DEVELOPING TRIP GENERATION RATES AND MODELS FOR SELECTED COMMERCIAL AND SERVICE LAND USE TYPES

by
Utku Terzi
B.S., Civil Engineering, Boğaziçi University, 2007

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ABSTRACT

DEVELOPING TRIP GENERATION RATES AND MODELS FOR SELECTED COMMERCIAL AND SERVICE LAND USES

Changing social, economic and environmental conditions necessitates planning studies. Transportation demand created by different land use categories is known to vary considerably and therefore trip generation rates or functions of different land use categories have been developed for several countries in detail for estimating this demand (ITE, 2003). Trip generation rates/functions have not been developed for Turkish cities yet. Once these trip generation rates or functions are created for different land uses, it becomes possible to directly use them in various studies such as transportation planning in small urban areas, traffic operational studies and traffic impact analysis without performing household travel studies, site surveys, traffic counts, and so on, which require considerable time and financial resources. In Turkey, these types of studies are performed mostly according to the rates/functions which are presented in the Trip Generation Manual of ITE. The main goal of this study is to investigate and present the theoretical background of trip generation modeling and to develop such rates/functions for some selected commercial and service land use types. The data that have been used in this study have been collected by the Transportation Planning Directorate of the Istanbul Metropolitan Municipality[1]. The trip generation relationships are developed by using regression analysis and found to be statistically significant.

As the next step, the trip generation rates and models for General Office Buildings and Hotels are developed. Afterwards, an example application showing the methodology to follow for performing a simple traffic impact analysis with the obtained results is presented and finally conclusions and recommendations for further research needed in this area is given.

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[1] "Trip Generation of Land Use Categories Handbook Project that was included in the Revision of Transportation Master Plan Project, 2008"

ÖZET

SEÇİLMİŞ TİCARET VE HİZMET ALANLARI İÇİN YOLCULUK YARATIM ORANLARI VE MODELLERİNİN GELİŞTİRİLMESİ

Değişen sosyal, ekonomik ve çevresel koşullar planlama çalışmalarını gerekli kılar. Farklı arazi kullanım türlerinin oldukça değişik ulaşım talepleri oluşturacağı bilinmektedir. Bu amaçla, birçok ülkede değişik arazi kullanım türleri için yolculuk yaratım oranları ve fonksiyonları detaylı olarak geliştirilmiştir (ITE, 2003). Türkiye illeri için böyle bir çalışma henüz yapılmamıştır. Arazi kullanım türleri için talep fonksiyonları ve yolculuk yaratım oranları oluşturulduğunda bu fonksiyonlar ve oranlar, küçük ölçekteki ulaşım planlama, trafik etüt ve trafik etkileşim analizleri gibi çalışmalarda hayli zaman ve finansal kaynağa gereksinim duyan hane halkı anketleri, arazi çalışmaları ya da trafik sayımı gibi çalışmalara ihtiyaç duyulmaksızın kullanılabilmektedir. Bahsi geçen çalışmalar için Türkiye'de genel olarak ITE tarafından geliştirilen Yolculuk Yaratımı El Kitabı kullanılmaktadır. Bu çalışmanın ana hedefi yolculuk yaratım modellemesinin teorik altyapısının incelenmesi, sunulması ve seçilen bazı arazi kullanım türleri (ofis binaları ve oteller) için yolculuk yaratım oranları ve fonksiyonlarının oluşturulmasıdır. Bu çalışmada kullanılan veriler İstanbul Büyük Şehir Belediyesi (İBB), Ulaşım Planlama Müdürlüğü[2] tarafından toplanmıştır. Yolculuk yaratım modelleri regresyon analizi ile oluşturulmuş ve elde edilen sonuçların ilgileşim katsayısı değerlerinin neredeyse tamamı 0.50'den fazla olmakla birlikte yolculuk yaratım modelleri istatistiksel olarak anlamlı çıkmıştır.

Bu çalışmada öncelikle yolculuk yaratım modellemesinin teorik altyapısı incelenmiş ve sunulmuş; sonraki adımda Ofis Binaları ve Oteller için yolculuk yaratım oranları ve modelleri geliştirilmiştir. Bunun sonrasında elde edilen sonuçlarla basit bir trafik etkileşim analizi yapılırken izlenecek yöntem sunulmuş ve en son olarak da bu alanla ilgili gelecek araştırmalarda yön gösterecek önerilere yer verilmiştir.

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[2] "Ulaşım Master Planı Revize Edilmesi Projesi kapsamında Arazi Kullanım Türleri Trafik Üretim Kılavuzu Hazırlanması, 2008"

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LIST OF SYMBOLS / ABBREVIATIONS

E	Number of employee
T	Trip ends
R	Coefficient of determination
F	F- test
t	t -test
Y_i	Number of event occurring
X_i	The value of the Independent Variable
e	Error term
β	Regression coefficient
N	Number of observations
σ	Sample Mean
z	z statistics value

ITE	Institute of Transportation Engineers
IBB	Istanbul Metropolitan Municipality
FHWA	Federal Highway Administration
UTTP	Urban transportation planning process
CATS	Chicago area transportation study
TOF	Traffic observation form
DSF	Development Survey Form
WVT	Average weekday vehicle trip ends
WPT	Average weekday passenger trip ends
MWT	Morning vehicle trip ends
EVT	Evening vehicle trip ends
SAPT	Saturday passenger trip ends
SUWT	Sunday passenger trip ends
SAE	Saturday number of employee
SUE	Sunday number of employee
WE	Average weekday number of employee
ATR	Average trip rate
GFA	Gross floor area

SPSS	Statistical package for social sciences
ANOVA	Analysis of variance
SSR	Regression sum of squares
SST	Error sum of squares
Std. Dev.	Standard deviation
Ent.	Entrance

1. INTRODUCTION

1.1. Problem Definition

Istanbul is one of the major capital cities in the world having a population of approximately 12 million and a population density of 1,596 person/km^2. Istanbul, basically, is composed of two geographic segments; European and Asian sides, which are separated by the Bosporus Strait passing between them. The former side shelters 63.2 per cent and the latter one accounts for 36.8 per cent of Istanbul's total population. (Istanbul Transportation Master Plan, 2008) These values are similar to values in large and problematic metropolitan cities such as Tokyo with a population density of 1,546 person/km^2; London with 1,846 person/km^2 and New York with a density of 922 person/km^2 (Dericioğlu, 2007). These kinds of cities are faced with serious transportation problems. Anderson (1976) defines a modern nation as a modern business, which must have adequate information on many complex interrelated aspects of its activities in order to make decisions. Stemming from this idea, several transportation studies have been performed in the world. For Istanbul, the foremost one is the Transportation Master Plan Study which was completed in 2008. It basically presents not only the existing traffic conditions (transportation demands and productions), but also the effects of ongoing projects and the planned ones on the current transportation network of Istanbul. In this dynamic situation, accurate, meaningful, current data on land use are essential.

In transportation literature, land use is defined as the functional dimension of land for different human purposes or economic activities (OECD, 2007). Some of the typical categories for land use are dwellings, general office buildings, hotels, shopping centers, restaurants, schools, stores, banks, insurance buildings, libraries, universities, industrial use, transport, recreational use, and so on (ITE, 2003).

Land uses affect transportation by physically arranging the activities that people want to access. Changes in the location, type, and density of the land uses change people's travel choices and thereby transportation patterns. Before travel forecasts are made, it is necessary to determine how the community will be in the future. Transportation is directly linked to land use type and intensity and trips are assumed to follow future land use patterns. If land use is changed, there should be a change in travel (Beimborn, 2006). There are various types of land uses which generate different trip rates. These rates can be used in transportation planning, traffic impact studies, and so on. These studies are conducted by transport professionals to address concerns on traffic congestions, future travel demands and system for planning public and private transport requirements. These methods would require accurate and reliable trip generation data which are a crucial input to determine the impacts of different land uses along their surrounding highway and public transit networks. Therefore having accurate trip generation values for different land uses is the first step of travel demand studies.

1.2. Goals, Objective and Scope

The main goal of this research is to develop average trip rates and equations for selected land uses in the metropolitan city of Istanbul. To serve this main goal, following objectives have also been targeted:

- to do a thorough literature review about the trip generation theory and the methodology for development of the trip generation rates and models;
- to develop the trip generation rates/models for selected land use types;
- to present an example application for using these trip generation rates/models;
- to recommend topics for further research in this area.

Because the process that will be used in the development of the trip generation rates/models will be similar among various land use types, only two types of land uses, namely “office buildings” and “hotels” were selected for this work.

1.3. Outline

The next Chapter is a brief summary of some of the previous research in the trip generation modeling area; different models and types of studies in this research field. In Chapter 3, the methodology used in this study and the statistical background are presented.

Chapter 4 focuses on the method of data collection and the preliminary analysis of the data. The regression analysis and model development stage is presented in Chapter 5. The final Chapter summarizes the research findings and conclusions and presents recommendations for further research.

2. LITERATURE REVIEW OF TRIP GENERATION MODELLING

2.1. The Types of Transportation Planning Studies

Generally, it is believed that the Urban Transportation Planning Process (UTPP) originated with the Chicago Area Transportation Study (CATS, 1959), in which traffic demands are forecasted based on the assumption that they are related to human travel behavior, land use, and travel patterns. The UTPP has been the most popular tool for travel demand forecast in urban areas since 1959 (Dickey, 1983). Papacostas and Prevedouros (2005) define UTPP as "to perform a conditional prediction of travel demand in order to estimate the likely transportation consequences of several transportation alternatives". Transportation planning process also includes the determination of travel demand in terms of trip generation, trip distribution, mode of travel and the selected route assignment.

There are three major classes of transportation planning studies which utilize trip generation rate values. The first of these studies is a regional study which forecasts person trips by different trip purposes for a metropolitan area with a planning horizon of 10 to 30 years. Household survey data and socioeconomic characteristics such as income, automobile ownership, and family size are usually used to determine the number of person trips generated per household. Then these person trips are converted to vehicle trips using appropriate automobile occupancy values (ITE, 1992; FHWA, 2002). The second one is a subarea study which focuses on a subset of a metropolitan region in greater detail than the long-range regional study with a planning horizon of 20 years. The relative advantage of subarea studies is reduced computational requirements and data collection costs. Methodologically, the literature indicates that the subarea approach is similar to the regional approach: the trip generation, trip distribution, and traffic assignment steps are replicated for the subarea and modified as necessary to match modeled and observed traffic volumes (Winslow *et al.*, 1995). The last of these studies is a site impact study which estimates trip generation rates as the number of vehicle trips that will result from a specific new land use development such as a shopping center, restaurant, or residential neighborhood. The time frame until the build-out of the site for traffic forecasting is usually 3 to 5 years. Unless local data are collected, residential trip generation rates are usually taken from the Institute of Transportation Engineers' handbook (ITE, 2003).

2.1.1 Trip Generation as the First Step of Transportation Planning

Transportation planning is a process that develops information to help make decisions on the future development and management of transportation systems, especially in urban areas. It involves the determination of the need for new or expanded highways, transit systems, freight facilities, transportation terminals, their location, their capacity and the management of their demand. Typically transportation planning involves a forecast of travel patterns 15 to 25 years into the future with an aim to develop a future transportation system that will work effectively at that time.

Transportation can have significant effects on mobility, economic development, environmental quality, government finance and the quality of life (Beimborn, 2006). Wise planning is needed to create high quality transportation facilities and services at a reasonable cost with minimal environmental impact and to enhance economic activity. Failure to plan can lead to severe traffic congestion, dangerous travel patterns, slow economic growth, adverse environmental impact and wasteful use of money and resources. Transportation planning is required by law in many countries as well as in Turkey in order to receive local funding for transportation projects. Significant transportation projects require a long lead time for their design and construction. Furthermore, they can have major effects on future land use patterns which need to be assessed.

The modeling of trip generation is an essential stage of the conventional four-step transportation modeling procedure. In the four steps –trip generation, trip distribution, modal split and trip assignment- the total number of trips produced by and attracted to each part of the area in the first two steps. In the last two steps, the modes of the travel to make the trips and the specific routes taken are found. This is a standard method used by transportation planners to forecast travel demand which has been in use for decades.

The number of trips estimated at trip generation stage is later input to models that merely redistribute the total number of trips among different destinations, modes or routes. Poor estimates at the trip generation stage are carried over to other modeling steps (Stambi and Bilt, 1998).

Researchers have been trying to improve and eliminate the deficiencies of the conventional four-step travel demand forecasting scheme. There exist some combined models for travel demand forecasting which integrate some or all of the steps of this scheme. Some researchers tried to eliminate the deficiencies of the scheme by approaching the problem as an optimization process. One of these models approaches the problem as equivalent optimization process in which all the steps are combined together (Safwat and Magnanti 1998). When the process is solved, it yields the desired equilibrium solution. The common perspective of the models is to solve the steps of the travel demand forecasting problem simultaneously. Another model only combines the first two steps of the conventional four-step process which are trip generation and trip distribution (Cesario, 1975). This model proposes that since each step is independently processed of the others, it may include certain inconsistencies. Like other simultaneous equilibrium models, this one also proposes to eliminate the inconsistencies in between the steps by combining the first two steps.

The main function of the trip generation is to process and estimate the total number of trips generated and attracted by each area unit (zone) in conjunction with the land use and the socio-economic characteristics of each zone (Oyedepo *et al.*, 2009). Basically, there are three approaches commonly used in the trip generation analysis: regression analysis, trip rate analysis, and cross-classification analysis. These three approaches are used in this study.

2.2. Trip Generation Modeling

The first step in transportation planning is trip generation. In this step, information from land use, population and economic forecasts are used to estimate how many trips will be made to and from each zone, land use or building type.

Trip generation rates vary depending upon land use types. These values are generally the basis for studies such as transportation planning, traffic impact assessment, and so on. According to Hutchinson (1974), information-gathering and the coding of data are important parts of urban transport planning and this aspect of the systems approach absorbs, typically, from one half to two thirds of the total budget. Therefore, being a costly procedure, obtaining trip generation rates every time for a study (i.e. traffic impact, planning) is practically impossible. Stemming from this idea, the Institute of Transportation Engineers (ITE) has developed Trip Generation Handbook (ITE, 2003) for various land use trip generation models.

Trip Generation Handbook is an informational report of the Institute of Transportation Engineers (ITE). The handbook includes three basic information of land use: weighted trip generation rate, a plot of the actual trip ends versus the size of the independent variable for each land use type (such as number of employees, number of beds, gross floor area, etc.) and regression equation of trip ends related to the independent variable. Its primary objective is to provide traffic and transportation engineers with a single document on trip generation for all land uses and building types. Estimation of the number of trips that may be generated by a specific building or land use have been developed for the average weekday, weekend; for the peak hours of the generator; and for the one hour when the adjacent street traffic is at its peak (ITE, 2003).

The procedures applied the initial steps of the established ITE methodology in estimating the trip generation rates which entails basic survey of the site characteristics. Since gross floor area (GFA) and number of employees (E) -obtained from the accomplished survey forms- are physical, measurable and predictable units describing the study sites, they are identified as the independent variables. Table 2.1 presents the trip generation rates and volumes (two-way volume) for General Office Buildings with the independent variable selected as GFA and E for different time zones.

Table 2.1 General office building vehicle trip generation rates (ITE, 2003)

Gross Floor Area (1,000 feet^2)	Average Weekday Vehicle Trip Ends per 1,000 feet^2	Number of Employee	Average Weekday Vehicle Trip Ends per Employee
10	24.39	50	4.72
50	16.31	100	4.31
100	13.72	200	3.94
150	12.40	300	3.74
200	11.54	400	3.60
300	10.42	500	3.50
400	9.70	600	3.42
500	9.17	800	3.29
600	8.77	1000	3.20
700	8.43	1200	3.12
800+	8.16	1600+	3.01

Researches in United States have revealed that when the gross floor area of general office buildings increases, the employee density decrease even if the number of employee increases (ITE, 2003). Like the decrease in employee density, average weekday vehicle trip ends decline when gross floor area increases. Table 2.1 demonstrates this issue. For instance, a gross floor area of less than 10.000 ft^2 (≈9,000 m^2) corresponds to an employee density of 4.72 and an average weekday vehicle trip end of 24.39 per 1,000 ft^2 (≈90 m^2). On the other hand, a gross floor area of 300.000 ft^2 (≈27,000 m^2) gives an average weekday vehicle trip end of 10.42 per 1000 ft^2 and 3.5 per employee.

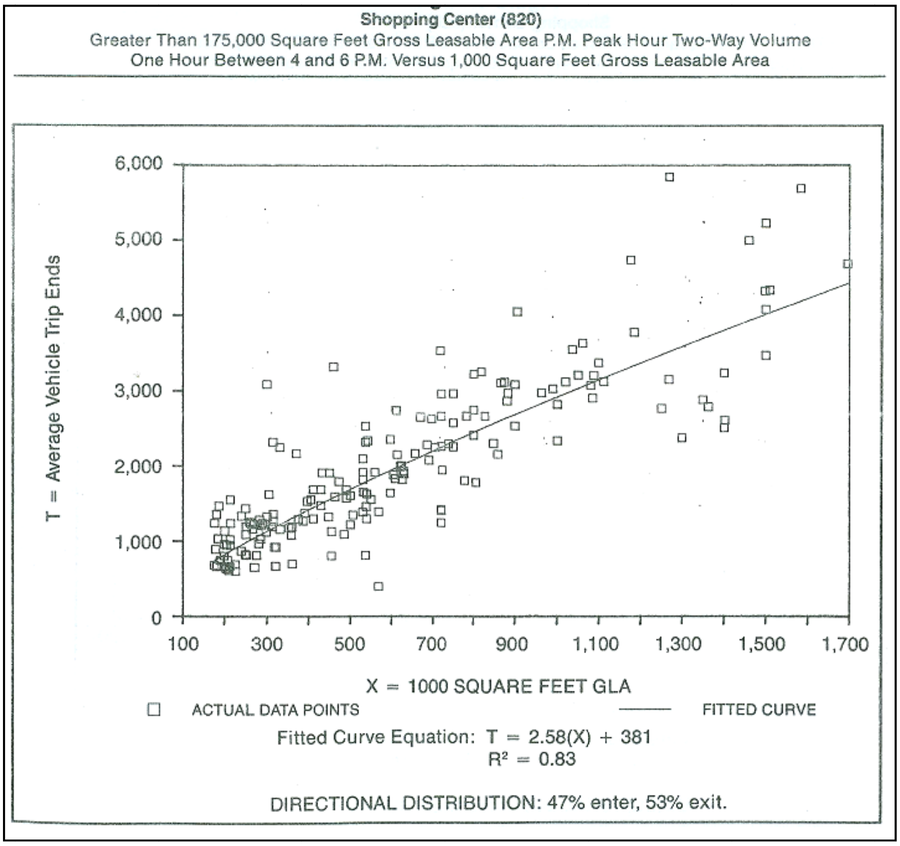


Figure 2.1. Regression plot example (ITE, 2003)

In Trip Generation Manual, regression plots and equations are provided for land uses at different time periods. The collected data fits into the methodology for establishing regression equations described in Trip Generation Handbook (2003). An example data plot and regression model for Shopping Centers are depicted in Figure 2.1. In this plot, the relationship between Average Vehicle Trip Ends and Gross Leasable Area of the Shopping Center is demonstrated. The figure does not only show the data plot and the outputs explaining the quality of the model (regression equation and curve, R^2), but also gives information about the directional distribution percentages for entrance and exit, and states information about the time period (One Hour Between 4-6 P.M.) and the area constraint (Greater Than 175,000 Square Feet Gross Leasable Area) where the figure is valid for use.

One of the main concerns about the data that needs attention is that, the sample size may not cover the variations in trip generation characteristics of a land use when the sample size is relatively small. Therefore, it is imposed to the users of the report to take extreme caution when using the rates of small sample sizes.

The average rates in the report are the weighted averages of studies collected throughout United States since 1996 (ITE, 2003). Because of the availability of a good public transportation service, ride sharing, or because of the proximity of the specific site to other developments at specific sites, the users can modify the trip generation rates presented in the report. Since these issues may reduce vehicle trip making through walking or combining trips or other, special characteristics of the site or surrounding areas may affect the rates.

2.3. Transferability of Trip Generation Models

The transferability of trip generation models has been the subject of investigation since soon after the development of the system-wide transportation planning process (Hill and Dodd 1966, Schmidt 1969). In order to improve the use of urban transportation planning in developing countries, an expedient and resource efficient transportation planning process, which neither requires expensive data collection nor complex or sophisticated techniques, must be provided (Kawamoto, 2003). Therefore, if some basic models could be transferred from one geographical area to another in a reliable way, the forecasting of travel demand will become simpler, saving time and money by combining transferable mathematical models with recent census data.

Because of the high cost associated with collecting the data, trip generation rates are sometimes extracted from one study and applied elsewhere. Although national references point out that locally collected data are preferable, the feasibility of using existing rates rather than collecting data anew is an attractive option that agencies with scarce resources often wish to explore (Mann, 2003a; 2003b). If there is not much difference in data collection method and the socio economic characteristics of different locations, there are no statistically significant differences in trip generation rates. However, if the socio economic, environmental or behavioral characteristics are so different, it is so obvious that these rates should be obtained locally. In other words, the applicability of the trip rates developed by ITE would be doubtful for Turkish cities.

Istanbul Greater Municipality (IBB), Transportation Planning Directorate had collected data for different land uses to overcome this deficiency. This study is focused on the development of trip generation rates of Istanbul for selected commercial and service land uses.

Socio economic, environmental and behavioral characteristics obviously differ between United States and Turkey. In a research (Wilmot, 1995), transferability of trip generation rates was measured within cities (inter-cities), between areas in a region (inter-regional) and between several cities (intra-cities) for three different data sets. In this study, transfer of an entire model is referred to as full transfer (Koppelman and Wilmot 1982). According to the results of this research, models transfer better between areas of similar income (high and low income areas). The research proposes that income is the most significant factor influencing the trip rate transferability, that is, models transfer better when the average income levels are similar as long as the influence of other factors such as the quality of the data in the area in which the model is transferred into is reduced. Knowledge of some of the characteristics of a local situation permits local estimation of portions of a model (Wilmot, 1995). Partial transfer could be achieved in this case when some model parameters are estimated locally and the remaining parameters are transferred. It is mentioned that full transfer could be achieved under favorable conditions, that is the requirement of high consistency of data sets of the two area or the high quality of the data used while modeling trip generation. One of the outcomes of this research is that, application of a simply partial transfer would improve all transfers. The results show that a partial transfer with only using local constants improves the results dramatically.

Although transferability of trip generation models is not in the scope of this thesis, it is of primary importance due to the fact that the rates generated for Istanbul would be helpful in the preparation of a trip generation manual for Turkey.

3. METHODOLOGY

3.1. Introduction

In this section the methodology used in the research is explained. In the following sections the types of analyses performed for the preliminary investigation of the collected data, an explanation of the basic terminology that was used in the research, statistical methods and their performance measures that were used in the model building are presented.

3.2. Error Checking and Preliminary Analysis of the Data

The data that has been used in this study has been collected by Transportation Planning Directorate of the Istanbul Greater Municipality in 2008. The ultimate aim of this study was to develop a Trip Generation Handbook which would combine the land use categories and their characteristics (area of the land use category and/or the number of employee) with the person/vehicle trip ends and present their relationships. This purpose stems from the need of an informational report which would present trip generation rates and equations for different land use categories for the use of engineers and planners who would assess the travel demand of current/new land uses and find out the effects (traffic load) of them on the existing transportation system. In this thesis only two of the land uses were selected for investigation. Figure 3.1 depicts the stages of the preparation of this report.

Having the data collected, it was first checked for any type of error by the staff of BIMTAS (Istanbul Greater Municipality, Metropolitan Planning and Urban Design Center). As the next step, the data were coded and entered in the statistical analysis software SPSS (2008) which became the basic environment for all of the statistical analysis performed. The coded data was further checked for any missing or wrong entries and logical errors. The errors were either corrected by going through the original survey forms or by deleting the case if the error was found to be an uncorrectable type.

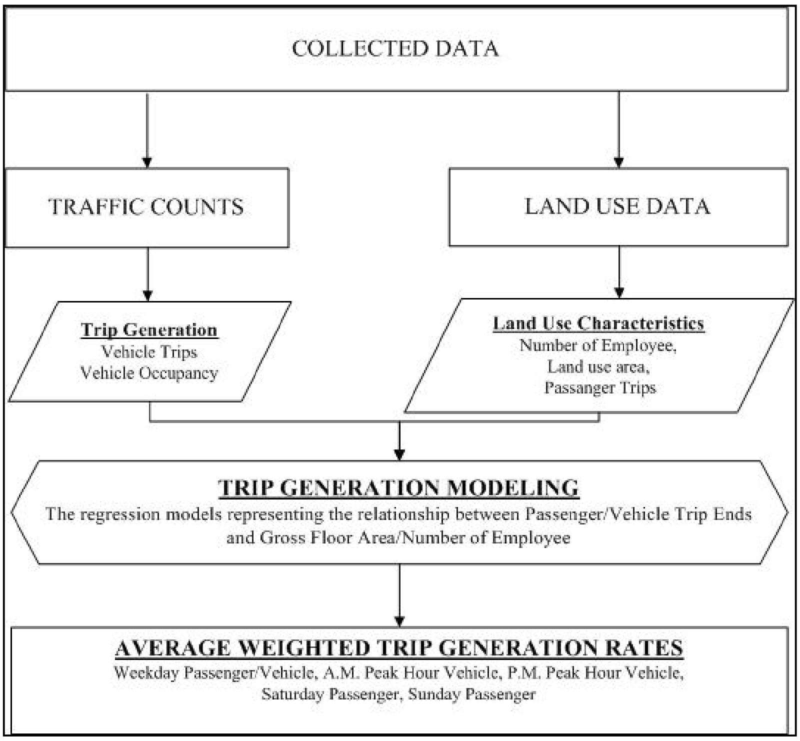


Figure 3.1. Development stages of Trip Generation Handbook

The data was further subjected to simple preliminary analysis such as obtaining frequency distributions, cross tabulations, descriptive statistics and correlation analysis using various statistical procedures in the SPSS (2008) program. These analyses also revealed some further anomalies in the data set which were either corrected or if the anomaly could not be corrected the whole case was deleted. These analyses are described in Chapter 4.

3.3. Basic Terminology and Definitions

The definitions of the terminology that was used in the research are given below (ITE, 2003):

- Weighted Average Trip Generation Rate: The number of weighted trip ends per one unit of the independent variable (i.e. per employee or per 100 m^2). The average rate was calculated by summing all trips or average trip ends and all independent variables where paired data were available and then dividing them by the sum of the independent variables to obtain a weighted average.

- Average Trip Rate for Peak Hour of Generator: The weighted average trip rate during the hour of highest volume of traffic entering and exiting the study site in the A.M. or in the P.M. In this study A.M. peak hours are determined as between 6 and 10 in the morning; P.M. peak hours are 6 and 8 in the afternoon, respectively. Peak hour calculations were carried out for one hour in those specified time intervals.
- Average Weekday Vehicle Trip Ends (WVT): The weighted 24-hour total of all vehicle trips counted to and from a study site a weekday from Monday through Friday.
- Average Weekday Passenger Trip Ends (WPT): The weighted 24-hour total of all passenger trips obtained from Istanbul Origin Destination Household Survey 2006.
- Gross Floor Area (GFA): The gross floor area of a building is the sum of the area at each floor level, including cellars, basements, mezzanines, penthouses, corridors, lobbies, stores and offices that are included within the principle outside faces of exterior walls, not including architectural setbacks or projections. For trip generation calculations the gross floor area of parking garages are not included within the area of the entire building.
- Independent Variable: A physical, measurable and predictable unit quantifying the study site or generator (e.g., building area, employees)
- Regression Equation: An expression of the optimal mathematical relationship between two or more related items (variables) according to a specified criterion as,

$$Y = a + bX \tag{3.1}$$

The objective in developing the relationship between X (independent variable) and Y (dependent variable) is to determine values of the parameters ‘a’ and ‘b’ so that the expected error involved in estimating the dependent variable given estimates of the independent variable will be a minimum.

- Coefficient of Determination (R^2): A measure of what proportion of the total variation in the dependent variable is explained by the fitted model.
- Trip: A single or one-direction vehicle movement with either the origin or destination (exiting or entering) inside the study site.
- Trip Ends: In this report, trip ends are the total of all trips entering plus all leaving a designated land use or building type over a given period of time.

3.4. Statistical Analysis and Modeling

Trip generation equations were developed using Simple Linear Regression Method which is briefly explained below.

Modeling refers to the development of mathematical expressions that describe in some sense the behavior of a random variable of interest. This variable may be the price of wheat in the world market, the number of deaths from lung cancer, the rate of growth of a particular type of tumor, or the tensile strength of metal wire. In all cases, this variable is called the dependent variable and denoted with Y (Rawlings *et al.*, 1998). Regression Models in general; use a relationship between two or more variables so that one dependent variable can be predicted from the other independent variable(s). Other variables which are thought to provide information on the behavior of the dependent variable are incorporated into the model as predictor or explanatory variables. These variables are called the independent variables (regressors) and are denoted by X with subscripts as needed to identify different independent variables. Assigning X to the independent variable and Y to the dependent variable respectively; for every X value plugged into the equation there will be a corresponding Y value produced. The relationship between X and Y values can be generalized as in Equation 3.2 (Walpole *et al.*, 2001).

$$Y_i = \beta_0 + \beta_1 X_i \tag{3.2}$$

Where,

Y_i = The number of event occurring (in this case number of trips generated)

X_i = The value of the independent variable

β_0, β_1 = Regression coefficients

The concept of regression analysis deals with finding the best relationship between *Y* and *X*, quantifying the strength of that relationship, and using methods that allow for prediction of the response values given values of the regressor. In other words, regression analysis examines the relationship between a quantitative dependent variable Y and one or more (in multiple regression analysis case) quantitative independent variables, $X_1,\ldots X_2$ (Fox, 1997). The subscripts denote the observational unit from which the data were taken. The *X*'s are assumed to be known constants. In addition to the *X*'s, all models involve unknown constants, called parameters, which control the behavior of the model (Rawlings *et al.*, 1998). These parameters (β_0,β_1) , are denoted by Greek letters and are to be estimated from the data.

An analysis of the relationship between *Y* and *X* requires the statement of a statistical model and it must include the set $[(x_i,y_j);\ i = 1,2,\ldots,n]$ of data involving *n* pairs of *(x, y)* values. The statistical model for simple linear regression takes the form of the equation below and shows how the response (dependent variable) *Y* is related to the independent variable *x*.

$$Y = a + bx + e \tag{3.3}$$

In Equation 3.3, *a* and *b* are unknown intercept and slope parameters, respectively, and e is a random variable that is assumed to be distributed with $E(e) = 0$ and $Var(e) = \sigma^2$. The quantity σ^2 is often called the error variance or residual variance (Walpole *et al.*, 2001).

The simple linear model has two parameters β_0 and β_1, which are to be estimated from the data. If there were no random error in Y_i, any two data points could be used to solve explicitly for the values of the parameters. The random variation in *Y*, however, causes each pair of observed data points to give different results. (All estimates would be identical only if the observed data fell exactly on the straight line.) A method is needed that will combine all the information to give one solution which is "best" by some criterion.

The least squares estimation procedure uses the criterion that the solution must give the smallest possible sum of squared deviations of the observed Y_i from the estimates of their true means provided by the solution. Let $\hat{\beta}_0$ and $\hat{\beta}_1$ be numerical estimates of the parameters β_0 and β_1, respectively.

$$\hat{Y}_i = \hat{\beta}_0 + \hat{\beta}_1 X_i \tag{3.4}$$

Let Equation 3.4 be the estimated mean of Y for each X_i = 1,….,n. The least squares principle chooses $\hat{\beta}_0$ and $\hat{\beta}_1$ that minimize the sum of squares of the residuals (Rawlings *et al.*, 1998). In other words, the least squares method of regression minimizes the squares of the differences between actual points of a data set and points predicted by a linear equation. These squares of the errors are added up and the total is called the Residual Sum of Squares (RSS) and the calculation of RSS is shown in Equation 3.5.

$$RSS = \sum_{i=1}^{n} (Y_i - \hat{Y}_i)^2$$

$$= \sum (e_i{}^2) \tag{3.5}$$

Where, $e_i = (Y_i - \hat{Y}_i)$ is the observed residual for the i^{th} observation. The summation indicated by $\sum$ is over all observations in the data set as indicated by the index of summation; $i = 1\ to\ n$. (The index of summation is omitted when the limits of summation are clear from the context.)

The estimator for β_0 and β_1 are obtained by using calculus to find the values that minimizes RSS. The derivatives of RSS with respect to $\hat{\beta}_0$ and $\hat{\beta}_1$ in turn are set equal to zero. This gives two equations in two unknowns called the normal equations:

$$n(\hat{\beta}_0) + (\sum X_i)\hat{\beta}_1 = \sum Y_i$$

$$(\sum X_i)\hat{\beta}_0 + (\sum X_i{}^2)\hat{\beta}_1 = \sum X_i Y_i \tag{3.6}$$

Solving the normal equations simultaneously for $\hat{\beta}_0$ and $\hat{\beta}_1$ gives the estimates of β_1 and β_0 as;

$$\hat{\beta}_1 = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sum((X_i - \bar{X})^2} = \frac{\sum x_i y_i}{\sum {x_i}^2}$$

$$\hat{\beta}_0 = \bar{Y} - \hat{\beta}_1 \bar{X} \tag{3.7}$$

Note that $x_i = (X_i - \bar{X})$ and $y_i = (Y_i - \bar{Y})$ denotes observations expressed as deviations from their sample means $\bar{X}$ and $\bar{Y}$, respectively.

In general, the linear regression model has been used for trip production or attraction of trip generation, first step in the conventional four step travel demand forecasting model (Goulias and Kitamura 1989; Monzon et al. 1989; Goulias et al. 1990). The linear regression method was used to obtain the trip generation models in this thesis.

The most common criterion for comparing the goodness-of-fit of regression models is the Coefficient of Determination (Coefficient of Multiple Correlation), or R^2. Mathematically it is defined as:

$$R^2 = \frac{SSR}{SST} = \frac{\sum_{i=1}^{n}(\hat{y}_i - \bar{y})^2}{\sum_{i=1}^{n}(y_i - \bar{y})^2} \tag{3.8}$$

Where,

SSR = Regression Sum of Squares

SST = Error Sum of Squares

This is the proportion of the (corrected) sum of squares of Y attributable to the information obtained from the independent variable(s). The coefficient of determination ranges from zero to one and is the square of the product moment correlation between Y_i and $\hat{Y}_i$. If there is only one independent variable, it is also the square of the correlation coefficient between Y_i and X_i (Rawlings *et al.*, 1998).

The Coefficient of Determination is indirectly an indicator of how much of the explained behavior that can be captured by the model is contained in the model. It could also be interpreted as the "quality of data". In other words, (R^2 value) per cent of the variation in the dependent variable is explained by its linear relationship with the independent variable

Aside from merely estimating the linear relationship between *x* and *Y* for purposes of prediction, the experimenter may also be interested in drawing certain inferences about, the slope and intercept (Walpole *et al*., 2001). Therefore, t and F tests were utilized for the significance assessment of slope and the intercept in developing trip generation rates and models.

The most common hypothesis in simple linear regression is the hypothesis that the true value of the linear regression coefficient, the slope is zero, that is, the dependent variable *Y* shows neither a linear increase nor decrease as the independent variable changes. The coefficients of the slope and the intercept of the models can be tested via Equation 3.7.

$$t = \frac{\widehat{\beta_i} - m}{s(\widehat{\beta_i})} \tag{3.9}$$

In equation 3.7, the numerator $\widehat{\beta_i} - m$ tests the hypothesis that $H_0 : \beta_i = m,$ where m is any constant or slope of interest and of course can be (in most cases) equal to zero. In any case, the numerator of the t-statistic is the difference between the estimated value of the parameter and the hypothesized value. The denominator is the standard error of $\widehat{\beta_i}$. The computed t-value is compared to the appropriate critical value of Student's t (available in several books as t-tables), determined by the Type I error rate α and whether the alternative hypothesis is one-tailed or two-tailed. If $t < t_{\alpha,f}$ (for two tailed case α=α/2) where f is the degrees of freedom, the conclusion is that the data do not provide convincing evidence that β_i is different from zero. Otherwise, the conclusion would be so that β_i is significantly different from m.

The F-statistic can be used as an alternative to Student's t for two-tailed hypotheses about the regression coefficients (Rawlings *et al.*, 1998). F-test in the context of this thesis is used to test the overall significance of the established models (the relationship between the variables) yet it has various other uses as well. MS (Regr) is an estimate of $\beta_0{}^2 + \beta_1{}^2 \sum x_i{}^2$, and that MS (Res) is an estimate of σ^2, the standard error term. Equation 3.8 calculates the F value of the model.

$$F = \frac{MS(Regr)}{MS(Res)} \tag{3.10}$$

This is next compared to the critical value of the F-distribution with α and *f* values (available in several books as F-tables). If the calculated F value is higher than the table one, then the relationship between dependent and the independent variables comes out as significant. Otherwise, the conclusion would be so that, there would not be a relationship between the variables.

4. DATA COLLECTION AND ANALYSIS

4.1. Introduction

The data that have been used in this study have been collected by Transportation Planning directorate of the Istanbul Greater Municipality (IBB, 2008). In this section first, the data and the methodology for the data collection that has been used in the study was explained and this was followed with a preliminary analysis of this data.

4.2. Trip Generation of Land Use Categories Data Collection

The data points were selected randomly for the chosen land use categories (general office buildings and hotels) via a land survey accomplished previously. The general office buildings were observed at 53 locations and hotels were investigated at 37 observation points. This data gathering work was completed between September 2007 and March 2008. Land use and employee information were obtained through the Development Survey Forms (DSF) which is one of the questionnaires used in this thesis. This form made the calculation of person trip ends possible by the direct addition of customers visiting the building and number of employees working in the building and is presented in Appendix A. Traffic Observation Forms (TOF) which is given in Appendix B, is the other form that was requested to be filled by the authorized people in the building under investigation which are used to obtain the information of the number of vehicles and people entering and exiting the facility exist. TOF not only made possible to obtain 24-hour vehicle and person inflow and outflow values but also provided information about the modal distribution of vehicles.

4.3. ITE Trip Generation Handbook Method of Data Collection

Before beginning the comparison of the trip generation rates, the differences between the methodologies used to gather information for the trip generation rates should be discussed. ITE trip generation rates are mostly based upon data that has been collected with automatic counters that record the vehicular traffic entering and exiting a site. Sometimes the automatic counts are supplemented by manual counts to verify the results or to determine vehicle occupancy and classification (ITE, 1991). Because the automatic counters record both the entry and exit of a vehicle from a building under investigation, the trip generation rates represent two average trip ends per vehicle. Moreover, because traffic on foot or other modes not counted by the equipment is missing, the data represent the vehicle (auto) average trip ends (Steiner, 1998), whereas data used in this thesis enable the calculation of person trip ends since the counts of person was available with the survey forms. Hence, the vehicle occupancy rates could be calculated with the available vehicle and person trip end data. On the other hand, the automatic counters seem to be more advantageous than the manual counts in terms of the reliability of the data. Therefore, for developing more reliable trip generation models, automatic counters may be preferred. Furthermore, these counts should be supported by manual count to have the vehicle occupancy rates and classification scheme.

4.4. Preliminary Data Analysis

In this section, a preliminary analysis for the two selected land uses which are "General Office Buildings" and "Hotels" are presented. The data was first subjected to a thorough check for missing data, out-of-range fields, wrong coding etc., and they were corrected by either referring to the original survey forms or by completely deleting the case if this was not possible.

Firstly, an outlier analysis was performed for general office buildings to see if there were any anomalies in the data. As a result of this analysis, six offices which had no trip ends data (most likely missing information), two money-exchange bureaus which had, relatively, too many visitors in very small offices, one timber factory which had very few visitors and, and one sports club were discarded from the data. Most of these deleted cases obviously have different characteristics than a general office building and obviously form a special land use type that needs to be analyzed separately. Totally 10 observations were removed and thus 43 data points were utilized in the analysis of general office buildings. In Figure 4.1, the general office building data locations can be observed.

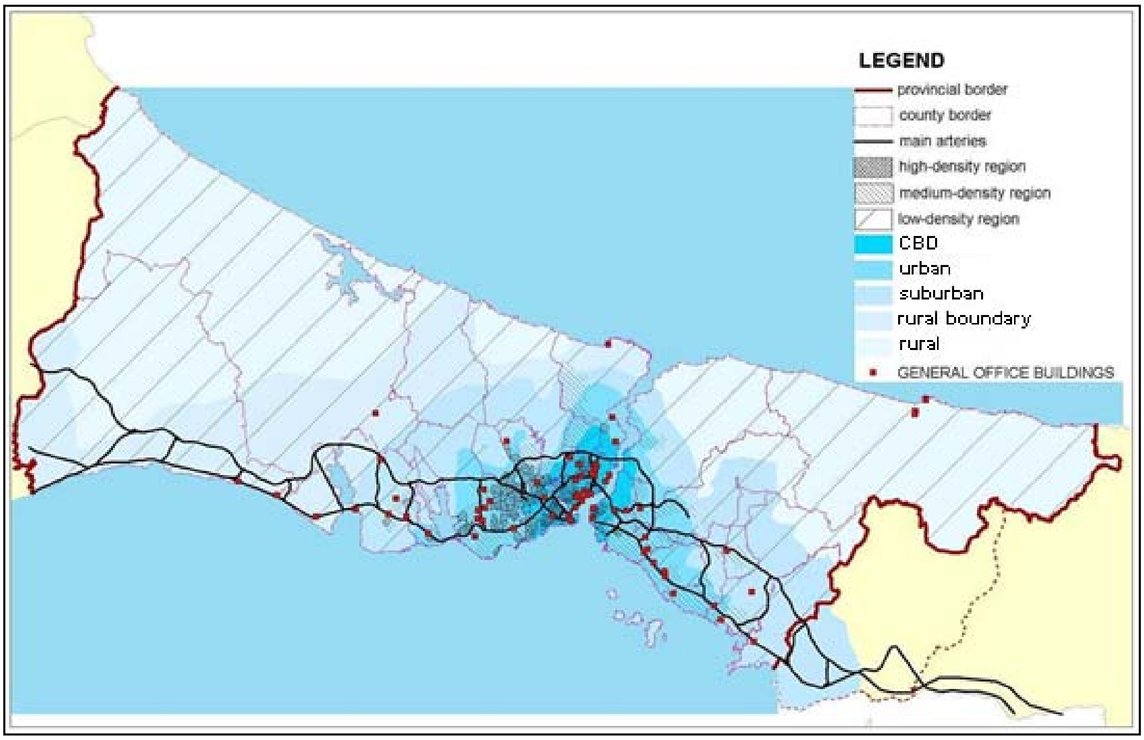


Figure 4.1. General office buildings' data locations

Secondly, hotels were investigated through an outlier analysis with the aim of the elimination of possible anomalies in the data. The analysis showed that three of the observation points were not hotels and did not include land use information (gross floor area); hence they were excluded from the data. Furthermore, one women's refuge house, a security camp, a motel and a hostel were discarded from the data since the average mean trip rate and land use outputs (gross floor area and number of employee) were different from the other data points in this land use category. Totally, seven observations were removed and remaining 30 hotels were used in the analyses of hotels. Unlike general office buildings, hotels were also classified according to the zonal area classification employed by IBB.

These classes include "CBD", "urban", "suburban", "rural boundary" and "rural" segments. The locations and the zonal separation of hotels' data are shown in Figure 4.2.

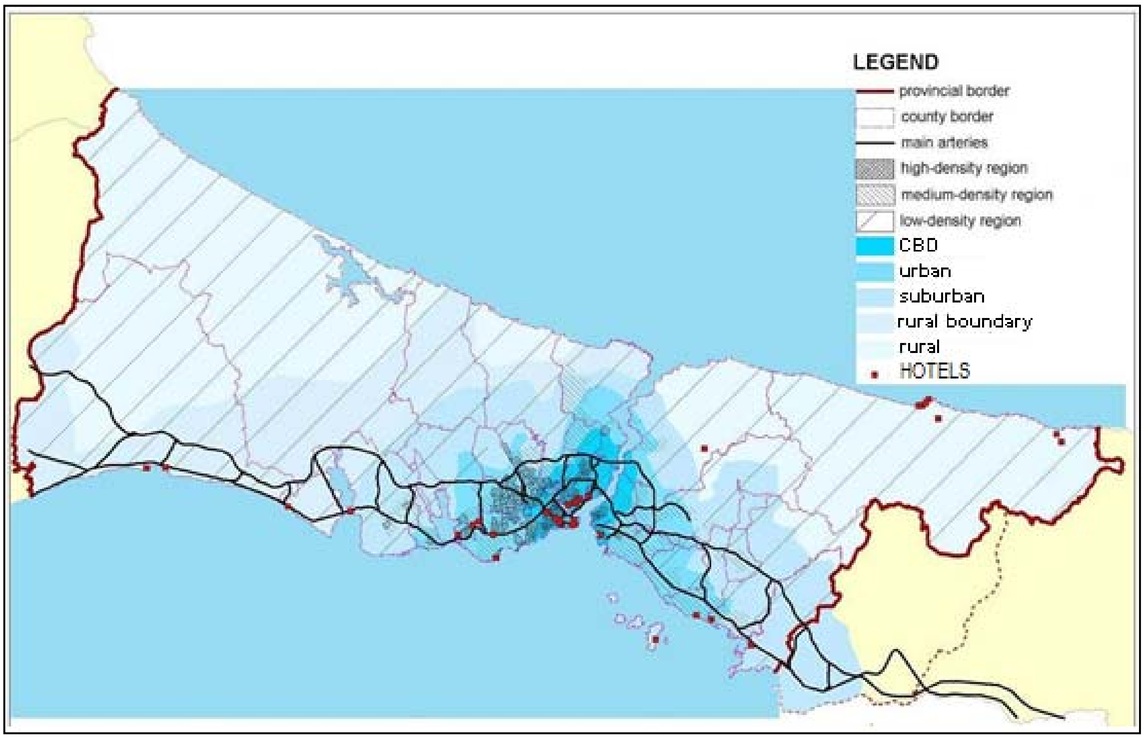


Figure 4.2. Hotels’ data locations and zonal separation

4.4.1. Preliminary Analysis of General Office Buildings’ Data

General Office Buildings are defined as a type of building which houses one or more tenants and is the location where affairs of a business, commercial or industrial organization, professional person or firm are conducted (ITE, 2003). The building or buildings may be limited to one tenant, either the owner or lessee, or contain a mixture of tenants including professional services, insurance companies, investment brokers, company headquarters, and services for the tenants such as bank or savings and loan, a restaurant or cafeteria, and service retail facilities.

Initial analyses were performed with the purpose of finding out the employee densities for Weekday, Saturday and Sunday and gross floor area (GFA) intervals. In Table 4.1 it can be observed that the employee densities decrease when the gross area of the office building increases. One other observation from this table, which is expected, is that the employee densities decrease in the weekends. Further, it seems that on Saturdays, most of the office buildings are open since the difference in employee densities between weekday and Saturday is insignificant. Although there are 6 observations in 500 to 750 m^2 GFA range, the employee density is zero due to the fact that those offices are closed on Sundays.

Table 4.1. General office building employee densities (Employee per 100 m^2 GFA)

Gross Floor Area (m^2)	Sample Size (N)	Statistics	Weekday	Saturday	Sunday
Under 250	26	Mean	6.37	5.09	1.67
		Std. Deviation	3.55	4.47	3.67
250 to 500	5	Mean	3.95	3.28	0.48
		Std. Deviation	2.95	3.46	0.72
500 to 750	6	Mean	3.33	1.62	--
		Std. Deviation	1.48	2.44	--
Over 750	6	Mean	3.11	1.74	1.47
		Std. Deviation	2.79	1.37	1.62
Average	43	Mean	5.21	3.93	1.27
		Std. Deviation	3.42	4.04	2.96

In Tables 4.2 and 4.3, the trip rates and the traffic volumes for five different time periods under the gross floor area intervals of 250 m^2 are presented. Table 4.2 presents the trip rates, number of observations and standard deviation of each segment. For example, for general office buildings with a GFA of less than 250 m^2 attracts and generates 13.43 vehicle trips per 100 m^2 with a standard deviation value of 15.84 in an average weekday.

Table 4.2. General office building trip generation rates (GFA)

(Vehicle & Person, Two-Way Volume)
Independent Variable – Trips per 100 m^2 Gross Floor Building Area

Gross Floor Area (m^2)	Stats	Average Weekday Vehicle Trip Rates (vehicle/100m^2)	Average Weekday Person Trip Rates (person/100m^2)	A.M. Peak Hour Vehicle Trip Rates (vehicle/100m^2)	P.M. Peak Hour Vehicle Trip Rates (vehicle/100m^2)	Saturday Person Trip Rates (person/100m^2)	Sunday Person Trip Rates (person/100m^2)
Under 250	Rate	13.43	35.06	0.84	2.25	36.15	27.88
	N	26	26	26	26	26	26
	Std. Dev.	15.84	23.73	0.89	3.69	59.86	72.96
250 - 500	Rate	7.93	20.22	0.63	1.37	16.43	9.76
	N	5	5	5	5	5	5
	Std. Dev.	2.37	14.24	0.64	1.7	16.67	18.85
500 - 750	Rate	6.3	11.85	0.31	0.89	6.9	--
	N	6	6	6	6	6	6
	Std. Dev.	4.25	7.25	0.19	1.46	9.74	--
Over 750	Rate	2.17	22	0.13	0.34	9.84	3.79
	N	6	6	6	6	6	6
	Std. Dev.	2.41	35.5	0.18	0.33	13.31	3.72
Average	Rate	10.22	28.28	0.64	1.69	26.11	18.52
	N	43	43	43	43	43	43
	Std. Dev.	13.09	24.31	0.77	3.03	48.54	57.85

An interesting outcome of the analysis is that, P.M Peak Hour trip generation values are much greater than A.M. ones. The reason behind this situation may stem from the fact that, offices open generally at between 8 and 9 A.M., whereas the data collected gives the A.M. trip ends in the interval of 6 and 10 A.M. Therefore, A.M. Peak Hour calculations seem to underestimate the trip generation rate since the total volume should be divided by 4 to obtain the hourly rate. This calculation involves the 2 hours –6 to 7 A.M and 9 to 10 A.M. intervals – in which the vehicle volume is expected to be very low. On the other hand, in order to clarify this issue according to the working hours of the employees in the buildings are obtained from the collected data and the hourly variation of the openings of the office buildings are listed in Table 4.3. It could be observed from Table 4.3 that, all office buildings open either at 08:00 or at 09:00. Therefore, if the average travel time is assumed as approximately one hour for the city of Istanbul, than the morning peak hour generated by the office buildings would be between 07:00 and 09:00 or around this interval. Therefore, users of Table 4.2 should be aware of the underestimation of morning peak trips and should perform the calculations accordingly.

Table 4.3. Hourly variation of the opening times of general office buildings

Time	06:00	07:00	08:00	09:00	10:00	Total
Per cent	0,0	0,0	41,5	58,5	0,0	100

Figure 4.3 demonstrates the dramatic increase of trip volumes for general office buildings having more than 750 m^2 GFA. The attractiveness of the building particularly rises up when the GFA of it goes beyond 625 m^2.

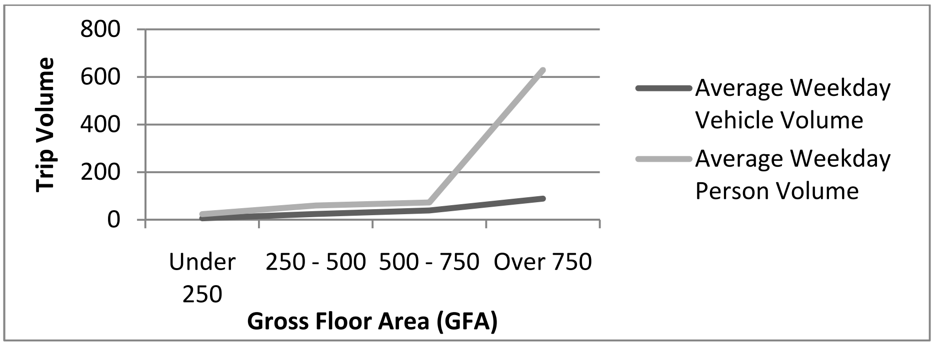


Figure 4.3. Trip volume variations versus GFA for average weekday

Table 4.4 cross-tabulates the variation of trip generation rates and volumes for the previously mentioned five time periods with a classification of number of employees working in the office building as less than 20, between 20 and 100 and over 100. The classifications of GFA (Table 4.3) and number of employee variables were made according to several trials of ANOVA statistics and the best categorization was found as stated above, that is, the mean rates of each category were found to be significantly different from each other and the classifications increased the models quality by decreasing the variation and the standard error values. This situation could be observed by comparing the standard deviation values at each categorized rows with the average rows in Tables 4.2 and 4.4. Hence, rather than stating only the average values for trip rates and volumes, researcher tried to render the results by categorization for the sake of the accuracy of the analysis.

As can be observed from Table 4.4, it appears that for office buildings having relatively small number of employees, average weekday vehicle trip ends per employee value is much greater than for buildings having relatively high number of employees. Another conclusion is that, Saturday person trip ends per employee values are greater than average weekday ones. This is due to the less number of employees working on weekends.

Table 4.4. General office building trip generation rates (Employee)

(Vehicle & Person, Two-Way Volume)
Independent Variable – Trips per Employee

Number of Employee	Stats	Average Weekday Vehicle Trip Ends (vehicle/ employee)	Average Weekday Person Trip Ends (person/ employee)	A.M. Peak Hour Vehicle Trip Ends (vehicle/ employee)	P.M. Peak Hour Vehicle Trip Ends (vehicle/ employee)	Saturday Person Trip Ends (person/ employee)	Sunday Person Trip Ends (person/ employee)
Under 20	Rate	2.63	6.59	0.16	0.44	8.15	19.04
	N	33	33	33	33	23	9
	Std. Dev.	2.58	5.09	0.11	0.79	7.11	14.35
20 - 100	Rate	1.35	3.69	0.06	0.3	4.92	2
	N	6	6	6	6	5	1
	Std. Dev.	1.11	1.49	0.05	0.25	4.66	--
Over 100	Rate	0.72	5.24	0.04	0.14	3	2.58
	N	4	4	4	4	3	2
	Std. Dev.	0.42	3.96	0.02	0.17	0.74	0.04
Average	Rate	2.28	6.06	0.13	0.39	7.13	16.06
	N	43	43	43	43	31	12
	Std. Dev.	2.39	4.71	0.11	0.7	6.58	14,44

The hourly variation of daily trips (vehicles and persons respectively) by mode is given in Table 4.5 and Table 4.6. In table 4.5, the average vehicle trips to the buildings are presented, whereas the outputs listed at Table 4.6 are the average trip values counted in terms of the passengers (person) inside the vehicles and the pedestrians. These two tables show that, the office building trips mostly occur in walking mode with a factor of approximately 2.5 than the other modes in total. The time intervals presented in those two tables were not converted into hourly values by dividing them by the duration in hours. However, if the values were converted into hourly rates, A.M Peak Hour seems to fit into the 10:00-12:00 interval. The morning peak calculations were made according to the 06:00-10:00 interval with the purpose of sticking to the general method of A.M. peak hour calculations. It can also be observed that P.M. peak values (values that occur between 16:00-18:00) are higher than the A.M. peak values.

Table 4.5. Hourly variations of vehicle trip ends and modal split in a weekday

Time	Auto	Others (All type)	Motorcylce	Total Vehicle	Hourly Variation (%)	Entrance (%)	Exit (%)
06:00-10:00	5.2	0.7	0.1	6.0	25.8	83.6	16.4
10:00-12:00	3.7	0.3	0.0	4.0	17.4	51.2	48.8
12:00-16:00	5.7	0.5	0.0	6.2	26.9	45.3	54.7
16:00-18:00	3.0	0.7	0.0	3.7	16.0	33.0	67.0
18:00-06:00	2.6	0.4	0.2	3.2	13.9	14.3	85.7
Total	20.1	2.6	0.4	23.1	100.0	49.9	50.1
Modal Split (%)	87.0	11.2	1.7				

Table 4.6. Hourly variations of person trip ends and modal split in a weekday

Time	Auto	Others (All type)	Motorcylc e	Walking	Total Person	Hourly Variation(%)	Entranc e (%)	Exit (%)
06:00-10:00	7.8	0.5	0.1	14.5	22.9	20.0	87.2	12.8
10:00-12:00	5.2	1.1	0.0	19.4	25.7	22.4	51.3	48.7
12:00-16:00	8.2	0.2	0.0	22.5	30.9	26.9	45.2	54.8
16:00-18:00	5.0	0.2	0.0	20.3	25.5	22.2	33.5	66.5
18:00-06:00	3.6	0.1	0.5	5.6	9.8	8.6	14.4	85.6
Total	29.8	2.1	0.6	82.4	114.9	100.0	50.0	50.0
Modal Split (%)	25.9	1.8	0.6	71.7				

Figure 4.4 presents the modal split of person trips. Walking mode is the leading one with a 71.7 per cent, while the other modes -Vehicle, Others (All Types) and Motorcycle- share the remaining percentages.

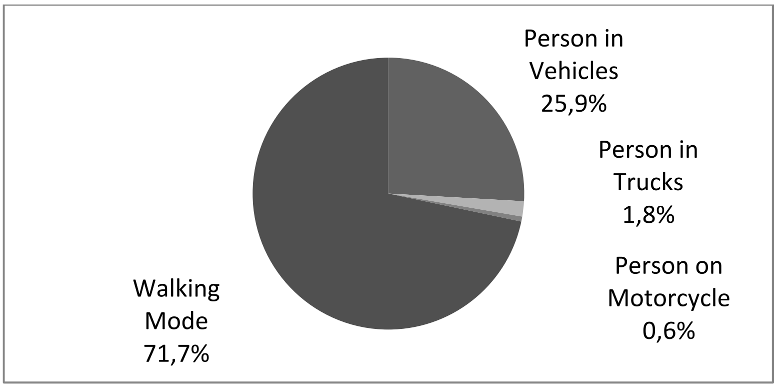


Figure 4.4. Modal separations of trips

The comparison of vehicle and passenger vehicle mode travels is presented in Figure 4.5. The direct division of person trips (the number of visitors inside their vehicles) to vehicle trips gives the occupancy values for each time interval. The occupancy value for automobile travel ranges from 1.4 to 1.5 which is very near to the occupancy rate 1.75, obtained in the Transportation Master Plan (IBB, 2008).

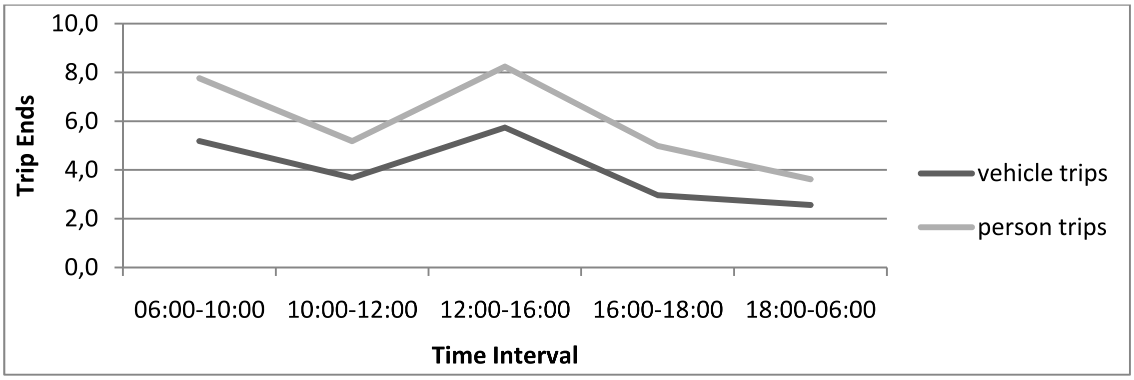


Figure 4.5. Hourly variations of vehicle and person trip ends for automobile trips

To sum up, in this section the trip rates and volumes in general office buildings were projected. The example shown below figures out how a trip end value should be calculated with the given input and declares the differences of trip values between ITE Trip Generation Manual and Turkish ones.

If a general office building has 50 employees; average weekday trip ends could be calculated as 236 for ITE conditions (From Table 2.1; p. 8) and 68 trip ends (from Table 4.4) for Istanbul/ Turkey. The difference in the number of trips between these two could be due to many reasons, such as difference in socioeconomic characteristics or mode choices of visitors, average income difference, etc. Given example could be expanded for other time periods, but the difference in number of trip ends would still remain. This situation supports the initial hypothesis stating the necessity of establishment of trip generation rates for Turkey.

When the average weighted trip rates and corresponding standard deviations are examined, one could easily observe the high variation in average trip generation rates.

Hence, in Table 4.7, necessary sample sizes are calculated for various confidence intervals (90, 80 and 75 per cents) using the sample size formula:

$$n=\left(\frac{z_{\alpha/2}\sigma}{e}\right)^2 \tag{4.1}$$

In formula 4.1, e stands for the error term and 0.10 is used as the allowed error value in the calculations. The confidence interval of the sample is determined by $z_{\alpha/2}$ term, that is, the error will not exceed the assigned 0.10 value with a $100(1-\alpha)\%$ confidence.

Table 4.7. Sample size calculation for general office buildings

Independent Variable	Statistics	Average Weekday Vehicle Trips	Average Weekday Passenger Trips	Weekday Morning Vehicle Trips	Weekday Evening Vehicle Trips	Saturday Passenger Trips	Sunday Passenger Trips
GFA	Rate	10.22	28.28	0.64	1.69	26.11	18.52
	N	43	43	43	43	43	43
	Std. Dev.	13.09	24.31	0.77	3.03	48.54	57.85
	90% confidence N	211	141	198	295	306	514
	85% confidence N	184	124	173	258	268	449
	75% confidence N	147	99	138	206	214	360
E	Rate	2.28	6.06	0.13	0.39	7.13	14.87
	N	43	43	43	43	31	12
	Std. Dev.	2.39	4.71	0.11	0.7	6.58	14.37
	90% confidence N	172	128	139	295	152	159
	85% confidence N	151	112	122	258	133	139
	75% confidence N	121	89	97	207	106	111

For instance, for 85 per cent confidence, 184 observations are needed in weekday vehicle trip rate case. 43 observations are found to be unsatisfactory for all time periods at each confidence interval. In order to have a sample size not exceeding 0.10 error value in a confidence interval of 90 per cent, at least 296 observations are required for vehicle trip and 515 for person trip calculations.

4.4.2. Preliminary Analysis of Hotels' Data

In ITE, Trip Generation Handbook, a hotel is defined as a place of lodging that provides sleeping accommodations, restaurants, cocktail lounges, meeting and banquet rooms or convention facilities, and other retail service shops. All suites hotel, business hotel, motel and resort hotel are presented in that informal report as "the other types of hotels".

In Trip Generation Manual, the independent variables are chosen as "number of rooms", "gross floor area" and "number of employee". Therefore unlike in this thesis, the trips per room were listed in the manual. The inexistence of room information in the data collected by BIMTAS in 2007 prevented the calculation of the trip rates in terms of number of rooms.

While calculating the GFA for hotels, "main building", "general store", "social facilities" and "common use" areas were summed up. Five observations were discarded form the vehicle trip rate calculation analysis since the TOF were not available for them and five observations were eliminated due to the inconsistencies existing in TOF. Consequently, the vehicle trip rates (Average Weekday, A.M Peak and P.M Peak Hour) were calculated for 20 locations. On the contrary, the calculation of person trips, (Average Weekday, Saturday and Sunday) with the addition of previously discarded locations which did not have TOF and having inconsistencies in TOF, was performed for 30 hotels.

Initially, as it was done in the previous section, the employee variation in terms of employee/100m^2 GFA was investigated but this time it was done for the predefined zoning scheme. The results are presented in Table 4.8. The examination of these results brings out the following observations: CBD zone employee rates are the highest; mean GFA of CBD and urban zones do not differ that much but employee densities are distinctive; suburban and rural zones' GFA values are much higher than the other ones; the expected decrease in employee density going through CBD to rural was not observed which might happened due to the random nature of the data, or because, the analysis was performed for all kind of hotels ,without the distinction like resort hotel, business hotel, etc., unlike the ITE Trip

Generation Manual case as mentioned previously, or due to insufficient number of observations in the cells.

Table 4.8. Hotel employee densities
(Employee per 100 m^2 GFA)

Area Categorization	Stats.	Average Weekday Number of Employee per 100 m^2 GFA	Saturday Number of Employee per 100 m^2 GFA	Sunday Number of Employee per 100 m^2 GFA	Gross Floor Area (GFA)
CBD	Mean	1.32	1.31	1.30	3141.64
	Std. Dev.	0.86	0.87	0.88	4495.38
	N	14	14	14	14
Urban	Mean	0.74	0.74	0.74	3363.33
	Std. Dev.	0.38	0.38	0.38	6206.34
	N	6	6	6	6
Suburban	Mean	1.02	1.02	1.02	23220.00
	Std. Dev.	0.85	0.85	0.85	32125.36
	N	3	3	3	3
Rural	Mean	0.71	0.69	0.69	13597.14
	Std. Dev.	0.44	0.42	0.42	25530.09
	N	7	7	7	7
Total	Mean	1.03	1.02	1.02	7633.43
	Std. Dev.	0.73	0.73	0.73	16399.90
	N	30	30	30	30

The first set of analyses for Hotels were performed with the purpose of calculation of trip rates in different time periods previously described in the last section. Unlike the analysis for General Office Buildings, the trip rates were calculated for the zoning schemes as well. The results are shown in Table 4.9.

When the results are examined for all columns in Table 4.9 showing trip rates for different time periods, it can be observed that trip rates decrease as the density of the zone declines. In other words, for CBD zones the trip rates are the highest, whereas for rural zones they are the lowest. If the results are compared with the total (average) trip rate values, one can say that, CBD and urban zones trip rates are greater for almost all columns which was an expected result to occur. The weekend trip rates are slightly greater than the weekday ones which was an expected situation and as a result, there seems to be a higher trip attraction and production for hotel trip rates in the weekends.

Table 4.9. Hotel trip generation rates (GFA)

(Vehicle & Person, Two-Way Volume)
Independent Variable – Trips per 100 m^2 Gross Floor Building Area

Area Categorization	Stats.	Average Weekday Vehicle Trip Rates (vehicle/100m²)	Average Weekday Person Trip Rates (person/100m²)	A.M. Peak Hour Vehicle Trip Rates (vehicle/100m²)	P.M. Peak Hour Vehicle Trip Rates (vehicle/100m²)	Saturday Person Trip Rates (person/100m²)	Sunday Person Trip Rates (person/100 m²)
CBD	Mean	1.76	9.83	0.05	0.10	9.42	9.28
	N	8	14	8	8	14	14
	Std. Dev.	1.60	5.27	0.05	0.17	5.28	5.35
Urban	Mean	1.41	8.19	0.05	0.33	7.87	8.71
	N	4	6	4	4	6	6
	Std. Dev.	0.91	5.22	0.07	0.37	4.40	5.64
Suburban	Mean	0.69	4.73	0.14	--	6.11	6.11
	N	2	3	2	2	3	3
	Std. Dev.	0.86	4.92	0.19	--	6.83	6.83
Rural	Mean	0.72	3.43	0.03	0.05	6.41	6.33
	N	6	7	6	6	7	7
	Std. Dev.	0.61	1.90	0.05	0.06	3.78	3.83
Total	Mean	1.27	7.50	0.05	0.12	8.08	8.16
	N	20	30	20	20	30	30
	Std. Dev.	1.20	5.20	0.07	0.21	4.89	5.15

A.M and P.M Peak Hour trip generation rates seem to vary significantly on the ground that, standard deviations of these rates are relatively greater. Furthermore, at suburban row there was no rate calculable for P.M Peak Hour. It is recommended to increase the data points to have more reliable results for these peak hours. In general, however, P.M. peak hour rates are higher than the A.M. ones for all different zonal areas.

In Table 4.10 the trip generation rates per employee for different time segments versus area segmentation are summarized. Inference to this seems that, the weekday trip generation rates for urban zone are slightly higher than the inside-centre ones which may stem from the lower employee density in the urban zone as could be observed from Table 4.10. However, both of these rates are higher than the average trip generation rate. In general, the trip rates seem to decrease as the hotels get away from the city center. Also, although trip rates are comparable for urban areas for weekday and weekend passenger trip rates, for outside zones the passenger trip rates are higher. For passenger trip rates, weekend values are higher than the weekday values in general.

Table 4.10. Hotel trip generation rates (Employee)

(Vehicle & Person, Two-Way Volume)
Independent Variable – Trips per Employee

Area Categorization	Stats.	Average Weekday Vehicle Trip Ends per Employee	Average Weekday Passenger Trip Ends per Employee	A.M. Peak Hour Vehicle Trip Ends per Employee	P.M. Peak Hour Vehicle Trip Ends per Employee	Saturday Vehicle Trip Ends per Employee	Sunday Vehicle Trip Ends per Employee
CBD	Mean	1.70	9.47	0.04	0.08	8.29	8.34
	Std. Dev.	1.65	5.74	0.05	0.17	3.53	3.79
	N	8	14	8	8	14	14
Urban	Mean	1.99	10.33	0.05	0.57	11.79	11.75
	Std. Dev.	1.39	6.13	0.06	0.77	4.88	5.46
	N	4	6	4	4	6	5
Suburban	Mean	0.40	4.17	0.07	--	5.09	5.09
	Std. Dev.	0.36	1.12	0.09	--	1.66	1.66
	N	2	3	2	2	3	3
Rural	Mean	1.28	6.05	0.05	0.12	11.03	10.98
	Std. Dev.	1.11	5.09	0.09	0.15	9.96	10.02
	N	6	7	6	6	7	7
Total	Mean	1.50	8.31	0.05	0.18	9.31	9.23
	Std. Dev.	1.36	5.59	0.06	0.39	5.89	6.06
	N	20	30	20	20	30	29

The average trip ends for hotels are presented in Table 4.11. As can be observed in this table, the average weekday vehicle and passenger trip ends for suburban area categorization zone are much higher than the weekend trip ends. Since most of these hotels are located in the historical peninsula which has a significant amount of tourists this

Table 4.11. Hotel average trip ends

(Vehicle & Person, Two-Way Volume)

Area Categorization	Stats.	Average Weekday Vehicle Trip Ends (vehicle/day)	Average Weekday Passenger Trip Ends (Pass./day)	Weekday Morning Vehicle Trip Ends (vehicle/hour)	Weekday Evening Vehicle Trip Ends (vehicle/hour)	Saturday Passenger Trip Ends (Pass./day)	Sunday Passenger Trip Ends (Pass./day)
CBD	Mean	39.50	188.51	2.13	2.81	173.00	169.71
	Std. Dev.	57.07	332.34	4.19	4.78	332.44	332.36
	N	8	14	8	8	14	14
Urban	Mean	40.75	159.00	3.06	5.50	122.67	126.00
	Std. Dev.	60.53	244.28	5.17	5.80	153.71	151.98
	N	4	6	4	4	6	6
Suburban	Mean	16.00	543.33	3.00	0.00	580.67	580.67
	Std. Dev.	14.14	656.70	3.54	0.00	625.75	625.75
	N	2	3	2	2	3	3
Rural	Mean	54.67	176.57	3.17	3.58	352.86	355.14
	Std. Dev.	91.29	182.96	5.59	5.18	487.60	487.17
	N	6	7	6	6	7	7
Total	Mean	41.95	215.31	2.71	3.30	245.67	245.33
	Std. Dev.	64.09	330.10	4.45	4.81	387.13	387.12
	N	20	30	20	20	30	30

might be a particular characteristics for this area. Another interesting point is that, the weekend person trips for rural zone are higher than the week ones and this might be explained by the fact that these hotels may be used as a weekend retreat possibility.

Tables 4.12 and 4.13 present the hourly variations and modal split of trips. In Table 4.12, it can be observed that, trip ends in the automobile mode is the highest with a per cent of 82.5. When the modal split values listed in Table 4.12 are compared with the ones in Table 4.13, the decrease in automobile and an increase in the others mode could be observed. This situation reflects the visitors' modal choice to the Hotels coming with a vehicle.

Table 4.12. Hourly variations of vehicle trip ends and modal split in a weekday

Time	Auto	Others[a] (All type)	Motorcylce	Total Vehicle	Hourly Variation (%)	Entrance (%)	Exit (%)
06:00-10:00	8.0	2.1	0.8	10.9	25.9	61.8	38.2
10:00-12:00	9.0	0.7	0.0	9.7	23.0	50.3	49.7
12:00-16:00	4.8	0.6	0.0	5.3	12.6	44.3	55.7
16:00-18:00	6.2	0.4	0.0	6.6	15.7	43.2	56.8
18:00-06:00	6.7	2.9	0.0	9.6	22.8	36.6	63.4
Total	34.6	6.6	0.8	42.0	100.0	48.3	51.7
Modal Split (%)	82.5	15.6	1.9				

[a] tractor trailer, truck, pickup truck, bus, minibus

When the hourly variation of vehicle trips is examined, as presented in Table 4.12, the morning peak seems to occur between 06:00 and 10:00 interval. But, if the length of this interval is considered, the 10:00-12:00 interval seems to be the morning peak since in the former case the average number of entering and exiting vehicle is 10.9 for four hours, whereas in the latter case the average number of vehicle is 9.7 in total for two hours. Since the variation of trips in 06:00-10:00 interval is unknown, it would be incorrect to directly state that 10:00-12:00 interval is the morning peak although it has a higher average vehicle per hour value. In order to have a better understanding in this issue, person trips could be examined. Table 4.13 presents the person trip variation in time and modal split. The total person column in Table 4.13 designates the lead of morning entrance with the high number of person entrance in truck. The truck (all types) mode dominates the person trips in the 06:00-10:00 interval most probably due to the provision of needs of the hotels in terms of employee and goods. Unlike the results presented in Table 4.12, person trip modal split per cents expose the high walking mode trip ends. Further, it would be more explanatory to present the vehicle occupancy values.

Table 4.13. Hourly variations of person trip ends and modal split in a weekday

Time	Auto	Others[a] (All type)	Motorcylce	Walking	Total Person	Hourly Variation(%)	Entrance (%)	Exit (%)
06:00-10:00	10.2	15.9	0.8	23.4	50.3	26.6	61.6	38.4
10:00-12:00	26.0	0.8	0.0	6.7	33.5	17.7	48.4	51.6
12:00-16:00	8.2	1.9	0.0	21.7	31.7	16.8	45.7	54.3
16:00-18:00	8.0	2.1	0.0	13.6	23.6	12.5	54.6	45.4
18:00-06:00	9.8	11.5	0.0	28.9	50.2	26.5	47.5	52.5
Total	62.1	32.1	0.8	94.2	189.2	100.0	52.0	48.0
Modal Split (%)	32.8	17.0	0.4	49.8				

[a] tractor trailer, truck, pickup truck, bus, minibus

As it was discussed in the section for General Office Buildings, the direct division of person trips to vehicle trips, at first glance, yields to the vehicle occupancy value. However, the person trips include the visitors of walking mode. Hence, the occupancy values were calculated for an average weekday in a further step and listed in Table 4.14.

Table 4.14. Vehicle occupancy rates in a weekday per period

Time	Auto	Others (All type)	Motorcylce	Average
06.00-10.00	1.3	7.6	1.0	2.5
10.00-12.00	2.9	1.2	--	2.8
12.00-16.00	1.7	3.5	--	1.9
16.00-18.00	1.3	5.1	--	1.5
18.00-06.00	1.5	4.0	--	2.2
Average	1.8	4.9	1.0	2.3

When the auto mode occupancy values are examined in Table 4.14, it is seen that occupancy rate in 10:00-12:00 interval goes beyond the average rate, whereas in other intervals this rate is below the average one. The others (bus and minibus for Hotels) occupancy rate is the maximum in 06.00-10.00 interval.

The calculated average trip rates and corresponding standard deviations due to high variation observed in the data necessitated the calculation of required sample sizes of hotels for various confidence intervals (90, 85 and 75 per cents) using Formula 4.1. Table 4.15 presents the calculated sample sizes for these confidence intervals.

Table 4.15. Sample size calculation for hotels

Independent Variable	Statistics	Average Weekday Vehicle Trips	Average Weekday Passenger Trips	Weekday Morning Vehicle Trips	Weekday Evening Vehicle Trips	Saturday Passenger Trips	Sunday Passenger Trips
GFA	Rate	1.27	7.5	0.05	0.12	8.08	8.16
	N	20	30	20	20	30	30
	Std. Dev.	1.20	5.2	0.07	0.21	4.89	5.15
	90% confidence N	156	114	230	288	100	104
	85% confidence N	136	100	201	252	87	91
	75% confidence N	109	80	161	201	70	73
E	Rate	1.00	8.32	0.04	0.12	9.31	9.23
	N	20	30	20	20	30	30
	Std. Dev.	1.32	5.59	0.06	0.32	5.89	6.06
	90% confidence N	180	177	141	251	198	194
	85% confidence N	158	155	123	219	173	168
	75% confidence N	126	124	99	175	139	135

For average weekday vehicle trip rate case for instance, at 85 per cent confidence, 136 observations are required. Weekday peak hour trip rates suffer more variation than the other time periods and need larger sample size. One other inference is that, in all confidence rows both for GFA and E, the required sample sizes are much higher than the available number of observations.

5. DEVELOPMENT OF TRIP GENERATION MODELS

Development of Trip Generation Models is one of the most important stages in modeling process. In Trip Generation Manual (ITE, 2003), the basic and the suggested rout for the correct use of the manual starts from the selection of either the use of regression equations or weighted average rate for the determination of the number of trips. If the number of trips for a specific site and a time is under investigation, first thing to do is the selection between the two sources which basically depends on the existence of a regression equation. If there is a regression equation provided where the data plot contains more than 20 data points at the same time, the use of the regression equation is recommended. Not only that, but also the regression equation should have an R^2 of at least 0.75 which indicates the desired level of correlation between the trips generated by a land use and the value measured for an independent variable. If these are not satisfied and additionally the standard deviation is less than or equal to 110 percent of the weighted average rate, then the use of weighted average rate is recommended (ITE, 2003). But, in any case the common requirement is that, the value of the independent variable for the land use must fall within the range of data included to use either the rate or equation. If the user cannot take the advantage of rate or equation should collect local data to accomplish in trip estimation.

This chapter focuses on the regression analysis of the relationships between the dependent (T) and independent variables (GFA and E). While accomplishing these, the plots of the collected data were presented so as to have a visual understanding on the variation of points. Additionally, R^2 values and the regression model equations were also presented on these plots with the purpose of having a more representative figure and the statistics test results were presented in separate tables as “F” and “t” tests’ significance values and standard deviations.

In the following two sections, trip generation regression models of Office Buildings and Hotels are given. Separate models have been calibrated for average weekdays (vehicle and person trips), average weekday peak hours (A.M. and P.M.) and weekend (Saturday and Sunday) periods. This chapter ends with an example of how the obtained results could be utilized.

5.1. Calibration of Regression Models for Office Buildings

Office Buildings were investigated for the average trip generation rates in the last chapter. In this section model calibration for Office Buildings using regression analysis have been explained. To have a better understanding of the relationships among the dependent variable and the independent variables scatter plots were prepared. These plots revealed the variance of the data, the kind of relationships (linear, logarithmic, etc.) between the dependent and the independent variables. Using the information obtained from these plots, regression models were then calibrated. In an example given in Section 5.3, the trip generation rates obtained from the regression equations and average trip rates were compared.

5.1.1. Data Plots of General Office Buildings

In this section, Figures 5.1 to 5.6 were given so as to show the plots of the collected data and related outputs such as the regression equation and curve, R^2 value, standard deviation, number of observations, the range of the data, average trip rate and the average value of the independent variable for various time periods (weekday, weekends, peak periods etc).

When the relations between the trip ends for varying time periods and GFA/ E are examined, except the relationship of weekday morning peak hour vehicle trip ends and GFA, all R^2 values were found to be higher than 0.50. Furthermore, the weekday person trip ends and WE relations have an R^2 value of 0.82 which is shown in Figure 5.2. In weekends, R^2 values have a range of 0.70-0.87. The models with person trip ends in weekdays generally have standard deviation values of less than the corresponding average trip rates, whereas, the models developed with vehicle trip rates in weekdays have standard deviations which are higher than the average trip rates. These deviations are shown in Figures 5.1 and 5.2. In Figure 5.4, the standard deviations for both independent variables almost double the mean trip rates which are a representation of a high variation in these models. The models developed with GFA as independent variable, when compared to the models with E yields higher standard deviation values. This situation could be observed in Figures 5.5 and 5.6.

5.1.2. Regression Models of General Office Buildings

The plots of General Office Buildings designate the variation of data collected and several outputs such as regression equation and curve, per cent of entry and exit (directional distribution) and R^2 value. Besides, tables showing related statistical outputs such as trip generation rate, rate range, standard deviation of data, number of studies (observation) and the average values of the independent variables are given above these plots. The plots and associated tables are satisfactory for a detailed study which aims to find the average trip generation value of an Office Building if the analyzer is interested in the variation of trips. However, due to data restrictions it is not possible to obtain plots every time. Therefore, a table which states the necessary information for a transportation study is prepared. Table 5.1 is a summary table showing the Regression Models obtained from the analysis performed for General Office Buildings which includes the alternative regression equations, the transformed versions of logarithmic equations listed under plots, t and F statistics which are not present in the plots.

The column showing F statistics results and the significance values of the models brings out that all the models are statistically significant with having significance values much less than the critical value of $\alpha = 0.05$. All of the R^2 values are higher than 0.50 except for A.M. Peak Hour Vehicle Trip Ends row, which is 0.48. For the person trip end results (weekday and weekend) the R^2 values are found to be in 0.72-0.87 interval; whereas, the vehicle trip ends are in 0.48-0.66 interval. The difference in these results may stem from several factors such as, the quality of data and data collection, data entry, the randomness of the data, etc. One interesting output of the regression analysis results is that, logarithmic linearization of the variables led to the best models in almost all cases except for the Saturday person trips' relation with employee.

Average Weekday Vehicle Trip Ends & **Employees**
On a: **WEEKDAY**

TRIP GENERATION RATES

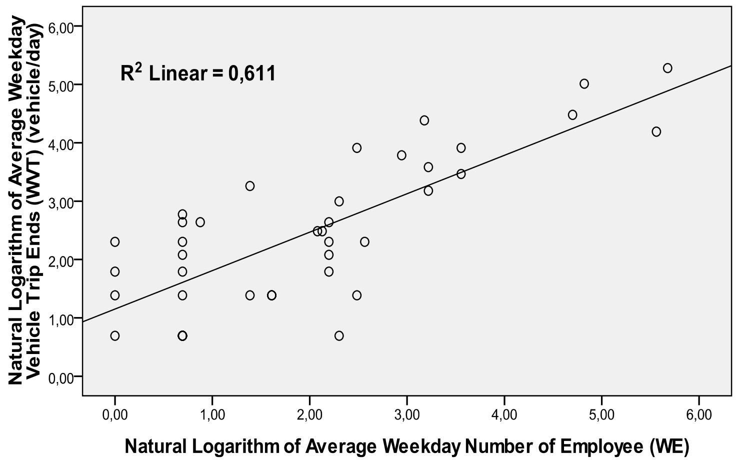
Average Weekday Vehicle Trip Ends per Employee				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average Number of Employees
2,276	0,00-10,00	2,385	43	26,4

Average Weekday Vehicle Trip Ends & **100 m^2 Gross Floor Area**
On a: **WEEKDAY**

TRIP GENERATION RATES

Average Weekday Vehicle Trip Ends per 100 m^2 Gross Floor Area				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average 100 m^2 GFA
10,222	0,00-70,00	13,086	43	10,8

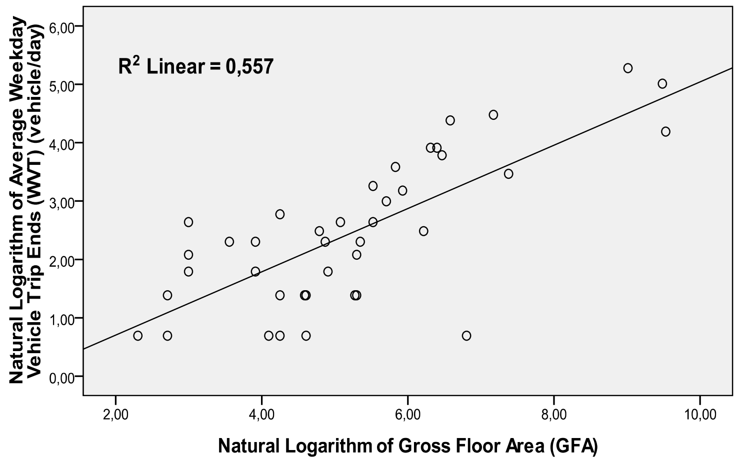
Trip Generation - WEEKDAY (Vehicle/WE)



Fitted Curve Equation :Ln (WVT) = 1.152 + 0,658 * Ln (WE)

DIRECTIONAL DISTRIBUTION : 50%enter 50%exit

Trip Generation - WEEKDAY (Vehicle/GFA)



Fitted Curve Equation :Ln (WVT) = -0.382 + 0.542 * Ln (GFA)

DIRECTIONAL DISTRIBUTION : 50%enter 50%exit

Figure 5.1. Average weekday vehicle trips’ variation with GFA and E

Average Weekday Person Trip Ends & **Employees**
On a: **WEEKDAY**

TRIP GENERATION RATES

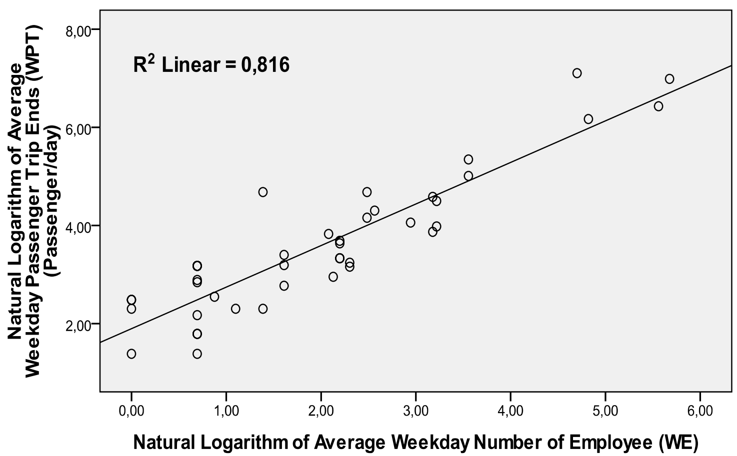
Average Weekday Person Trip Ends per Employee				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average Number of Employees
6,101	2,00-27,00	4,704	43	26,4

Average Weekday Person Trip Ends & **100 m² Gross Floor Area**
On a: **WEEKDAY**

TRIP GENERATION RATES

Average Weekday Person Trip Ends per 100 m² Gross Floor Area				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average 100 m² GFA
28,510	2,62-114,67	24,479	43	10,8

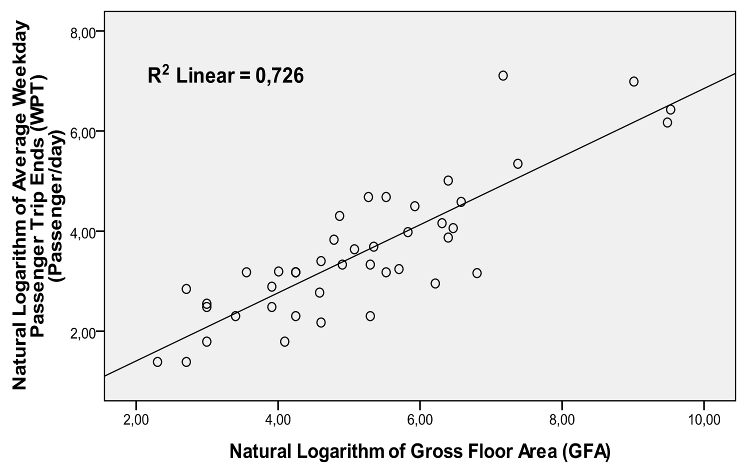
Trip Generation - WEEKDAY (Passenger/WE)



Fitted Curve Equation :Ln (WPT) = 1,899 + 0,847 * Ln (WE)

DIRECTIONAL DISTRIBUTION : 50%enter 50%exit

Trip Generation - WEEKDAY (Passenger/GFA)



Fitted Curve Equation :Ln (WPT) = 0,044 + 0,681 * Ln (GFA)

DIRECTIONAL DISTRIBUTION : 50%enter 50%exit

Figure 5.2. Average weekday person trips' variation with GFA and E

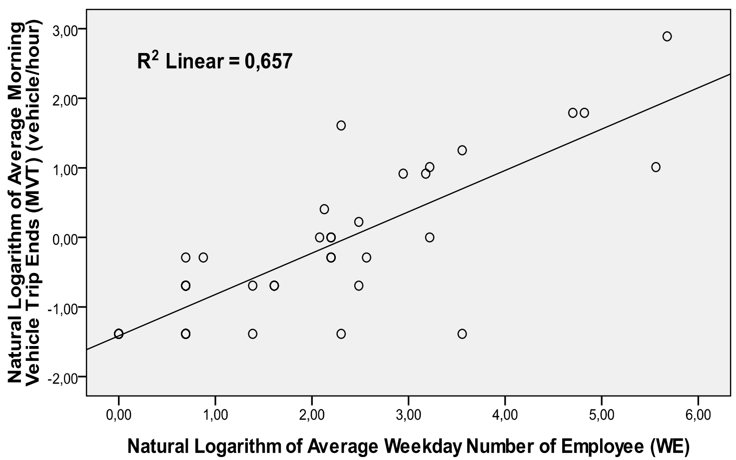
Average Vehicle Trip Ends & **Employees**
On a: **WEEKDAY, AM PEAK HOUR OF GENERATOR**
TRIP GENERATION RATES

AM Peak Hour Average Vehicle Trip Ends per Employee				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average Number of Employees
0,132	0,00-0,50	0,110	43	26,4

Average Vehicle Trip Ends & **100 m² Gross Floor Area**
On a: **WEEKDAY, AM PEAK HOUR OF GENERATOR**
TRIP GENERATION RATES

AM Peak Hour Average Vehicle Trip Ends per 100 m² Gross Floor Area				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average 100 m² GFA
0,643	0,00-3,75	0,773	43	10,8

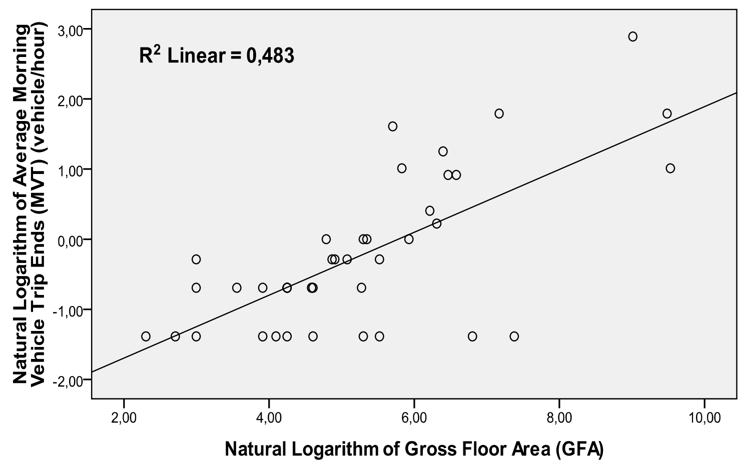
Trip Generation - WEEKDAY MORNING PEAK HOUR (Vehicle/WE)



Fitted Curve Equation: Ln (MVT) = -1,415 + 0,594 * Ln (WE)

DIRECTIONAL DISTRIBUTION : 83,6%enter 16,4%exit

Trip Generation - WEEKDAY MORNING PEAK HOUR (Vehicle/GFA)



Fitted Curve Equation: Ln (MVT) = -2,592 + 0,448 * Ln (GFA)

DIRECTIONAL DISTRIBUTION : 83,6%enter 16,4%exit

Figure 5.3. Average morning vehicle trips' variation with GFA and E

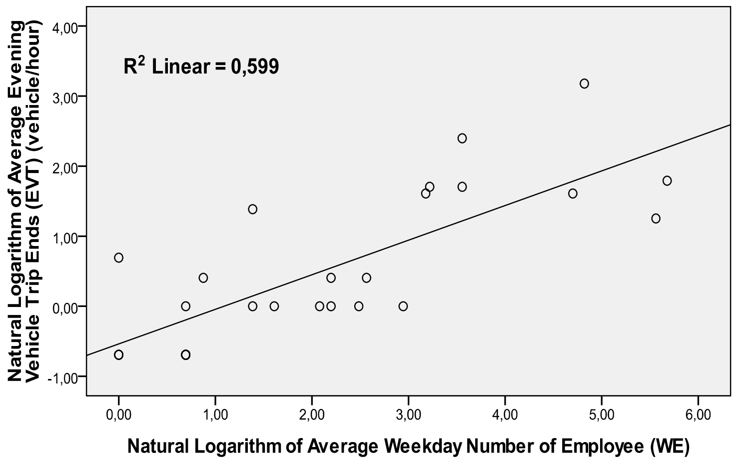
Average Vehicle Trip Ends & **Employees**
On a: **WEEKDAY, PM PEAK HOUR OF GENERATOR**
TRIP GENERATION RATES

PM Peak Hour Average Vehicle Trip Ends per Employee				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average Number of Employees
0,195	0,00-2,00	0,351	43	26,4

Average Vehicle Trip Ends & **100 m^2 Gross Floor Area**
On a: **WEEKDAY, PM PEAK HOUR OF GENERATOR**
TRIP GENERATION RATES

PM Peak Hour Average Vehicle Trip Ends per 100 m^2 Gross Floor Area				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average 100 m^2 GFA
0,845	0,00-7,50	1,517	43	10,8

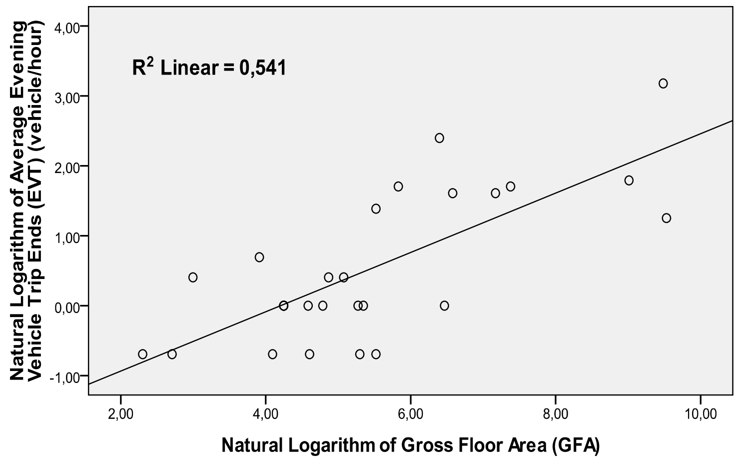
Trip Generation - WEEKDAY EVENING PEAK HOUR (Vehicle/WE)



Fitted Curve Equation: Ln (EVT) = -0,539 + 0,494 * Ln (WE)

DIRECTIONAL DISTRIBUTION : 33,2%enter 66,8%exit

Trip Generation - WEEKDAY EVENING PEAK HOUR (Vehicle/GFA)



Fitted Curve Equation: Ln (EVT) = -1,784 + 0,424 * Ln (GFA)

DIRECTIONAL DISTRIBUTION : 33,2%enter 66,8%exit

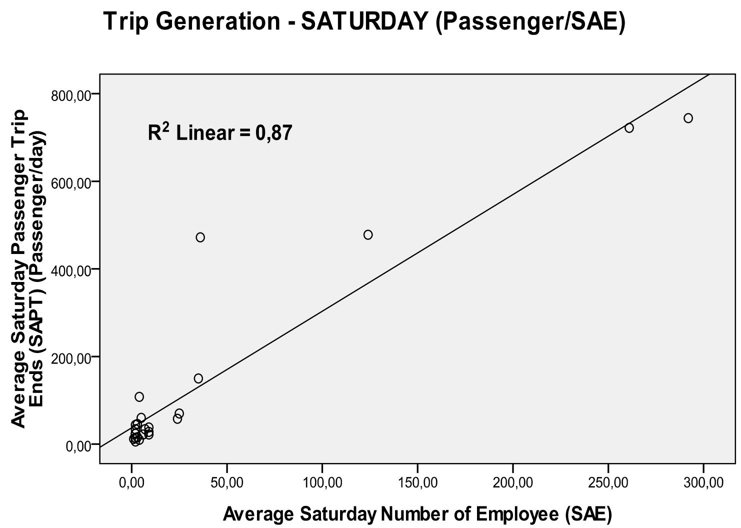
Figure 5.4. Average evening vehicle trips' variation with GFA and E

Saturday Person Trip Ends & **Employees**
On a: **SATURDAY**
TRIP GENERATION RATES

Saturday Person Trip Ends per Employee				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average Number of Employees
8,170	2,42-27,00	6,738	25	29,7

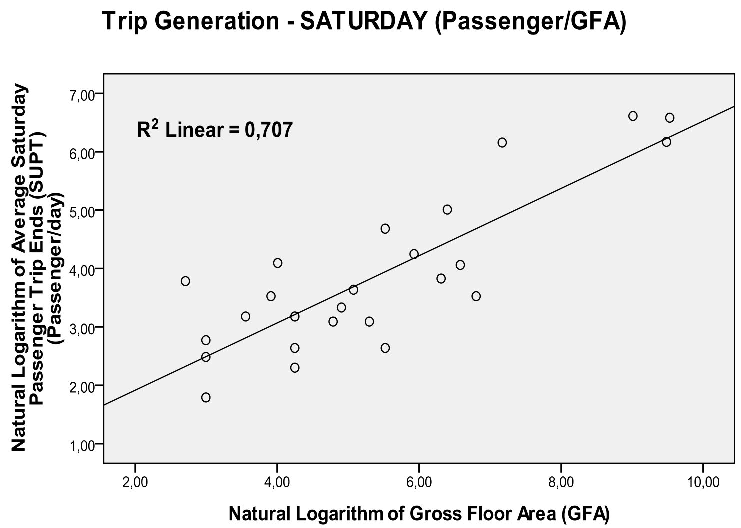
Saturday Person Trip Ends & **100 m² Gross Floor Area**
On a: **SATURDAY**
TRIP GENERATION RATES

Saturday Person Trip Ends per 100 m² Gross Floor Area				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average 100 m² GFA
23,682	0,00-293,33	49,220	43	10,8



Fitted Curve Equation :SAPT = 37,244 + 2,662 * SAE

DIRECTIONAL DISTRIBUTION : Not available



Fitted Curve Equation :Ln (SAPT) = 0,765 + 0,576 * Ln (GFA)

DIRECTIONAL DISTRIBUTION : Not available

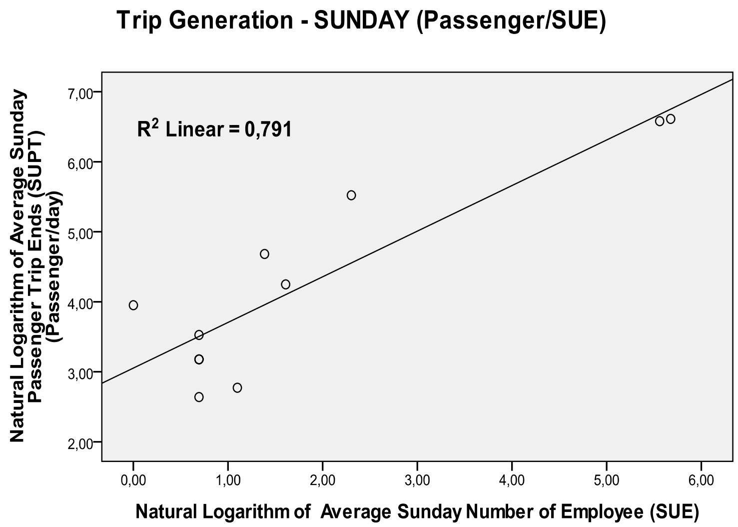
Figure 5.5. Average Saturday person trips' variation with GFA and E

Sunday Person Trip Ends & **Employees**
On a: **SUNDAY**
TRIP GENERATION RATES

Sunday Person Trip Ends per Employee				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average Number of Employees
16,059	2,55-52,00	14,442	11	51,6

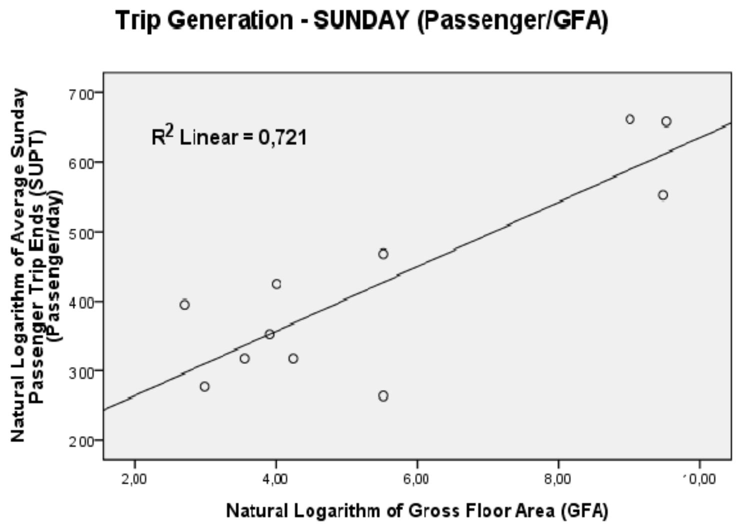
Sunday Person Trip Ends & **100 m^2 Gross Floor Area**
On a: **SUNDAY**
TRIP GENERATION RATES

Sunday Person Trip Ends per 100 m^2 Gross Floor Area				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average 100 m^2 GFA
18,368	0,00-346,67	57,896	43	10,8



Fitted Curve Equation :Ln (SUPT) = 3,054 + 0,651 * Ln (SUE)

DIRECTIONAL DISTRIBUTION : Not available



Fitted Curve Equation :Ln (SUPT) = 1,711 + 0,464 * Ln (GFA)

DIRECTIONAL DISTRIBUTION : Not available

Figure 5.6. Average Sunday person trips' variation with GFA and E

Table 5.1. Regression models of office buildings

Time	Regression Equation (t-values) Alternative Regression Equation	F Stats. (sign.)	R^2	ATR (Std. Dev.)	Percent Entering Trips	Percent Exiting Trips
Average Weekday Vehicle Trip Ends (vehicle/day)	Ln (WVT) = -0.382 + 0.542 * Ln (GFA) (-0.884) (6.912) $WVT = e^{-0.382} \times GFA^{0.542}$	47.77 0.00	0.56	10.22 (13.09)	50	50
	Ln (WVT) = 1.152 + 0.658 * Ln (WE) (5.456) (7.727) $WVT = e^{1.152} \times WE^{0.658}$	59.71 0.00	0.61	2.28 (2.39)	50	50
Average Weekday Person Trip Ends (person/day)	Ln (WPT) = 0.044 + 0.681 * Ln (GFA) (0.122) (10.417) $WPT = e^{0.044} \times GFA^{0.681}$	108.51 0.00	0.73	28.28 (24.31)	50	50
	Ln (WPT) = 1.899 + 0.847 * Ln (WE) (12.326) (13.498) $WPT = e^{1.899} \times WE^{0.847}$	182.21 0.00	0.82	6.06 (4.71)	50	50
A.M. Peak Hour Vehicle Trip Ends (vehicle/1 peak hour)	Ln (MVT) = -2.592 + 0.448 * Ln (GFA) (-6.112) (5.882) $MVT = e^{-2.592} \times GFA^{0.448}$	34.60 0.00	0.48	0.64 (0.77)	83.6	16.4
	Ln (MVT) = -1.415 + 0.594 * Ln (WE) (-7.987) (8.412) $MVT = e^{-1.415} \times WE^{0.594}$	70.76 0.00	0.66	0.13 (0.11)	83.6	16.4
P.M. Peak Hour Vehicle Trip Ends (vehicle/1 peak hour)	Ln (EVT) = -1.784 + 0.424 * Ln (GFA) (-3.853) (5.323) $EVT = e^{-1.784} \times GFA^{0.424}$	28.34 0.00	0.54	1.69 (3.03)	33.2	66.8
	Ln (EVT) = -0.539 + 0.494 * Ln (WE) (-2.360) (5.992) $EVT = e^{-0.539} \times WE^{0.494}$	34.90 0.00	0.60	0.39 (0.70)	33.2	66.8
Saturday Person Trip Ends (person/day)	Ln (SAPT) = 0.765 + 0.576 * Ln (GFA) (1.734) (7.448) $SAPT = e^{0.765} \times GFA^{0.576}$	55.47 0.00	0.71	26.11 (48.54)	NA	NA
	SAPT = 37.244 + 2.662 * SAE (2.089) (12.418)	154.21 0.00	0.87	7.13 (6.58)	NA	NA
Sunday Person Trip Ends (person/day)	Ln (SUPT) = 1.711 + 0.464 * Ln (GFA) (2.941) (4.818) $SUPT = e^{1.711} \times GFA^{0.464}$	23.22 0.00	0.72	18.52 57.85	NA	NA
	Ln (SUPT) = 3.054 + 0.651 * Ln (SUE) (10.416) (5.842) $SUPT = e^{3.054} \times SUE^{0.651}$	34.13 0.00	0.79	16.06 14.44	NA	NA

The significance values of the t-statistics results of the coefficients are not stated in Table 5.1, yet the t-values are given instead. The β_0 coefficients of some equations are not significantly different from zero since their t values are less than the critical table value which is around 2.0 for $t_{0.05,9\text{-}41}$ where, 0.05 is the α level and 9-41 is the range of the degree of freedom. For instance the first equation has an insignificant β_0 value since its t value is -0.884. The t-values for β_1 coefficients are all greater than the table value of t. Hence, the β_1 coefficients are all significantly different from zero. The ATR (Average Trip Rate) column shows the average trip rates for each time category and the standard deviations of them. Except for the average weekday person trips relations with GFA and E, standard deviation results are found to be almost equal or higher than the average trip generation rates which indicate an existence of high variation in the data.

5.2. Calibration of Regression Models for Hotels

The preliminary analyses of hotels were accomplished in Chapter 4. This section includes the calibration of regression models for hotels. Like the process followed in the calibration of regression models for general office buildings, the relationship among the dependent and the independent variables were investigated. The scatter plots reveal the variance of the data and regression equation/curve indicates the goodness of fit of the model visually. Next, the developed models were combined in a look-up table which includes some statistics that the plots did not have (t and F statistics). Finally, an example is given in Section 5.3 in which a combination of two office buildings and a hotel were investigated in terms the trips generated from these buildings; furthermore, the average trip generation and the regression methods were compared.

5.2.1. Data Plots of Hotels

Figures 5.7 to 5.12 present the plots of the collected data for hotels and related outputs such as the regression equation and curve, R^2 value, and so on for various time periods (weekday, weekends, peak periods, and so on). The R^2 values of all of the developed models for Hotels were found to be higher than 0.50. As it was observed for General Office Buildings, the models developed with person trips have higher R^2 values than the models with vehicle trips in weekdays. If the standard deviations of vehicle and person trips are examined for weekdays which are shown in Figures 5.7 and 5.8, it could be observed that models with person trips have less variation than the vehicle ones. In Figures 5.9 and 5.10, high variation could be observed from the plots and from the listed standard deviation values. Best models for Hotels were obtained for the weekend case since they have a R^2 range of 0.73-0.85 and standard deviations of all models are less than the average trip rates. These values could be seen in Figures 5.10 and 5.11.

Average Weekday Vehicle Trip Ends & **Employees**
On a: **WEEKDAY**

TRIP GENERATION RATES

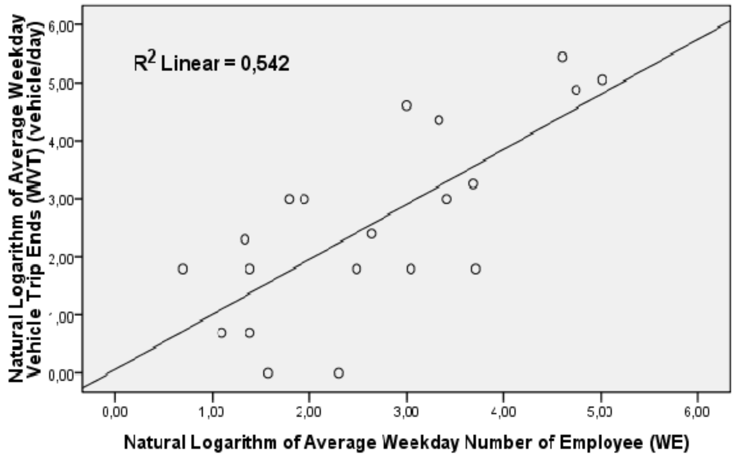
Average Weekday Vehicle Trip Ends per Employee				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average Number of Employees
1,003	0,00-5,00	1,317	30	39,0

Average Weekday Vehicle Trip Ends & **100 m² Gross Floor Area**
On a: **WEEKDAY**

TRIP GENERATION RATES

Average Weekday Vehicle Trip Ends per 100 m² Gross Floor Area				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average 100 m2 GFA
1,268	0,08-4,57	1,202	20	76,3

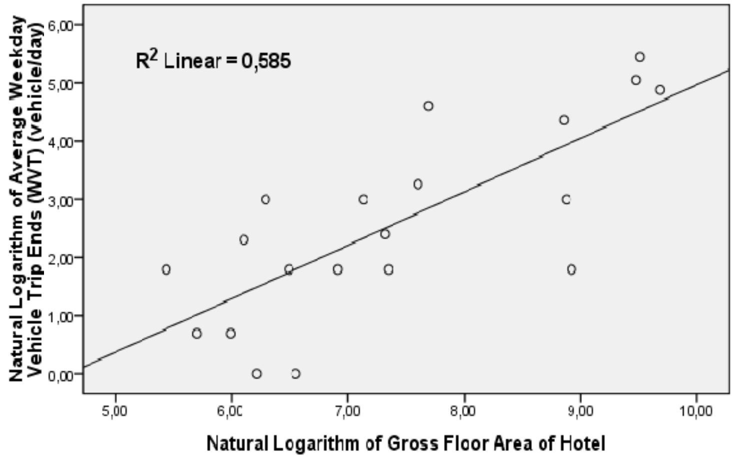
Trip Generation - WEEKDAY (Vehicle/WE)



Fitted Curve Equation : Ln (WVT) = 0,061 + 0,948 * Ln (WE)

DIRECTIONAL DISTRIBUTION : 48%enter 52%exit

Trip Generation - WEEKDAY (Vehicle/GFA)



Fitted Curve Equation : Ln (WVT) = -4,232 + 0,920 * Ln (GFA)

DIRECTIONAL DISTRIBUTION : 48%enter 52%exit

Figure 5.7. Average weekday vehicle trips' variation with GFA and E

Average Weekday Person Trip Ends & **Employees**
On a: **WEEKDAY**

TRIP GENERATION RATES

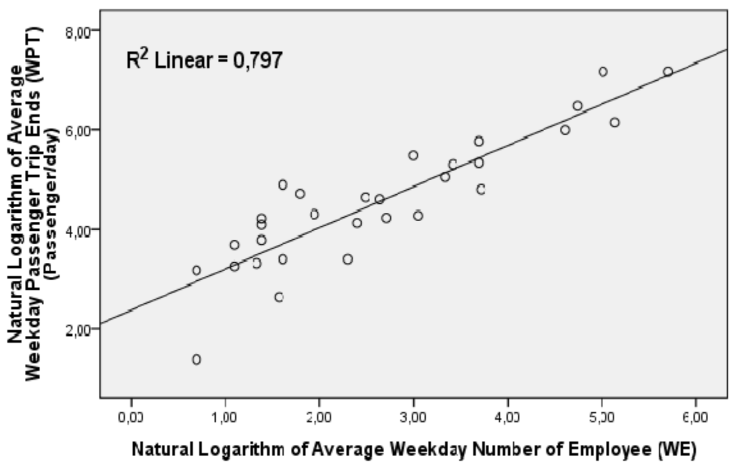
Average Weekday Person Trip Ends per Employee				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average Number of Employees
8,315	2,00-26,80	5,587	30	39,0

Average Weekday Person Trip Ends & **100 m² Gross Floor Area**
On a: **WEEKDAY**

TRIP GENERATION RATES

Average Weekday Person Trip Ends per 100 m² Gross Floor Area				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average 100 m2 GFA
7,497	0,31-20,00	5,201	30	76,3

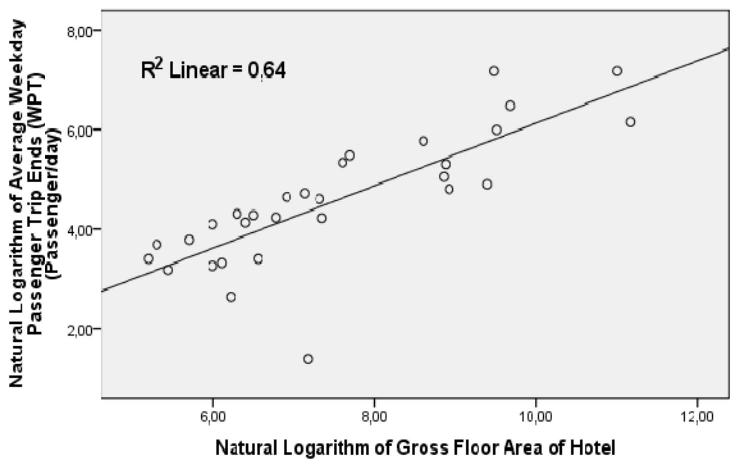
Trip Generation - WEEKDAY (Passenger/WE)



Fitted Curve Equation : Ln (WPT) = 2,379 – 0,827 * Ln (WE)

DIRECTIONAL DISTRIBUTION : 52%enter 48%exit

Trip Generation - WEEKDAY (Passenger/GFA)



Fitted Curve Equation : Ln (WPT) = -0,144 + 0,627 * Ln (GFA)

DIRECTIONAL DISTRIBUTION : 52%enter 48%exit

Figure 5.8. Average weekday person trips' variation with GFA and E

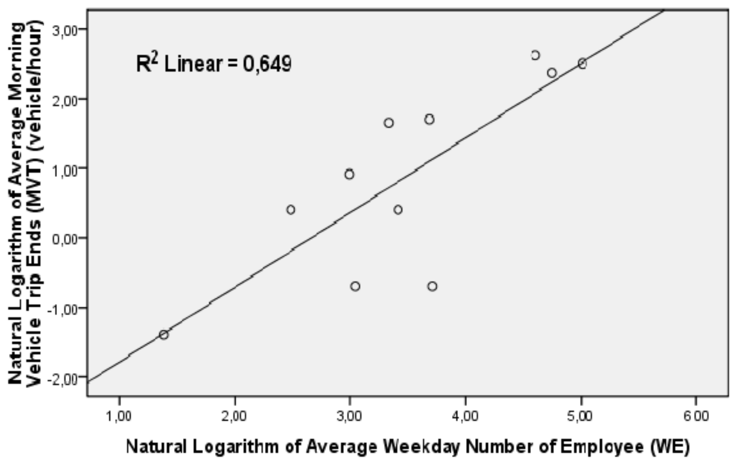
Average Vehicle Trip Ends & **Employees**
On a: **WEEKDAY, AM PEAK HOUR OF GENERATOR**
TRIP GENERATION RATES

AM Peak Hour Average Vehicle Trip Ends per Employee				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average Number of Employees
0,035	0,00-0,19	0,056	30	39,0

Average Vehicle Trip Ends & **100 m² Gross Floor Area**
On a: **WEEKDAY, AM PEAK HOUR OF GENERATOR**
TRIP GENERATION RATES

AM Peak Hour Average Vehicle Trip Ends per 100 m² Gross Floor Area				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average 100 m² GFA
0,053	0,00-0,28	0,072	20	76,3

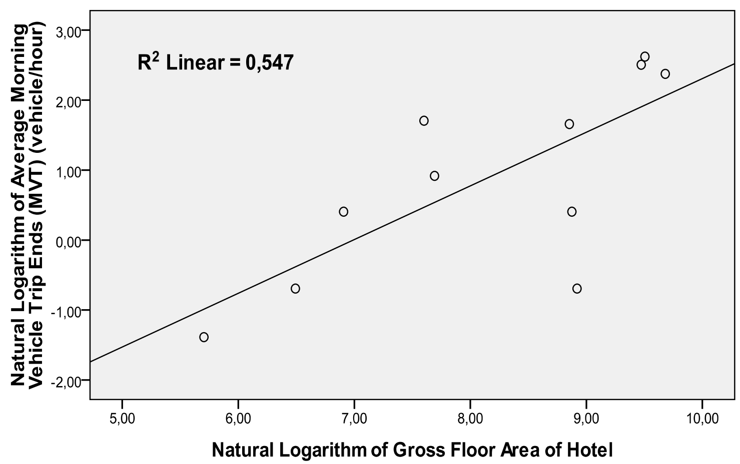
Trip Generation - WEEKDAY MORNING PEAK HOUR (Vehicle/WE)



Fitted Curve Equation: Ln (MVT) = -2,855 + 1,073 * Ln (WE)

DIRECTIONAL DISTRIBUTION : 62%enter 38%exit

Trip Generation - WEEKDAY MORNING PEAK HOUR (Vehicle/GFA)



Fitted Curve Equation: Ln (MVT) = -5,363 + 0,767 * Ln (GFA)

DIRECTIONAL DISTRIBUTION : 62%enter 38%exit

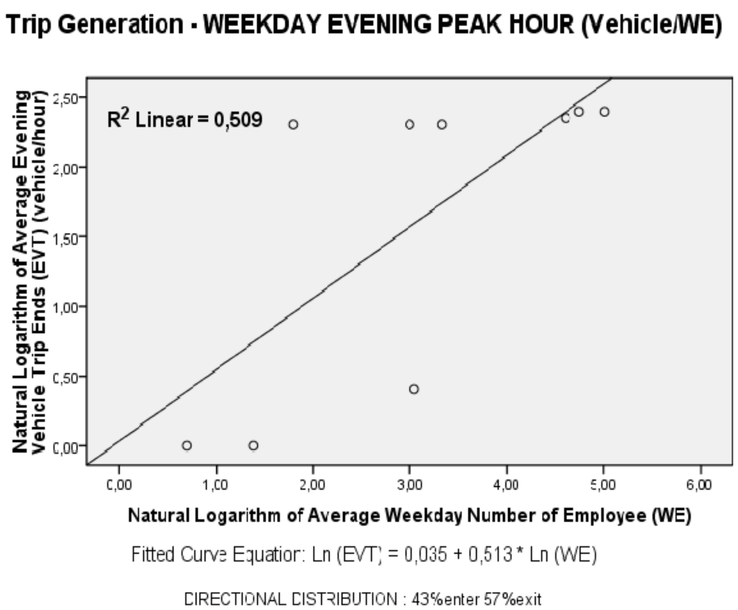
Figure 5.9. Average morning vehicle trips' variation with GFA and E

Average Vehicle Trip Ends & **Employees**
On a: **WEEKDAY, PM PEAK HOUR OF GENERATOR**
TRIP GENERATION RATES

PM Peak Hour Average Vehicle Trip Ends per Employee				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average Number of Employees
0,121	0,00-1,67	0,325	30	39,0

Average Vehicle Trip Ends & **100 m² Gross Floor Area**
On a: **WEEKDAY, PM PEAK HOUR OF GENERATOR**
TRIP GENERATION RATES

PM Peak Hour Average Vehicle Trip Ends per 100 m² Gross Floor Area				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average 100 m² GFA
0,118	0,00-0,80	0,212	20	76,3



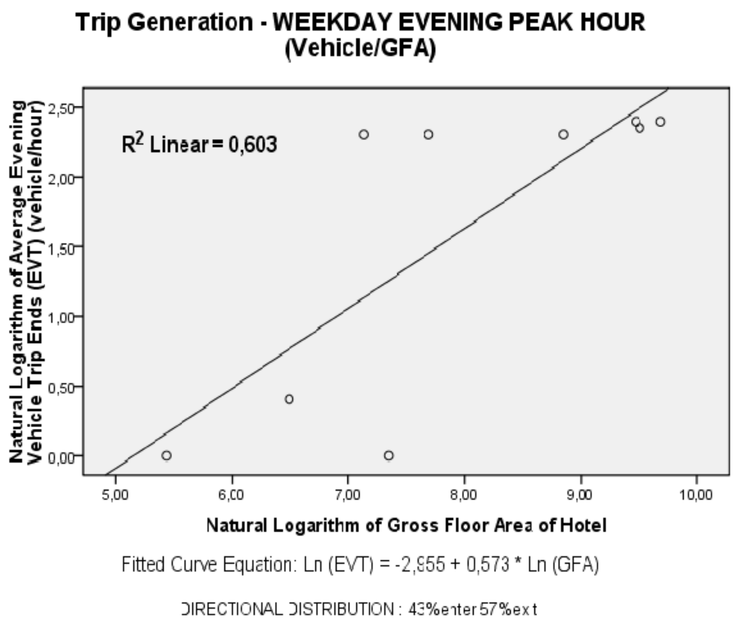


Figure 5.10. Average evening vehicle trips' variation with GFA and E

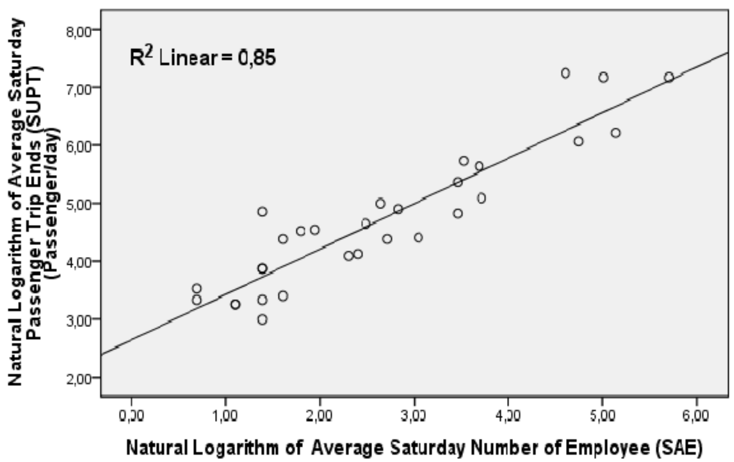
Saturday Person Trip Ends & **Employees**
On a: **SATURDAY**
TRIP GENERATION RATES

Saturday Person Trip Ends per Employee				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average Number of Employees
9,311	2,94-32,00	5,893	30	38,9

Saturday Person Trip Ends & **100 m² Gross Floor Area**
On a: **SATURDAY**
TRIP GENERATION RATES

Saturday Person Trip Ends per 100 m² Gross Floor Area				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average 100 m² GFA
8,078	0,67-17,41	4,893	30	76,3

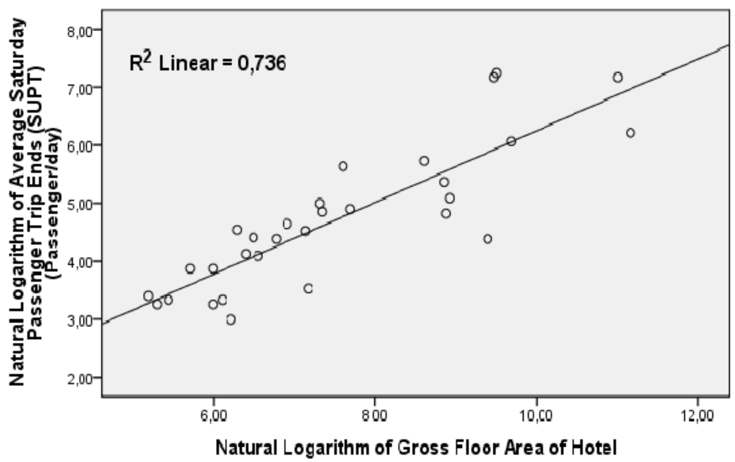
Trip Generation - SATURDAY (Passenger/SAE)



Fitted Curve Equation : Ln (SAFT) = 2,644 + 0,784 * Ln (SAE)

DIRECTIONAL DISTRIBUTION : Not available

Trip Generation - SATURDAY (Passenger/GFA)



Fitted Curve Equation : Ln (SAPT) = 0,069 + 0,618 * Ln (GFA)

DIRECTIONAL DISTRIBUTION : Not available

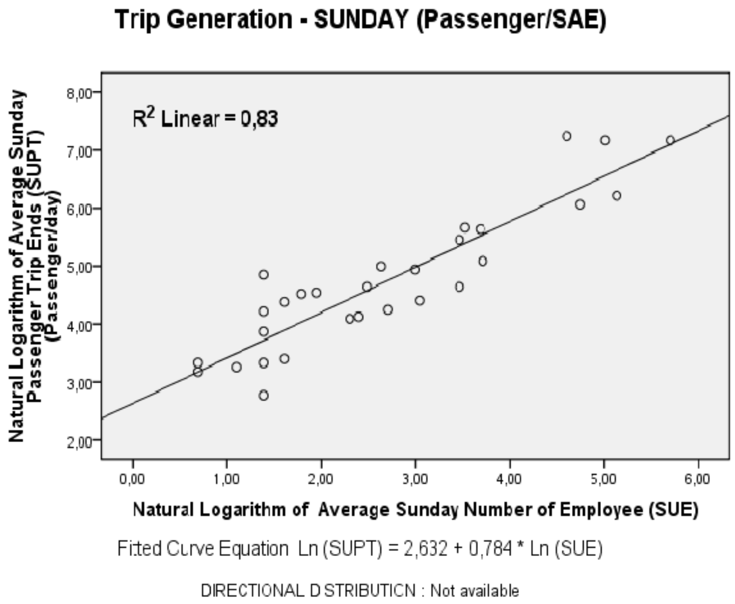
Figure 5.11. Average Saturday person trips’ variation with GFA and E

Sunday Person Trip Ends & **Employees**
On a: **SUNDAY**
TRIP GENERATION RATES

Sunday Person Trip Ends per Employee				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average Number of Employees
9,225	2,94-32,00	6,065	29	39,0

Sunday Person Trip Ends & **100 m² Gross Floor Area**
On a: **SUNDAY**
TRIP GENERATION RATES

Sunday Person Trip Ends per 100 m² Gross Floor Area				
Average Trip Rate	Range of rates	Standard Deviation	Number of Studies	Average 100 m² GFA
8,160	0,67-17,41	5,146	30	76,3



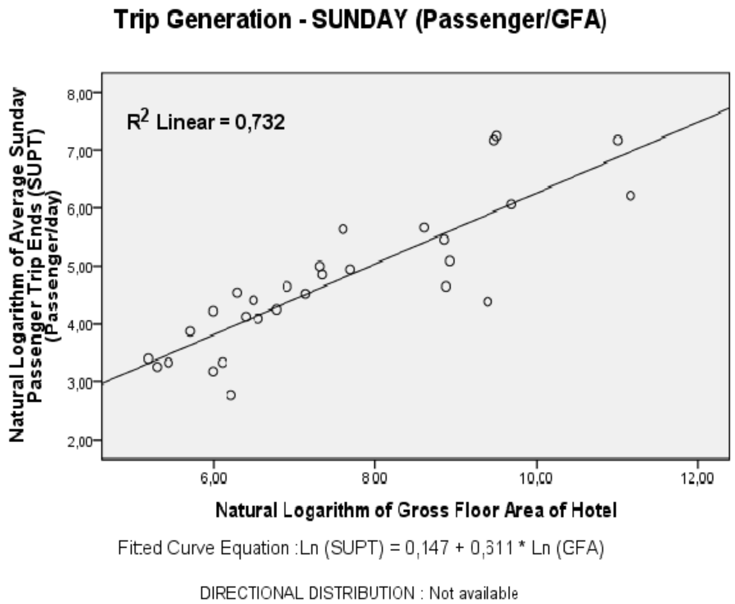


Figure 5.12. Average Sunday person trips’ variation with GFA and E

5.2.2 Regression Models of Hotels

Regression models of hotels are collected in Table 5.2 which includes the alternative regression equations -the transformed version of logarithmic equation listed under plots- t and F statistics which were not presented in the regression plots.

When the results are examined, the calibrated regression models for hotels have R^2 values of higher than 0.50 for every time periods. The person trips have a R^2 range of 0.64-0.85 in all possible time periods (weekday, weekend) whereas; vehicle trips have a range of 0.51-0.65. This situation was also observed in the analyses for general office buildings. The developed models were reasonably good since they were significant regarding the F statistics and significance values presented in Table 5.2. Moreover, the t-statistics results which were stated just below the regression equations indicates that, β_1 coefficients were all significantly different from zero (as $t_{0.05,18\text{-}28} \cong 2.0$) ; whereas β_0 coefficients, except for three cases which are average weekday vehicle trip relation with employee, P.M. peak hour vehicle relation with employee Saturday person trip relation with employee, were significantly different from zero. The standard deviations of ATR for person trips were less than the mean rates; however the deviations for vehicle trips (peak hours, weekday) were higher than the averages in almost every row.

The resulting regression models for all time periods were logarithmic. Table 5.2 includes the transformed versions of these logarithmic functions with the purpose of an easy use of the results. .

In the next section, the trip generation rate and regression analysis results were utilized in an example which shows the use of these in an impact analysis and compares the two methods.

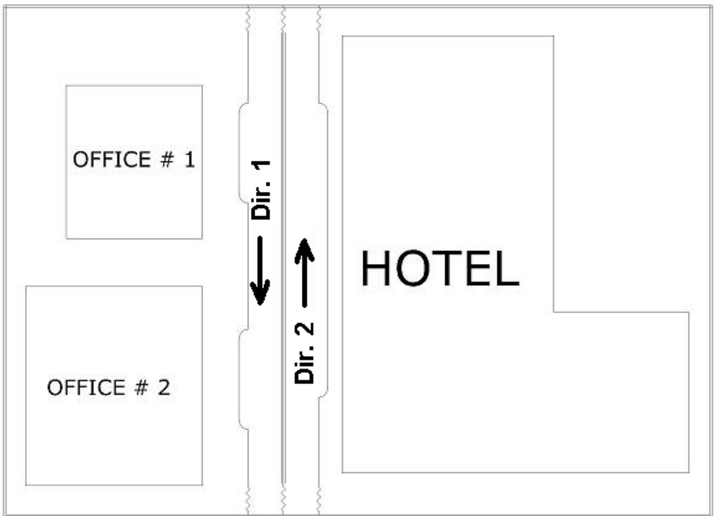
Table 5.2. Regression models of hotels

Time	Regression Equation (t-values) Alternative Regression Equation	F Stats. (sign.)	R^2	ATR (Std. Dev.)	Percent Entering Trips	Percent Exiting Trips
Average Weekday Vehicle Trip Ends (vehicle/day)	Ln (WVT) = -4.232 + 0.920 * Ln (GFA) (-3.079) (5.036) $WVT = e^{-4.232} \times GFA^{0.920}$	25.37 0.00	0.58	1.27 (1.20)	48	52
	Ln (WVT) = 0.061 + 0.948 * Ln (WE) (0.101) (4.612) $WVT = e^{0.061} \times WE^{0.948}$	21.27 0.00	0.54	1.00 (1.32)	48	52
Average Weekday Person Trip Ends (person/day)	Ln (WPT) = 0.144 + 0.627 * Ln (GFA) (-0.211) (7.057) $WPT = e^{0.144} \times GFA^{0.627}$	49.80 0.00	0.64	7.50 (5.20)	52	48
	Ln (WPT) = 2.379 + 0.827 * Ln (WE) (10.103) (10.476) $WPT = e^{2.379} \times WE^{0.827}$	109.75 0.00	0.80	8.32 (5.59)	52	48
A.M. Peak Hour Vehicle Trip Ends (vehicle/1 peak hour)	Ln (MVT) = -5.363 + 0.767 * Ln (GFA) (-2.790) (3.295) $MVT = e^{-5.363} \times GFA^{0.767}$	10.86 0.00	0.55	0.05 (0.07)	62	38
	Ln (MVT) = -2.855 + 1.073 * Ln (WE) (-2.989) (4.083) $MVT = e^{-2.855} \times WE^{1.073}$	16.67 0.00	0.65	0.04 (0.06)	62	38
P.M. Peak Hour Vehicle Trip Ends (vehicle/1 peak hour)	Ln (EVT) = -2.955 + 0.573 * Ln (GFA) (-2.078) (3.285) $EVT = e^{-2.955} \times GFA^{0.573}$	10.61 0.01	0.60	0.12 (0.21)	43	57
	Ln (EVT) = 0.035 + 0.513 * Ln (WE) (0.054) (2.694) $EVT = e^{0.035} \times WE^{0.513}$	7.26 0.03	0.51	0.12 (0.32)	43	57
Saturday Person Trip Ends (person/day)	Ln (SAPT) = 0.069 + 0.618 * Ln (GFA) (0.129) (8.831) $SAPT = e^{0.069} \times GFA^{0.618}$	77.98 0.00	0.74	8.08 (4.89)	NA	NA
	Ln (SAPT) = 2.644 + 0.784 * Ln(SAE) (14.286) (12.601) $SAPT = e^{2.644} \times GFA^{0.784}$	158.79 0.00	0.85	9.31 (5.89)	NA	NA
Sunday Person Trip Ends (person/day)	Ln (SUPT) = 0.147 + 0.611 * Ln (GFA) (0.267) (8.580) $SUPT = e^{0.147} \times GFA^{0.611}$	73.61 0.00	0.73	8.16 (5.15)	NA	NA
	Ln (SUPT) = 2.632 + 0.784 * Ln (SUE) (12.735) (11.468) $SUPT = e^{2.632} \times SUE^{0.784}$	131.52 0.00	0.83	9.23 (6.06)	NA	NA

5.3. Trip Generation Calculation Example

As discussed in previous sections, the results obtained in this research can be used by traffic engineers and transportation planners for various purposes explained above. Therefore, it would be useful to give an example for the application of the rates and the regression models. The example given below has been prepared for this purpose.

Suppose that two office buildings and a hotel would be established in the CBD zone of Istanbul. Figure 5.13 shows the layout of the new facilities and the necessary inputs.



DATA SHEET OF THE LAND USES

	GFA (meters square)	**# of EMPLOYEE** Weekday/Saturday/Sunday
OFFICE # 1	300	32/21/10
OFFICE # 2	450	25/13/0
HOTEL	4500	55/55/55

Figure 5.13. Data sheet of the example

The example was solved for two cases which are the calculated trip ends with weighted average trip rate method and the regression equation solution. The results were obtained for all possible times – average weekday, peak hours and weekend- and they were calculated both according to the number of employee (E) in the facility and the gross floor area (GFA) of the land use. All calculable entrance and exit values were also stated.

Since, the analysis performed for the office buildings do not include results for zonal categorization, average values would be used for the solution. While calculating the trip end values for Office 1 in terms of the area of the building, Table 4.2 was used. Since the GFA of Office 1 was given as 300 m^2, the rates were taken from the second row where the GFA interval is 250-500 m^2. Since the rates in Table 4.2 were given as vehicle/100 m^2 or person/100 m^2, the trip ends for all time periods were found by multiplying those rates with 3 which is found by dividing 300 by 100. Likewise, the trip ends of Office 1 were found in terms of the number of the employee which was also given in the example. Those rates were taken from Table 4.3 in which, the input (given) number of employee which varies with the day of the week, was entered and then for Weekdays and Saturdays the row of the employee category "20-100" was used and for Sundays, "under 20" category was used. The trip ends were found by direct multiplication of the rates with the given number of employee since the rates were in terms of vehicle/employee or person/employee. In the calculation of trip rates from average trip generation rate method for Office 2, the path explained above was followed as well. The trip ends for the Hotel in terms of GFA was calculated through using Table 4.7. Since the Hotel was planned to be built in the CBD zone of Istanbul, the first row of this table was used in calculation process and the GFA of the hotel was given as 4500 m^2, hence the trip ends were found by multiplying the rates by 45 which was found by dividing 4500 to 100. Likewise, trip rates for the Hotel in terms of number of employee were obtained from Table 4.8 and the first row of this table was used due to the given zone specification and the number of employees for different day of week. Once the trip ends were found, the directional trip ends were found by multiplying the entrance and exit per cents obtained from Figure 5.1.

The calculation of trip ends for the given example by regression method was completed through several steps. One of the cells in Table 6.3 which was solved by regression method is explained below. The selected cell is Saturday Person Trips of Office 2. The regression equation was obtained from Table 5.1. The solution steps are shown in Table 5.3.

Table 5.3. Example use of trip generation equations

	Logarithmic Equation Solution	Alternative Equation Solution
Equations	Ln (SAPT) = 0.765 + 0.576 * Ln (GFA).	$\mathrm{SAPT} = e^{0.765} \times \mathrm{GFA}^{0.576}$
Solutions	Ln (SAPT) = 0.765 + 0.576 * Ln (450) = 0.765 + 0.576 * 6.11 = 4.28	$\mathrm{SAPT} = e^{0.765} \times 450^{0.576}$ = 72.52
Results	SAPT = $e^{4.28}$ = 72.52 person/day	SAPT =72.52 person/day

Table 5.4 exhibits the obtained outputs of the problem. Apart from the trip ends listed in this table, the last two columns were given to show the results for the two methods used in the analysis in total. Only for A.M. Peak Hour calculated trip end was higher for the regression method, while for the other time periods average trip generation rate calculations resulted in higher trip end values. In selecting the results to be used, Trip Generation Manual suggestions were taken into account which was explained in the initial paragraph of Section 5. According to these suggestions, the bold numbers at the lowest two rows in Table 5.4 were chosen.

Another issue which needs attention is the differences of the result found by the weighted average trip rate and the regression methods. The average weighted trip generation method obtains the result from a broad range data intervals, whereas regression equation method gives the trip end values with the entry of the independent variable value to the function. This situation leads to the conclusion that regression equation method is more reliable than the average weighted trip generation method. Therefore, in the calculation of the impact of the attracted and generated traffic on the street, the regression equation method should be preferable to the rates method. It should be remembered that the inputs of the problem were in the data range of the regression plots obtained in Section 4 which lead the researcher to utilize the trip end values obtained by regression equation method in Tables 5.1 and 5.2 wherever the R^2 values were higher than 0.75. The values used for the simple impact analysis problem are in bold in Table 5.4.

Table 5.4. Solution of the example

			Average Weekday								**Weekend**			
			Vehicle/Day		Person/Day		A.M. (1 hour)		P.M. (1 Hour)		Saturday (Person/Day)		Sunday (Person/Day)	
			Entr.	Exit	Entr.	Exit	Entr.	Exit	Entr.	Exit	Entr.	Exit	Entr.	Exit
Weighted Average Trip Rate Solution	***Office#1***	GFA	**11.9**	**11.9**	30.33	30.33	**1.58**	**0.31**	**1.36**	**2.74**	NA	NA	NA	NA
		Total	**23.79**		60.66		**1.89**		**4.11**		49.29		29.28	
		E	**21.6**	**21.6**	59.04	59.04	**1.6**	**0.32**	**3.18**	**6.41**	NA	NA	NA	NA
		Total	**43.2**		118.08		**1.92**		**9.6**		103.32		20	
	Office#2	GFA	**15.86**	**15.86**	40.44	40.44	**2.12**	**0.41**	**1.82**	**3.66**	NA	NA	NA	NA
		Total	**31.72**		80.88		**2.52**		**5.48**		65.72		39.04	
		E	**16.88**	**16.88**	46.13	46.13	**1.25**	**0.25**	**2.49**	**5.01**	NA	NA	NA	NA
		Total	**33.75**		92.25		**1.5**		**7.5**		63.96		--	
	Hotel	GFA	**38.02**	**41.18**	**230**	**212.4**	**1.4**	**0.85**	**1.94**	**2.56**	NA	NA	NA	NA
		Total	**79.2**		**442.35**		**2.25**		**4.5**		423.9		417.6	
		E	**44.88**	**48.62**	270.8	250	**1.36**	**0.84**	**1.89**	**2.51**	NA	NA	NA	NA
		Total	**93.5**		520.85		**2.2**		**4.4**		455.95		458.7	
Regression Equation Solution	***Office#1***	GFA	7.51	7.51	**25.41**	**25.41**	0.81	0.16	0.63	1.26	**NA**	**NA**	**NA**	**NA**
		Total	15.02		**50.82**		0.96		1.89		**57.42**		**78.07**	
		E	15.48	15.48	**62.89**	**62.89**	1.59	0.31	1.07	2.16	**NA**	**NA**	**NA**	**NA**
		Total	30.95		**125.77**		1.9		3.23		**93.15**		**94.92**	
	Office#2	GFA	9.36	9.36	**33.49**	**33.49**	0.97	0.19	0.74	1.5	**NA**	**NA**	**NA**	**NA**
		Total	18.71		**66.98**		1.16		2.24		**72.52**		**94.23**	
		E	13.16	13.16	**51.02**	**51.02**	1.37	0.27	0.95	1.91	**NA**	**NA**	**NA**	**NA**
		Total	26.31		**102.04**		1.64		2.86		**71.85**		**--**	
	Hotel	GFA	16.01	7.81	117.2	7.21	1.84	5.71	2.78	8.56	**NA**	**NA**	**NA**	**NA**
		Total	33.34		225.48		2.97		6.46		**193.93**		**197.68**	
		E	22.78	7.81	**154.3**	**7.21**	2.63	5.71	3.48	8.56	**NA**	**NA**	**NA**	**NA**
		Total	47.46		**296.8**		4.24		8.09		**325.63**		**321.74**	
Weighted Average Trip Rate Solution		**Total**	**83.36**	**87.1**	376	355.2	**4.21**	**1.41**	**7.56**	**13.9**	NA	NA	NA	NA
			170.46		731.14		**5.62**		**21.49**		623.23		478.7	
Regression Equation Solution		**Total**	51.42	36.45	**268.2**	**121.1**	5.59	6.29	5.5	12.6	**NA**	**NA**	**NA**	**NA**
			87.87		**389.33**		11.88		18.13		**490.63**		**416.66**	

The traffic impact of the new facilities were calculated and represented in Table 5.5. These values represent the additional load on the street when the two offices and the hotel are built.

Table 5.5. Traffic impact results of the example

	Average Weekday				Peak Hour				Weekend			
	Vehicle/Day		Person/Day		A.M. (Vehicle/hour)		P.M. (Vehicle/Hour)		Saturday (Person/Day)		Sunday (Person/Day)	
Direction	Entr.	Exit	Entr.	Exit	Entr.	Exit	Entr.	Exit	Entr.	Exit	Entr.	Exit
Dir 1 (Entr./Exit)	38	38	114	114	3	1	6	11	NA	NA	NA	NA
(Total)	77		228		3		17		165		95	
Dir 2 (Entr./Exit)	9	9	230	212	1	1	2	3	NA	NA	NA	NA
(Total)	19		442		2		5		326		322	

One of the major outcomes of this example was to be aware of the extra traffic load on the existing street that the new facilities (buildings) would generate. For instance, the example shows that at P.M. peak hour the street should accommodate 17 vehicles in Direction#1 and five in Direction#2. This example could be a part of a traffic impact statement which, in many countries is required by law if new facilities are designed. Moreover, the parking needs of the street or the facility was another matter of fact that should be under investigation.

6. CONCLUSION & RECOMMENDATIONS

It is a challenging issue for Turkey to come up with a handbook involving all land uses' trip generation rates and models. This study was a part of the study involving all types of land uses conducted by BIMTAS, for the city of Istanbul showing the method and theoretical background of trip generation rate and model development process.

In this thesis, trip generation rates and models for General Office Buildings and Hotels were developed. In order to accomplish the assigned scope, data obtained from Istanbul Greater Municipality was utilized in SPSS (2008) environment where all required statistical calculations were performed. In the presentation of the outputs obtained from these analyses, the format followed in the Trip Generation Handbook (ITE, 2003) was mostly used. Furthermore, vehicle occupancy rates were calculated and the use of the developed relationships and rates has been explained through an example.

If the acquired trip rates and regression models are observed regarding their statistical outputs, R^2 values are mostly higher than 0.50 which indicate relatively good models. However, these rates and models could be improved, revised and updated by other studies using similar data for other locations in Turkey as well.

This study reflects the importance of the requirement of traffic and transportation studies since they can forecast the impact of new establishments on existing road networks. One new office building or a hotel may not overload the existing road system too much but, a combination of these and more land uses which were not investigated in this thesis might affect the system considerably. Furthermore, small scale travel demand analysis could be performed without the need of a costly and timely data collection effort. The completion of this study will come out with the remaining land uses' trip generation rate and regression model analysis which could be a further study.

It is strongly recommended to increase the number of observations and integrity of the data points so as to take care of the high variability that was observed in the data. The increase of the number of observation will enable more specific and more detailed analysis. Hence, sample size calculations were performed for both land use types in Chapter 4 in order to find the required amount of observations which will satisfy the assigned confidence interval (90, 85, 75 per cents). For instance, so as to obey a 85 per cent confidence interval in weekdays for an office building 184 observations are needed for the models with GFA as the independent variable and 151 observations are needed for E models (Table 4.7); whereas the available sample size was 43 for general office buildings in this theses. For hotels, in order to calculate the trip generation rates in an 85 per cent confidence interval, sample sizes should be increased from 20 to 136 for the models developed with GFA and 158 for the models with E (Table 4.15). In any case, the available number of observations for both land use types was not satisfactory for all time periods (weekday, peak hours and weekends) in any of the confidence intervals and needs to be increased.

Being not divided in equal time intervals, the traffic observation forms (TOF) sometimes did not yield accurate A.M and P.M peak results. In other words, it was difficult to separate and assign A.M or P.M peak hours with the current data sheet. Therefore, it is recommended to survey the land uses in 1 hour intervals. In order to cope with this problem, researcher utilized the start of working hours of office buildings which might be a representation of the variation of A.M. peak hour traffic in 06:00-10:00 time interval. It is recommended to be aware of this variation which was stated in Chapter 4 (Table 4.3) while using the trip generation rates. On the other hand, at Saturday and Sunday trip rate calculations since the vehicle counts' data were not collected, vehicle trip generation rates and regression models could not be obtained. This data should also be obtained.

Transferability of the outputs was discussed in this study as well. It was mentioned that with similar socio-economic conditions, the trip rates and models could be transferred without resulting in erroneous results (Miller *et al.*, 2006).. Therefore, further studies are needed to study the transferability of the results obtained for Istanbul to other cities in Turkey.

APPENDIX A: DEVELOPMENT SURVEY FORM (DSF)

This section includes the customer survey questionnaire form obtained from BİMTAŞ.

EK 1B1. İSTANBUL'DA KENTSEL ÇALIŞMA VE ULAŞIM TESİSLERİ ALTYAPI ALANLARI TRAFİK ÜRETİMİ SORU FORMU

İSTANBUL BÜYÜKŞEHİR BELEDİYESİ
ULAŞIM PLANLAMA MÜDÜRLÜĞÜ

ULAŞIM MASTER PLANI REVİZE EDİLMESİ PROJESİ KAPSAMINDA ARAZİ KULLANIM TÜRLERİ TRAFİK ÜRETİM KILAVUZU HAZIRLANMASI HİZMETİ ALIMI İŞİ

YÜKLENİCİ:
BOĞAZİÇİ İNŞAAT MÜŞAVİRLİK A.Ş.

İSTANBUL'DA KENTSEL ÇALIŞMA VE ULAŞIM TESİSLERİ ALTYAPI ALANLARI TRAFİK ÜRETİMİ SORU FORMU

ANKET KAPSAMI

Arazi Kullanım Türü		
[1]Konut Yerleşme Alanları	[11] Düzenli	
	[12] Düzensiz	
	[13] Karma	
	[14] Toplu Konut	
	[15] Tarihi Doku	
[2]Kentsel Çalışma Alanları	[21]Ticaret ve Hizmet Alanları	√
	[22]Sanayi ve Organize Sanayi (SOS) Alanları	
	[23]Küçük ve Orta Ölçekli Sanayi (KOÖS) Alanları	
	[24]Konut Dışı Kentsel Çalışma Alanları	√
[3]Açık ve Yeşil Alanlar	[31]Kentsel Açık ve Yeşil Alanlar	
	[32]Doğal Açık ve Yeşil Alanlar	
[4]Kentsel Sosyal Altyapı Alanları	[41]Eğitim Tesisleri	
	[42]Sağlık Tesisleri	
	[43]Sosyal ve Kültürel Tesisler	
	[44]Dini Tesisler	
	[45]Spor Tesisleri	
	[46]Kamu Kurumu Alanları	
[5]Ulaşım ve Lojistik Altyapı Alanları	[51]Kent içi Ulaşım Tesisleri	√
	[52]Lojistik Tesisler	

İSTANBUL'DA KENTSEL ÇALIŞMA ALANLARI ve KENTİÇİ ULAŞIM TESİSLERİ İÇİN TRAFİK YÜKÜ TESPİTİ SOR

İyi günler efendim. Adım……………………. . Bildiğiniz gibi ulaşım, İstanbul'un en büyük problemlerinden biridir. İSTANBUL BÜYÜKŞEHİR BELEDİYESİ ulaşım probleminin çözülebilmesi için yeni projeler üretmek istemektedir. Bu amaçla İstanbul Büyükşehir Belediyesi Ulaşım Planlama Müdürlüğü tarafından ihale edilen "Arazi Kullanım Türleri Trafik Üretim Kılavuzu Anket ve Trafik Sayımları Çalışması" kapsamında İstanbul genelindeki çalışma alanlarında bu çalışmaya yönelik sizinle işyeri, çalışan yolculuk bilgilerini içeren bir anket yapmak istiyoruz. Araştırma sonunda işyeri adresleri, BİMTAŞ' a sizi arayarak anketin yapılıp yapılmadığının kontrol edilmesi amacıyla verilecektir. Bu anket ile derlenecek bilgiler istatistik amaçlı çalışmalar için kullanılacaktır. Anketimiz yaklaşık …… dk sürecektir. Bu çalışmada bize yardımcı olursanız seviniriz. Şimdiden teşekkür ederiz. İBB Ulaşım Planlama Müdürlüğü: 0212-449 4080-81, BİMTAŞ: 0212-245-9900

A. ADRES VE ÖRNEKLEME BİLGİLERİ

A1. FORM NO:	A2. KENTSEL ALAN KODU	1. İÇ MERKEZ	2. MERKEZ	3. KENTSEL ÇEPER	A.3. KENTSEL ÇALIŞMA ALANI TÜRÜ VE NİTELİĞİ			
KÇA-KUT/…….		☐	4. KIRSAL ÇEPER	5. ÇEPER KIRSALI	A.3.1. GELİŞME TÜRÜ	A.3.2. ARAZİ DEĞERİ	A.3.3. YOĞUNLUK	A.3.4. '9'LU TİPOLOJİ'
A.4. İL:	☐☐		A.9. BİNA / DIŞ KAPI NO:		[21]. TİCARET ve HİZMET ALANLARI	D O Y ☐☐☐	D O Y ☐☐☐	☐
A.5. İLÇE:	☐☐		A.10. DAİRE NO (VARSA):					
A.6. BUCAK (BELDE):	☐☐		A.11. KÜME:	☐☐☐☐	[24]. KONUT DIŞI KENTSEL ÇALIŞMA ALANLARI	D O Y ☐☐☐	D O Y ☐☐☐	☐
A.7. KÖY/MAHALLE:	☐☐☐☐		A.12. ÖRNEK İŞYERİ NO:	☐☐☐				
A.8. CADDE / SOKAK ADI:			A.13. ARAZİ KULLANIM TÜRÜ	☐☐	[51]. KENTİÇİ ULAŞIM TESİSLERİ	D O Y ☐☐☐	D O Y ☐☐☐	☐

A.14. ZİYARET SAYISI	1	2	3	4
A.15. ANKETÖR ADI SOYADI				
A.16. ANKET TARİHİ	☐☐ Gün ☐☐ Ay	☐☐ Gün ☐☐ Ay	☐☐ Gün ☐☐ Ay	☐☐ Gün ☐☐ Ay
A.17. BAŞLAMA SAATİ	☐☐ Saat ☐☐ Dak	☐☐ Saat ☐☐ Dak	☐☐ Saat ☐☐ Dak	☐☐ Saat ☐☐ Dak
A.18. BİTİŞ SAATİ	☐☐ Saat ☐☐ Dak	☐☐ Saat ☐☐ Dak	☐☐ Saat ☐☐ Dak	☐☐ Saat ☐☐ Dak
A.19. ZİYARET SONUCU	ANKET TAMAMLANDI 1 ANKET YARIM KALDI 2 İŞYERİNDE KİMSE YOK 3 GÖRÜŞME ERTELENDİ 4 GÖRÜŞME REDDEDİLDİ 5 DİĞER (Belirtin) ☐	ANKET TAMAMLANDI 1 ANKET YARIM KALDI 2 İŞYERİNDE KİMSE YOK 3 GÖRÜŞME ERTELENDİ 4 GÖRÜŞME REDDEDİLDİ 5 DİĞER (Belirtin) ☐	ANKET TAMAMLANDI 1 ANKET YARIM KALDI 2 İŞYERİNDE KİMSE YOK 3 GÖRÜŞME ERTELENDİ 4 GÖRÜŞME REDDEDİLDİ 5 DİĞER (Belirtin) ☐	ANKET TAMAMLANDI 1 ANKET YARIM KALDI 2 İŞYERİNDE KİMSE YOK 3 GÖRÜŞME ERTELENDİ 4 GÖRÜŞME REDDEDİLDİ 5 DİĞER (Belirtin) ☐
A.19.1 ANKETİN YAPILDIĞI KİŞİ ADI				
A.20 ANKET TAMAMLANMADI İSE, SONRAKİ RANDEVU GÜNÜ VE SAATİ	☐☐ Ay ☐☐ Gün ☐☐ Saat	☐☐ Ay ☐☐ Gün ☐☐ Saat	☐☐ Ay ☐☐ Gün ☐☐ Saat	☐☐ Ay ☐☐ Gün ☐☐ Saat

A.21. EKİP BAŞI (Alan Editörü)	ADI / SOYADI:	ANKET İLE İLGİLİ BÜTÜN ÇALIŞMA BİTTİĞİNDE DOLDURULACAKTIR.	
A.22. DENETÇİ (Telefon Kontrolü)	ADI / SOYADI:	A.26.1. TAM ANKET*	1
A.23. TEL. CEVAPLAYAN KİŞİ	ADI / SOYADI:	A.26.2. EKSİK ANKET**	2
A.24. TELEFON KONTROLÜ YAPILDI ☐ A.24.1 KONTROL TARİHİ ☐☐ ☐☐ ☐☐	A.25. ARAZİ KONTROLÜ YAPILDI ☐ A.25.1 KONTROL TARİHİ ☐☐ ☐☐ ☐☐	* TAM ANKET, HANEHALKI, YOLCULUK VE BİNA BİLGİLERİNİN EKSİK ALINMADIĞI ANKETTİR (6. BÖLÜM HARİÇ). ** EKSİK ANKET, HANEHALKI, YOLCULUK VE BİNA BİLGİLERİNDE EKSİKLİKLER OLAN ANKETTİR.	

A.27 HANEHALKININ TÜKETİM GÖSTERGELERİ

(Bu bilgiler hanehalkının sosyo-ekonomik yapısı ile temel tüketim göstergeleri arasındaki ilişkinin değerlendirilmesine yöneliktir.)

A27.1. SAYAÇ BİLGİSİNE DAYALI TÜKETİM GÖSTERGELERİ (Sayaç / Abone numarası bilgisine ulaşılan ayan hanelerde A.27.2'ye geçiniz.)

A.27.1.1. ELEKTRİK ABONE NO:	A.27.1.2. SU ABONE NO:	A.27.1.3. DOĞAL GAZ TESİSAT NO:
☐☐☐☐☐☐☐	☐☐☐☐☐☐☐☐	☐☐☐☐☐☐☐

A.27.2. SÖZLÜ (S) BİLGİ VEYA FATURAYA (F) DAYALI TÜKETİM GÖSTERGELERİ

27.2.1. ELEKTRİK (AY/YIL) ☐☐/☐☐		27.2.4. SU (AY/YIL) ☐☐/☐☐		27.2.7. DOĞAL GAZ (AY/YIL) ☐☐/☐☐	
27.2.2. TÜKETİM BEDELİ	27.2.3. FATURA?	27.2.5. TÜKETİM BEDELİ	27.2.6. FATURA?	27.2.8. TÜKETİM BEDELİ	27.2.9. FATURA?
☐☐☐ . ☐☐ YTL YKRş	☐ S ☐ F	☐☐☐ . ☐☐ YTL YKRş	☐ S ☐ F	☐☐☐ . ☐☐ YTL YKRş	☐ S ☐ F

GENEL BİLGİLER

1. Görüşmenin Yapıldığı Merkez veya Kurumun Adı		
	Adı ve (varsa) ticari ünvanı	
	Faks Numarası	
	E-mail adresi	
	Web adresi	

2. Görüşmenin Yapıldığı Merkez veya Kurumun Türünü İşaretleyiniz

			[X]İŞARETİ KOYUNUZ	NACE KODU
[21] TİCARET VE HİZMET ALANLARI	[2101]	Bürolar		
	[2102]	Çok amaçlı alışveriş Merkezleri [x]		
	[2103]	Gazino ve Gece Kulüpleri (Eğlence Merkezi)		
	[2104]	Lokantalar ve Restoranlar		
	[2105]	Tarihi Çarşılar [◊]		
	[2106]	Bankalar ve Finans Kuruluşları		
	[2107]	Oteller		
	[2108]	İşhanları		
	[2109]	Çok katlı mağazalar		
	[2110]	Küçük alışveriş mekanları [¤]		
[24] KONUT DIŞI KENTSEL ÇALIŞMA ALANLARI	[2201]	Akaryakıt satış ve bakım istasyonları*		
	[2202]	İmalathaneler[+]		
	[2203]	Oto galerileri		
[51] KENTİÇİ ULAŞIM TESİSLERİ	[5101]	Tren Garları		
	[5102]	Havaalanları		
	[5103]	Otogar/Otobüs Terminalleri		
	[5104]	Kentiçi Denizyolu İşletmecileri [◊]		

* [2102] Market, Hiper-Süper-Gross Market, Alışveriş Merkezleri, Büyük Alışveriş Merkezleri.
° [2105] Kapalı Çarşı, Mısır Çarşısı, Sahaflar, Sipahi Çarşısı.
° [2110] Bakkal, Şarküteri.
* [2201] İçerisinde motel ve lokanta da bulunabilen akaryakıt satış ve bakım istasyonları.
* [2202] Dumansız kokusuz atık ve artık bırakmayan ve çevre sağlığı yönünden tehlike yaratmayan imalathaneler(KSS ve OSB alanları dışındakiler).
§ [5104] İDO, Turyol, Avrasya-Dentur, Deniz Nakliyecileri Odası.

3. Firmanızın/Kurumun Alansal Kapasiteleri ve Kullanım Oranları Nedir? (Sadece Firmanızın Kendisinin Kullanabildiği Alanlar) ÖNCELİKLE TÜM ŞIKLARI TEK TEK OKUYARAK OLUP OLMADIĞINI VAR/YOK SÜTUNUNA İŞARETLEYİNİZ. DAHA SONRA VAR İŞARETLENENLERİN BÜYÜKLÜKLERİNİ ve KAPASİTE KULLANIM ORANLARINI SORUNUZ. BELİRTİLEN BİRİMLERDEN BİRDEN FAZLA OLMASI DURUMUNDA DİĞER SEÇENEĞİNE NE OLDUĞUNU BELİRTEREK YAZINIZ.	**Alan**		**Yok**	**Var**	**Toplam Alan (m²)**	**Yükseklik**	***Maksimumu Kapasite Kullanım Oranı (%)**
	Ana Bina**		2	1			
	Üretim Binası İL/İLÇE:		2	1			
	Genel Depo İL/İLÇE:		2	1			
	Yükleme Boşaltma Alanı İL/İLÇE:		2	1			
	Binek Araç Otopark Alanı***	Açık	2	1		**ARAÇ KAPASİTESİ**	
		Kapalı	2	1		**ARAÇ KAPASİTESİ**	
	Yük Aracı Otopark Alanı		2	1		**ARAÇ KAPASİTESİ**	
	Sosyal Donatı Alanı **** (yeşil alan, cami, sağlık tesisi, vb.)		2	1			
	Ortak Kullanım Alanı (Yatakhane, Yemekhane, vb.)		2	1			
	Açık alan *****		2	1			
	Diğer		2	1			
	TOPLAM						

* Maksimum Kapasite Kullanım Oranı (%): SON BIR AY içindeki maksimum kapasite kullanım oranıdır.
** Ana Bina: Firma ya da Kurumun YÖNETİMİNİN de içinde bulunduğu bina olup, ayrıca firmaya ya da kuruma ait diğer departmanları da içinde bulundurabilir.
*** Binek Araç Otopark Alanı: Firmanın/Kurumun anlaşmalı olduğu ya da ortak kullandığı otopark alanları da dahil olup, SADECE firmanın kullanımına ait alanın büyüklüğü yazılacaktır.
**** Sosyal Donatı Alanı: Firmanın/Kurumun faaliyet gösterdiği alan içerisinde var olan yesşil ala, sağlık tesisi ve cami gibi alanlardır.
***** Açık Alan: Firmanın/Kurumun faaliyet gösterdiği alan içerisinde bina alanları haricindeki tüm alanı kapsar. Örn.: 5 bin m2 lik alan içinde var olan 1000 m2 bina taban alanı çıkınca, Açık alan 4 bin m2 olarak yazılacaktır.

4. Firmanızın/Kurumun Otopark Ücretlendirme Durumu Nedir?

Firmaya/Kuruma ait otoparkın ANLAŞMALI ve/veya ORTAK KULLANIM olması durumunu dikkate alınız.

	ÜCRETLENDİRME		ÜCRET TABLOSU
	VAR	YOK	
ÇALIŞANLAR İÇİN (aşağıdakilerden birine [X] işareti koyun.) 1. Kendine ait: 2. Anlaşmalı ve sadece kendine ait: 3. Anlaşmalı ve ortak kullanım:	1	2	
ZİYARETÇİLER İÇİN (aşağıdakilerden birine [X] işareti koyun.) 1. Kendine ait: 2. Anlaşmalı ve sadece kendine ait: 3. Anlaşmalı ve ortak kullanım:	1	2	

5. Kurumunuzun/Tesisinin Hizmete Açık Olduğu Günler Hangileridir?

(KURUMUN/TESİSİN HİZMETE AÇIK OLDUĞU GÜNLERDEKİ VARDİYA SAATLERİNİ VE VARDİYALARDA ÇALIŞAN SAYILARINI YAZIN. GEREKİRSE EK SAYFA KULLANIN)

Çalışma Günleri	Çalışma Var mı?		1. Çalışma Dilimi		2. Çalışma Dilimi		3. Çalışma Dilimi	
	Evet	Hayır	Çalışma Saatleri	Çalışan Kişi	Çalışma Saatleri	Çalışan Kişi	Çalışma Saatleri	Çalışan Kişi
Pazartesi	1	2	: / :		: / :		: / :	
Salı	1	2	: / :		: / :		: / :	
Çarşamba	1	2	: / :		: / :		: / :	
Perşembe	1	2	: / :		: / :		: / :	
Cuma	1	2	: / :		: / :		: / :	
Cumartesi	1	2	: / .		: / .		: / .	
Pazar	1	2	: / :		: / :		: / :	
Dini Bayramlar	1	2	: / :		: / :		: / :	
Resmi Bayramlar	1	2	: / :		: / :		: / :	
Farklı Bir Cevap Veriyorsa Açıklayınız								

ÇOK ÖNEMLİ: KURUM YADA TESİSTE ÇALIŞAN PERSONELİN YÖNETİCİ, DOKTOR, HEMŞİRE, GENEL MÜDÜR, MÜDÜR, MÜDÜR YRD., İDARİ PERSONEL, SATIŞ ELEMANI, TEKNİK PERSONEL, TEKNİSYEN, TEKNİKER GİBİ SINIFLAMASI VAR İSE, ÇALIŞANLARIN ÇALIŞMA ZAMANLARINI (TAM/YARI ZAMANLI) DA BELİRTEN BU LİSTEYİ EK OLARAK GÖRÜŞÜLEN KİŞİDEN TALEP EDİNİZ!!!

STAJYERLER DE belirtilerek DAHİL EDİLECEKTİR.

Kurumunuzun/Tesisinizin Hizmete Açık Olduğu Günler Hangileridir?

(KURUMUN/TESİSİN HİZMETE AÇIK OLDUĞU GÜNLERDEKİ VARDİYA SAATLERİNİ VE VARDİYALARDA ÇALIŞAN SAYILARINI YAZIN. GEREKİRSE EK SAYFA KULLANIN)

Çalışma Günleri	Çalışma Var mı?		4. Çalışma Dilimi		5. Çalışma Dilimi		6. Ça
	Evet	Hayır	Çalışma Saatleri	Çalışan Kişi	Çalışma Saatleri	Çalışan Kişi	Çalışn Saatle
Pazartesi	1	2	: :		: :		: :
Salı	1	2	: :		: :		: :
Çarşamba	1	2	: :		: :		: :
Perşembe	1	2	: :		: :		: :
Cuma	1	2	: :		: :		: :
Cumartesi	1	2	: :		: :		: :
Pazar	1	2	: :		: :		: :
Dini Bayramlar	1	2	: :		: :		: :
Resmi Bayramlar	1	2	: :		: :		: :
Farklı Bir Cevap Veriyorsa Açıklayınız							

ÇOK ÖNEMLİ: KURUM YADA TESİSTE ÇALIŞAN PERSONELİN YÖNETİCİ, GENEL MÜDÜR, MÜDÜR, MÜDÜR YRD., İDARİ PERSONEL, SATIŞ ELEMANI, TEKNİK PERSONEL, TEKNİSYEN, TEKNİKER GİBİ SINIFLAMASI VAR İSE, ÇALIŞANLARIN ÇALIŞMA ZAMANLARINI (TAM/YARI ZAMANLI) DA BELİRTEN BU LİSTEYİ EK OLARAK GÖRÜŞÜLEN KİŞİDEN TALEP EDİNİZ!!!

STAJYERLER DE belirtilerek DAHİL EDİLECEKTİR.

6. Görüşmenin yapıldığı tesisin/ alanın yayaların ve araçların (küçük araç ve yük/ticari araç) GİRİŞ ve/veya ÇIKIŞ yaptıkları kapı sayısı nedir?

YAYA ve ARAÇLARIN GİRİŞ/ÇIKIŞ YAPTIKLARI KAPILAR BAZI DURUMLARDA AYNI OLABİLİR BU DURUMU DİKKATE ALARAK KAPI ÖZELLİKLERİNİ BELİRTİN

YANDAKİ TABLODA ÖZELLİKLERİ BELİRTİLEN KAPILARI [X] İLE İŞARETLEYİN.

	Giriş Yapılıyor			Çıkış Yapılıyor		
	Yaya	Küçük Araç	Yük/Ticari Araç	Yaya	Küçük Araç	Yük/Ticari Araç
1.Kapı						
2.Kapı						
3.Kapı						
4.Kapı						
5.Kapı						
6.Kapı						
7.Kapı						
8.Kapı						
9.Kapı						
10.Kapı						
Toplam Kapı Sayısı						

7. Yer seçimi yaparken bulunduğunuz yeri seçmenizde sayacağımız KRİTERLER etkili oldu mu?

(EĞER BİRİNCİ SEÇENEK "EVET" OLARAK İŞARETLENİRSE 8. SORUYA GEÇİNİZ, "HAYIR" İŞARETLENİRSE ŞIKLARI OKUMAYA DEVAM EDİNİZ)

KRİTERLER	**Evet**	**Hayır**	**Önem Derecesi***
1.Tercih Ettiğim İşte Başka Bir Yer Alternatifinin Olmaması (Devletin Yönlendirmesi)	1	2	
2.Arazi Fiyatlarının Uygunluğu	1	2	
3.Mal Temin Etmede Kolaylık	1	2	
4.Mekan Kiralarının Uygunluğu	1	2	
5.Gerekli Altyapının Varlığı	1	2	
6.Yeterli İşyeri Alanının Bulunması	1	2	
7.Üretim/Tüketim Merkezine Yakınlık	1	2	
8.Ulaşım Olanaklarına Yakınlık	1	2	
9.Lojistik Merkezine Yakınlık	1	2	
10.Benzer Firmalara Yakınlık	1	2	
11.Diğer (Belirtiniz)	1	2	
12.Diğer (Belirtiniz)	1	2	
13.Diğer (Belirtiniz)	1	2	

*** "EVET" cevabı verilen şikâyetlerin önem derecesini EN ÖNEMLİDEN başlamak suretiyle SIRA NUMARASINI bu sütuna yazarak kodlayınız.**

8. Şu sayacağım konularda bulunduğunuz konumla ilgili (mekânsal) **SIKINTILARINI**Z var mı?				
	SIKINTILAR	**Evet**	**Hayır**	**Önem Derecesi***
	1.Şehir Merkezinden Uzak Olması	1	2	
	2.Şehir Merkezine Yakın Olması	1	2	
	3.Ana Ulaşım Arterlerine Uzak Olması	1	2	
	4.Kentin Trafik Yoğunluğunun Fazla Olduğu Bölgede Bulunması	1	2	
	5.Müşterilerimin Yükü Ulaştırmadaki Sıkıntıları	1	2	
	6.Genişleme Alanının Olmaması	1	2	
	7.Çevre Arazi Kullanım Türünün Uygun Olmaması	1	2	
	8.Toplu Taşıma (Otobüs, metro, vb) Olanaklarının Bulunmaması veya Sınırlı Olması	1	2	
	9.Üretim Merkezine UZAK Olması	1	2	
	10.Üretim Merkezine YAKIN Olması	1	2	
	11.Diğer (Belirtiniz)			

*** "EVET" cevabı verilen şikâyetlerin önem derecesini EN ÖNEMLİDEN başlamak suretiyle SIRA NUMARASINI bu sütuna yazarak kodlayınız.**

9. İmkânınız olsaydı işyerinizi TAŞIMAYI düşünür müydünüz? Düşünürseniz NEDENİ nedir?

(EĞER CEVAP "EVET" OLARAK İŞARETLENİRSE NEDENLERİ OKUMAYA DEVAM EDİNİZ, "HAYIR" İŞARETLENİRSE 10. SORUYA GEÇİNİZ.)

*** İlgisi Yok:** Sıralanan NEDENLERİN sektörle alakasının olup olmadığını belirtmek için işaretlenecektir. Örn.: OTELLERİN lojistik merkezine yakın olup olmaması OTELİN yer seçiminde bir KRİTER değildir.

Evet, düşünürdüm	1
Hayır, düşünmezdim.	2

NEDENİ	**Evet**	**Hayır**	**İlgisi Yok***
1.Malı Temin Etmedeki Sıkıntılar	1	2	3
2.Malı Ulaştırmadaki Sıkıntılar	1	2	3
3.Fiziki Alan Yetersizliği	1	2	3
4.İşyerinin Bulunduğu Konumun Uygun Ol...	1	2	3
5.Genişleme İmkânının Olmaması	1	2	3
6.Arazi Fiyatlarının Yükselmesi	1	2	3
7.Mekân Kiralarının Artması	1	2	3
8.Müşteri Talebinin Firmanın Konumundan Ötürü Azalması	1	2	3
9.Altyapı Yetersizliği	1	2	3
10.Diğer			
11.Diğer			
12.Diğer			
13.Diğer			

10. **Günlük Ortalama Müşteri/ Yolcu Sayınız Kaçtır?**

Müşterilerinizin En yoğun olduğu Saat Dilimlerini Belirtiniz.

*BAZI TESİSLERDE SADECE YOLCU, BAZILARINDA İSE SADECE MÜŞTERİ, DİĞERLERİNDE DE HER İKİ BİRDEN VARDIR. BUNA DİKKAT EDİLSİN.

Günler	Toplam GÜNLÜK Müşteri/Yolcu Sayısı*	Yolcu Sayısının EN Yoğun Olan Saat Dilimleri
Pazartesi		
Salı		
Çarşamba		
Perşembe		
Cuma		
Cumartesi		
Pazar		
Dini Bayramlar		
Resmi Bayramlar		

Günlük Ortalama Müşteri / Yolcu Sayısı: ....

Haftalık Ortalama Müşteri / Yolcu Sayısı: ....

Aylık Ortalama Müşteri / Yolcu Sayısı: ....

Yıllık Ortalama Müşteri / Yolcu Sayısı: ....

11. **Kurumunuza YÜK GİRİŞİ veya kurumunuzdan YÜK ÇIKIŞI mevcut mu?**

Evet	1
Hayır	2

Cevap "EVET" ise 12, 13 ve 14. soruları yanıtlayınız, "HAYIR" ise 15. Soruya geçiniz.

12. **İstanbul içinden GELEN YÜKÜNÜZÜN geldiği İLÇE, MAHALLE ve ARAÇ SAYILARINI, geçtiğimiz haftayı düşünerek cevaplandırınız.**

(GÜNLÜK ORTALAMA RAKAMLARI YAZINIZ)

İstanbul içinden G E L E N Y Ü K

İLÇE	MAHALLE	YÜK ARACI SAYISI

13. **İstanbul içine DAĞITILAN YÜKÜN gönderdiğiniz İLÇE, MAHALLE ve ARAÇ SAYILARINI, geçtiğimiz haftayı düşünerek cevaplandırınız.**

(GÜNLÜK ORTALAMA RAKAMLARI YAZINIZ)

Istanbul içine D A G I T I L A N Y U K

İLÇE	MAHALLE	YÜK ARACI SAYISI

14. Gün içinde **YÜKLEME ve/veya BOŞALTMA** yaptığınız **Taşıt Sayısını** ve **Tonajını** Tabloda belirtilen **SAATLERE** göre söyleyiniz.

	8:00-10:00	10:00-12:00	12:00-14:00	14:00-16:00	16:00-18:00	18:00-20:00	20:00-24:00	24:00-08:00
Yükleme Sayısı								
Boşaltma Sayısı								
Yükleme Tonajı								
Boşaltma Tonajı								

15. Firmaya/ Kuruma ait Yük/Yolcu taşıma araçlarınızın **TÜR** ve **YAŞLARINA** göre sayılarını belirtiniz.

	VAR	YOK	[15 . 1] 0 - 1 Yıl	[15 . 2] 2 - 5 Yıl	[15 . 3] 6 - 10 Yıl	[15 . 4] 10 Yıl Üstü
TIR	1	2				
Kamyon	1	2				
Kamyonet	1	2				
Otomobil	1	2				
Servis (Yolcu) Aracı	1	2				
Diğer (Belirtiniz)	1	2				
Diğer (Belirtiniz)	1	2				
Diğer (Belirtiniz)	1	2				

16. Firmaya/Kuruma Ait Servis Aracınız varsa SERVİS BİLGİLERİNİ yandaki tabloya giriniz.

(EĞER FİRMAYA/KURUMA AIT SERVIS ARACI YOKSA 17. SORUYA GEÇİNİZ)

*** Servis aracını kullanan kişi sayısının tüm toplam ziyaretçi ve/veya personele bölümü şeklinde olup, OFİSTE hesaplanacaktır.**

SERVİS GÜZERGÂH BİLGİLERİ

[16 . 1]	[16 . 2]	[16 . 3]	[16 . 4]	[16 . 5]	[16 . 6]
Servis Güzergah Bilgileri	Servis Aracı Sayısı	Toplam Araç Kapasitesi (araçtaki koltuk sayısı)	Servis Aracında Geçen Süre	Servis Kullanan Çalışan/ Müşteri Sayısı (Tüm gün)	Servis Aracı Kullanım Oranı*

17. Ulaşım türüne bağlı olarak ARAÇ, YOLCU SAYISI ve DOLULUK Oranlarını belirtiniz.

BU SORU K E N T S E L U L A Ş I M T E S İ S L E R İ N E SORULACAKTIR

Kod	Ulaşım Türü	[17 . 1] Toplam Araç Sayısı	[17 . 2] Günlük Sefer Sayısı[1]	[17 . 3] Araçların Koltuk Sayısı	[17 . 4] Toplam Kapasite[2]	[17. 5] Ortalama Günlük Yolcu Sayısı	[17 . 6] Toplam Yıllık Yolcu Sayısı
1	Demiryolu*						
2	Denizyolu**						
3	Havayolu***						
4	Karayolu****						
5	Diğer (Belirtiniz)						
6	Diğer (Belirtiniz)						

Not: Kuruma ait hat karakteristik bilgileri (araç ve sefer sayısı, araç kapasitesi, hat uzunluğu, taşınan yolcu sayısı) doküman olarak ekte istenmelidir.

*	**Demiryolu***	Demiryolu işletmeciliği yapan HAYDARPAŞA, SİRKECİ ve HAKLALI TCDD işletmelerine SORULACAKTIR.
**	**Denizyolu****	Denizyolu işletmeciliği yapan İDO, TURYOL, AVRASYA-DENTUR, Deniz Nakliyecileri Esnaf Odası'na SORULACAKTIR.
***	**Havayolu*****	Havayolu işletmeciliği yapan ATATÜRK ve SABİHA GÖKÇEN HAVAALANLARI'na SORULACAKTIR.
****	**Karayolu******	Karayolu işletmeciliği yapan ESENLER ve HAREM OTOGARLARI'na SORULACAKTIR.

[1] Sefer Sayısı: Bir başlangıç noktasından bir en son varış noktasına gerçekleştirilen yolculuk. Örn. İstanbul-Adana arası sefer yapan bir otobüs, Ankara'da dursa da, seferi İstanbul-Adana arasında olup, bu 1 sefer sayılacaktır.

[2] Toplam Kapasite = (15 kişilik araçlar için) [17.1] * [17.2] * [17.3] + (31 kişilik araçlar için) [17.1] * [17.2] * [17.3] + (55 kişilik araçlar için) [17.1] * [17.2] * [17.3]

18. **Ulaşım tesisi içerisinde faaliyet gösteren İŞLETMELERİN günlük SEFER SAYILARI ve SIKLIKLARI, TAŞINAN YOLCU SAYISI nedir?**

(EĞER ULAŞIM TESİSİ TEK BİR İŞLETME GİBİ FAALİYET GÖSTERİYORSA- örneğin TCDD gibi, SADECE ONA AİT BİLGİLERİ KAYDEDİN!)

BU SORU K E N T S E L U L A Ş I M T E S İ S L E R İ N E SORULACAKTIR

[18 . 1]	[18 . 2]	[18 . 3]		[18 . 4]	[18 . 5]
İşletme Adı	Araç Sayısı	Günlük Ortalama Yolcu Sayısı		Günlük Araç Sefer Sayısı	Sefer Sıklığı[3]
		Gelen	Giden		

[13.6] İstanbul dışından gelen günlük yolcu sayısı: ....

[13.7 İstanbul'dan çıkan günlük yolcu sayısı: ....

[13.8] İstanbul dışından gelen günlük araç sayısı: ....

[13.9] İstanbul'dan çıkan günlük araç sayısı: ....

[3] Sefer sıklığı için, örneğin her saat başı ya da yarım saatte bir gibi bilgiler toplanacaktır. Ya da 7:00-10:00 17:00-20:00 arası yarım saatte bir, diğer zamanlarda saate bir ve gece 24:00 ile sabah 6:00 arası servisimiz yoktur gibi daha detaylı bilgiler de elde edilebilir.

19. **Firmanın/Kurumun bulunduğu semtte sağda belirtilen toplu taşıma araçlarından hangileri hizmet vermektedir?**

		[19 . 1]	[19 . 2]
Kod	**Ulaşım Türü**	**Evet**	**Hayır**
1	İETT Otobüsü	1	2
2	Özel Halk Otobüsü	1	2
3	Metro/LRT[4]	1	2
4	Tramvay[5]	1	2
5	Vapur	1	2
6	Deniz Otobüsü	1	2
7	Minibüs	1	2
8	Dolmuş[6]	1	2
9	Diğer (Belirtiniz)	1	2
10	Diğer (Belirtiniz)	1	2

20. **Semtinizde hizmet veren TOPLU TAŞIMA HATLARINDA şu belirtilen sorunlardan hangileri yaşanmaktadır?**

		[20 . 1]	[20 . 2]	[20 . 3]
Kod	**Ulaşım Türü**	**Evet**	**Hayır**	**Fikrim Yok**
1	Otobüslerin sefer saatlerine uymaması	1	2	3
2	Sefer sayılarının yetersiz olması	1	2	3
3	Hat sayısının yetersiz olması	1	2	3
4	Yolculuk ücretlerinin pahalı olması	1	2	3
5	Akbil dolum gişelerinin yetersiz olması	1	2	3
6	Araçların kalabalık olması	1	2	3
7	Araçların kirli olması	1	2	3
8	Diğer	1	2	3

[4] Metro: Taksim-4. Levent arasında, LRT: Aksaray-Havaalanı arasında.
[5] Kabataş-Zeytinburnu arasında.
[6] Dolmuşlar sarı renkli FORD TRANSİT araçlar olup, sadece belli hatlarda çalışmaktadırlar. MİNİBÜSler ile karıştırılmamalıdır.

21. Bir yolcu olarak İstanbul'daki ulaşım araçlarından Genel MEMNUNİYETİNİZİ nasıl ifade edersiniz?

(KULLANICI OLMAMA DURUMUNU DİKKATE ALINIZ)

KARA ULAŞIMI		DENİZ ULAŞIMI		RAYLI ULAŞIM	
Özel oto		Vapur		Metro (Taksim-4.Levent)	
Taksi		Feribot (Arabalı vapur)		Tramvay (Kabataş-Zeytinburnu)	
Dolmuş		Deniz otobüsü		Tünel (Kakaköy-Taksim)	
Minibüs		Deniz motoru		Banliyö (Halkalı-Gebze)	
İETT otobüsü				Füniküler(Taksim-Kabataş)	
Özel halk otobüsü					
Motosiklet					
Bisiklet Yolları					
Servis aracı					
Yaya Yolları					
Metrobüs					

Kodlama	
0	Kullanmıyorum
1	Hiç memnun değilim
2	Memnun değilim
3	Kararsızım
4	Memnunum
5	Çok memnunum

22. **Ulaşım Yatırımlarından Memnuniyetinizi söyler misiniz?**

ULAŞIM YATIRIMLARI	Memnuniyet Durumu (A)	Geleceğe İlişkin Düşünceler (B)
Yol ve Kavşak Projeler		
Karayolu Tünel Projeleri (Yeditepe Yedi Tünel projesi)		
Karayolu Boğaz Tünel Geçişi (Göztepe-Sarayburnu arası)		
Marmaray Projesi (Raylı Sistem Boğaz Tünel Geçişi)		
Metrobüs Projesi		
Raylı Sistem Yatırımları		
Deniz Ulaşımı Yatırımları		
Kentsel Ulaşım Türleri Arası Aktarma Merkezleri		

A. Memnuniyet Durumu	
0	Fikrim yok
1	Hiç memnun değilim
2	Memnun değilim
3	Kararsızım
4	Memnunum
5	Çok memnunum

B. Geleceğe İlişkin Düşünceler	
0	Fikrim yok
1	Bugün ki devam etmeli
2	Daha fazla yapılmalı
3	Yatırımlar başka alanlara kaydırılmalı

23. Gelecekte İstanbul'da ulaşım türlerinde var olmasını istediğiniz özellikleri önem sırasına göre sıralayınız				
1. HIZLI OLMASI	2. KONFORLU OLMASI	3. GÜVENLİ OLMASI	4. EKONOMİK OLMASI	5. TRANSFER KOLAYLIĞI
☐☐☐☐☐				

24. KONTROL BİLGİLERİ						
Bizi kontrol etmek için sizi arayabilirler. Sakıncası yoksa telefon numaranızı alabilir miyiz?						
TELEFON NUMARASI VAR ☐	TELEFON NUMARASI YOK ☐				NUMARA VERMEK İSTEMİYOR ☐	
TELEFON NUMARASI	☐☐☐ ☐☐☐ ☐☐ ☐☐					
CEVAPLAYICIYA TEŞEKKUR EDINIZ VE GORUŞMEYI BITIRINIZ.						
Size göre yanıtların güvenilirlik derecesi nedir?	1.Çok zayıf	2.Zayıf	3.Orta	4.İyi	5.Çok iyi	**ANKETÖR GÖZLEMLERİ:**
	☐	☐	☐	☐	☐	
ON KAPAGA GEÇINIZ, BITIŞ SAATINI DOLDURUNUZ.						

ANKET FORMU BİTTİ!!!

APPENDIX B: TRAFFIC OBSERVATION FORM (TOF)

In this section, the traffic observation form is presented which was used to calculate the vehicle trip ends and rates. It is obtained from BIMTAS.

TRAFİK ÜRETİM TESPİT FORMU

İl : ______	Bina / Dışkapı No: ______
İlçe : ______	Bina İç Kapı No : ______
Bucak(Belde) : ______	Alt Bölge (Odak vs No) : ______
Mahalle : ______	
Cadde : ______	Örnek Birim : ______

Görüşmenin yapıldığı tarih: ______/____/______

Araç giriş çıkış bilgilerine ait tarih: ______/____/______

Araç giriş çıkış bilgilerine ait Gün: 1 Pzt 2 Salı 3 Çarş. 4 Perş. 5 Cuma 6 Cmt 7 Paz.

Aşağıdaki Tablodaki Araç Türlerini Firmanıza Giriş Saatlere Göre Doldurunuz.

ARAÇ TÜRÜ	06:01-10:00	10:01-12:00	12:01-16:00	16:01-18:00	18:01-06:00
Özel Oto - Ticari Taksi Sayısı					
Araçtaki Kişi Sayısı					
Tır					
Araçtaki Kişi Sayısı					
Kamyon					
Araçtaki Kişi Sayısı					
Kamyonet					
Araçtaki Kişi Sayısı					
Otobüs					
Araçtaki Kişi Sayısı					
Minibüs / Midibüs					
Araçtaki Kişi Sayısı					
Motosiklet					
Araçtaki Kişi Sayısı					
Diğer (Ambulans /İtfaiye / Polis Aracı vs)					
Araçtaki Kişi Sayısı					
Hayvan gücü ile kullanılan araçlar (At arabası vs)					
Araçtaki Kişi Sayısı					
Yaya/Bisiklet					

Aşağıdaki Tablodaki Araç Türlerini Firmanızdan <u>Çıkış Saatlerine</u> Göre Doldurunuz.

ARAÇ TÜRÜ	06:01-10:00	10:01-12:00	12:01-16:00	16:01-18:00	18:01-06:00
Özel Oto - Ticari Taksi Sayısı					
Araçtaki Kişi Sayısı					
Tır					
Araçtaki Kişi Sayısı					
Kamyon					
Araçtaki Kişi Sayısı					
Kamyonet					
Araçtaki Kişi Sayısı					
Otobüs					
Araçtaki Kişi Sayısı					
Minibüs / Midibüs					
Araçtaki Kişi Sayısı					
Motosiklet					
Araçtaki Kişi Sayısı					
Diğer (Ambulans /İtfaiye / Polis Aracı vs)					
Araçtaki Kişi Sayısı					
Hayvan gücü ile kullanılan araçlar (At arabası vs)					
Araçtaki Kişi Sayısı					
Yaya/Bisiklet					

Trafik Araç Sayım Formu			Sayfa No:____	Toplam Sayfa:_____
ODAK ADI/KODU	☐☐☐☐	ODAK TÜRÜ	Sayım Yapan Adı - Soyadı:	SAYIM YAPAN KODU: ☐☐☐
TOPLAM KAPI SAYISI:		SAYIM YAPILAN KAPI ADI/NO:		
Ekip Başkanı Kodu:		KENTSEL ALAN KODU: ☐	TARİH:___/___/2008	GİRİŞ / ÇIKIŞ
		YOĞUNLUK KODU: ☐		

Sıra No	Saati	YAYA / BİSİKLET	ÖZEL OTO / TİCARİ ARAÇ	TIR	KAMYON	KAMYONET	OTOBÜS	MİNİBÜS / MİDİBÜS	MOTORSİKLET	DİĞER (Ambulans/İtfaiye/Polis Aracı, Hayvan Gücü İle Kullanılan Araç vs)	Araçtaki Tahmini Kişi Sayısı	GİRİŞ	ÇIKIŞ
1		1	2	3	4	5	6	7	8	9		1	2
2		1	2	3	4	5	6	7	8	9		1	2
3		1	2	3	4	5	6	7	8	9		1	2
4		1	2	3	4	5	6	7	8	9		1	2
5		1	2	3	4	5	6	7	8	9		1	2
6		1	2	3	4	5	6	7	8	9		1	2
7		1	2	3	4	5	6	7	8	9		1	2
8		1	2	3	4	5	6	7	8	9		1	2
9		1	2	3	4	5	6	7	8	9		1	2
10		1	2	3	4	5	6	7	8	9		1	2
11		1	2	3	4	5	6	7	8	9		1	2
12		1	2	3	4	5	6	7	8	9		1	2
13		1	2	3	4	5	6	7	8	9		1	2
14		1	2	3	4	5	6	7	8	9		1	2
15		1	2	3	4	5	6	7	8	9		1	2
16		1	2	3	4	5	6	7	8	9		1	2
17		1	2	3	4	5	6	7	8	9		1	2
18		1	2	3	4	5	6	7	8	9		1	2
19		1	2	3	4	5	6	7	8	9		1	2
20		1	2	3	4	5	6	7	8	9		1	2
21		1	2	3	4	5	6	7	8	9		1	2
22		1	2	3	4	5	6	7	8	9		1	2
23		1	2	3	4	5	6	7	8	9		1	2
24		1	2	3	4	5	6	7	8	9		1	2
25		1	2	3	4	5	6	7	8	9		1	2
26		1	2	3	4	5	6	7	8	9		1	2
27		1	2	3	4	5	6	7	8	9		1	2
28		1	2	3	4	5	6	7	8	9		1	2
29		1	2	3	4	5	6	7	8	9		1	2
30		1	2	3	4	5	6	7	8	9		1	2
31		1	2	3	4	5	6	7	8	9		1	2
32		1	2	3	4	5	6	7	8	9		1	2
33		1	2	3	4	5	6	7	8	9		1	2
34		1	2	3	4	5	6	7	8	9		1	2
35		1	2	3	4	5	6	7	8	9		1	2

Yaya; Özel oto; Ticari taksi ; Normal otobüs-oturan yolcu kapasitesi: 29-36 toplam yolcu kapasitesi:79-114 ; Körüklü otobüs-oturan yolcu kapasitesi: 37-49 toplam yolcu kapasitesi 107-199; Çift katlı otobüs-oturan yolcu kapasitesi: 62; Minibüs oturan yolcu kapasitesi: 14-toplam yolcu kapasitesi: 24; Dolmuş oturan yolcu kapasitesi: 8; Otobüs oturan yolcu kapasitesi: 45; Midibüs oturan yolcu kapasitesi: 31; Minibüs oturan yolcu [illegible]

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