36,0
	Minibus	565,8	17,3		3 to 1	463,5	14,2
	Pickup	369,7	11,3		4 to 1	1624,2	49,8
	Truck	392,5	12,0				
	Lorry	74,7	2,3				
	Bus	47,0	1,4				
	PT	88,8	2,7				
	Total Vehicle Rate	3261,3					

APPENDIX A-3

	HADIMKOY/MORNING						
	Vehicle Types	Average	Per %		Morning	Total Average	Per %
Due to Vehicle Types	Auto	2749,3	39,4	Due to Directions	1 to 2	910,7	13,1
	Minibus	2123,3	30,5		1 to 3	1088,2	15,6
	Pickup	560,2	8,0		1 to 4	123,0	1,8
	Truck	826,7	11,9		2 to 1	999,8	14,3
	Lorry	400,5	5,7		2 to 3	1349,0	19,4
	Bus	230,7	3,3		2 to 4	462,2	6,6
	PT	79,0	1,1		3 to 1	841,3	12,1
					3 to 2	610,2	8,8
					3 to 4	172,7	2,5
					4 to 1	143,2	2,1
					4 to 2	141,0	2,0
					4 to 3	128,5	1,8
	Total Vehicle Rate	6969,7	100,0				

	HADIMKOY/NOON						
	Vehicle Types	Average	Per %		Noon	Total Average	Per %
Due to Vehicle Types	Auto	3072,3	38,0	Due to Directions	1 to 2	1160,2	14,4
	Minibus	2154,0	26,7		1 to 3	1011,5	12,5
	Pickup	903,0	11,2		1 to 4	95,0	1,2
	Truck	1319,7	16,3		2 to 1	972,3	12,0
	Lorry	481,5	6,0		2 to 3	1104,7	13,7
	Bus	77,2	1,0		2 to 4	397,5	4,9
	PT	73,5	0,9		3 to 1	1325,0	16,4
					3 to 2	1018,5	12,6
					3 to 4	206,5	2,6
					4 to 1	323,7	4,0
					4 to 2	273,0	3,4
					4 to 3	193,3	2,4
	Total Vehicle Rate	8081,2	100,0				

	HADIMKOY/EVENING						
	Vehicle Types	Average	Per %		Evening	Total Average	Per %
Due to Vehicle Types	Auto	2947,7	38,4	Due to Directions	1 to 2	1191,5	15,5
	Minibus	2454,3	32,0		1 to 3	786,8	10,3
	Pickup	544,8	7,1		1 to 4	77,2	1,0
	Truck	935,0	12,2		2 to 1	1053,8	13,7
	Lorry	569,7	7,4		2 to 3	1025,5	13,4
	Bus	148,0	1,9		2 to 4	149,2	1,9
	PT	71,8	0,9		3 to 1	1105,2	14,4
					3 to 2	1333,0	17,4
					3 to 4	108,2	1,4
					4 to 1	303,2	4,0
					4 to 2	331,7	4,3
					4 to 3	206,2	2,7
	Total Vehicle Rate	7671,3	100,0				

APPENDIX B

FATİH UNIVERSITY
FACULTY OF ART AND SCIENCE
GEOGRAPHY DEPARTMENT

A GIS Based Analysis of the Effects of Neighbouring Land Use on the Traffic Congestion on Connector Roads: The Case of the Hadimkoy- Beylikduzu Connector Road

SURVEY

1. Where did you start to this trip?

1	Büyükşehir		Büyükçekmece	7
2	Bizimkent		Mimarsinan	8
3	Migros		Kıraç	9
4	Tatilya		Hadımköy	10
5	Beykent		Fabrikalar	11
6	Gürpınar		Bahçeşehir	12

Other:_____

2. Do you use this road in the morning / evening? If so, where does that trip start from?

1	Büyükşehir		Büyükçekmece	7
2	Bizimkent		Mimarsinan	8
3	Migros		Kıraç	9
4	Tatilya		Hadımköy	10
5	Beykent		Fabrikalar	11
6	Gürpınar		Bahçeşehir	12

Aim:_____

3. Where will you leave to this connector road?

1	Ankara Teks.		Alkent	7
2	Kıraç		Gişeler	8
3	Fevzi çakmak		Tüyap	9
4	Metro		B.Çekmece	10
5	9. cadde (Total)		Beykent	11
6	11. cadde		Beylikdüzü	12

Other:_____

4. Where is your destination?

1	Büyükşehir		Büyükçekmece	7
2	Bizimkent		Mimarsinan	8
3	Migros		Kıraç	9
4	Tatilya		Hadımköy	10
5	Beykent		Fabrikalar	11
6	Gürpınar		Bahçeşehir	12

Other:_____

5. What is your main purpose to generate this trip?

HBW ☐ WBH ☐ WB ☐

Shopping ☐ Recreation ☐ SB ☐

Other:_____

6. How often do you use this connector road?

More than 2 in a day _____ 1-2 times in a week _____
Everyday _____ 1-2 times in a month _____
Every week day _____ First time _____

Other:_____

7. How many people are there in the vehicle? Is everybody going to same place? If not, where is the passenger's destination?

Passenger Number				
1	Ankara Teks.		Alkent	7
2	Kıraç		Gişeler	8
3	Fevzi çakmak		Tüyap	9
4	Metro		B.Çekmece	10
5	9. cadde (Total)		Beykent	11
6	11. cadde		Beylikdüzü	12

Other:_____

8. Which intersection do you think the worse about congestion? Why?

1	Ankara Teks.		Alkent	7
2	Kıraç		Gişeler	8
3	Fevzi çakmak		Tüyap	9
4	Metro		B.Çekmece	10
5	9. cadde (Total)		Beykent	11
6	11. cadde		Beylikdüzü	12

Driver Behaviors ☐ **Traffic Lights** ☐ **Whether Condition** ☐

Other:_____

9. Do you have any other alternative way to do this trip? If so, where is it?

_____

10. Do you really think there is traffic congestion on this connector road?

_____

11. Do you arrange your travel time accvording to traffic condition on this road?

YES ____ **NO** ____

Type of Vehicle: Private ____ Commercial (people)____
Heavy Truck ____ Commercial (freight)____

Gender: Male ____ Female ____

Age Average: 18-25 ____ 25-30 ____
30-45 ____ 45-over ____

APPENDIX C

Intersection No: Direction:
Intersection ID: Date:

TIME	AUTOMOBILE	MINIBUS & VAN	PICKUP	TRUCK	LORRY	BUS	PUBLIC TRANS.	TOTAL	PER (%)
0-15									
15-30									
30-45									
45-60									
60-75									
75-90									
90-105									
105-120									
120-135									
135-150									
TOTAL									

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