FREIGHT TRIP GENERATION IN URBAN AREAS

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To my family

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ABSTRACT

FREIGHT TRIP GENERATION IN URBAN AREAS

Freight transportation planning and modeling in general, and Freight Trip Generation (FTG) in particular, is an area that is not covered as widely as passenger transportation. FTG mechanisms are different from passenger trip generation mechanisms, and they are driven by logistical decisions of establishments. So, the main goal of this research was to improve the understanding of FTG mechanisms and modeling in urban areas. The data for the study was obtained from Kocaeli Logistics Master Plan. Kocaeli is one of the largest industrial cities in Turkey with a population of 1,676,202 as of 2013 and has approximately 2200 industrial establishments. A preliminary factor analysis showed that FTG of TIRs is different from trucks and vans; with the latter two types are similar to each other. It was followed by segmentation of the similar logistical site types according to their FTG characteristics for each vehicle set using Analysis of Covariance (ANCOVA) and its associated post hoc tests. Then, regression models were built for the whole segment (called the pooled model) and for each logistical site included in the segment separately, and statistical tests were performed to test the null hypothesis that the segmentation does not improve the fit, thus the pooled model is sufficient. This procedure was named "market segmentation analysis". These analyses showed that the pooled model was sufficient for almost all the segments except one segment of truck and van trips. Following this, the segments with most zero-trip generators were modeled using a new approach which is called "conditional model" and compared with simple regression models of the segments. The results indicated that firstly, it was possible to group the similar logistical site types in terms of FTG patterns. Secondly, for TIR trips, the proposed "conditional model" showed an improvement over the common regression modeling approach; with reductions in RMSE and MAE of 29.58% and 23.57%, respectively. Finally, some recommendations were made for future research in this area.

ÖZET

KENTSEL ALANLARDA YÜK ARACI SEYAHATİ ÜRETİMİ

Yük taşımacılığı planlaması ve modellemesi, özellikle de yük aracı seyahati üretimi (YASÜ), yolcu taşımacılığındaki muadillerine göre yeterince incelenmemiştir. YASÜ, yolcu seyahati üretimindekinden farklıdır ve kuruluşlarda alınan lojistik konusundaki kararlardan etkilenir. Dolayısıyla, bu araştırmanın esas amacı YASÜ modellerini geliştirmek olmuştur. Yapılan bu çalışmada kullanılan veriler, Kocaeli Lojistik Master Planı'nda toplanan verilerdendir. Kocaeli, 2013 itibarı ile 1,676,202'lik nüfusuyla ve barındırdığı yaklaşık 2200 işletmeyle Türkiye'nin en önemli sanayi şehirlerinden birisidir. İlk olarak yapılan faktör analizine göre römorklu yük araçlarının (TIR) YASÜ'sü, kamyon ve kamyonetlerinkine göre farklı olarak bulundu. Kamyon ve kamyonetlerin YASÜ'lerinin ise benzer oldukları saptandı. Daha sonra bu araç grupları için, benzer YASÜ gösteren lojistik odak türleri Kovaryans Analizi ve ilgili post hoc testleri ile gruplandı. Ardından, her grubun bütününü ele alan havuz regresyon modelleri ile her gruptaki lojistik odak türleri için ayrı regresyon modelleri hazırlandı. Gruplar için, "pazar segmentasyonu analizi" ile grup içindeki lojistik odakların ayrı şekilde incelenmesinin havuz modellerine göre bir iyileştirme sağlamadığı hipotezi istatistiksel testlerle sınandı. Bu analizler, gruplardan biri hariç her grup için havuz modeli kullanmanın yeterli olduğunu göstermiştir. Daha sonra, içinde yük aracı seyahati üretmeyen işletmelerin en fazla olduğu gruplardaki YASÜ modellemesi için "koşul modeli" adı verilen bir model geliştirildi. Bu model, bu gruplara ait regresyon modelleri ile kıyaslandı. Sonuç olarak, lojistik odak türlerini benzer YASÜ'lere göre gruplandırmanın mümkün olduğu bulundu. Önerilen "koşul modeli", TIR seyahatleri için regresyon modellerine göre ortalama hata kareleri kökünde % 29.58, ortalama mutlak hatada % 23.57 azalma sağladı. Son olarak, gelecekte yapılabilecek çalışmalar için önerilerde bulunuldu.

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LIST OF SYMBOLS

a	Probability of an establishment generating trips
$\hat{a}$	Estimated probability of an establishment generating trips
b	Number of trips generated given that the facility generates trips
$\hat{b}$	Estimated number of trips generated given that the facility generates trips
F	F-statistic value
E	Employment
H	Attribute
H_o	Null hypothesis
i	Establishment index
j	Logistical site type index
K	Total number of groups (or segments)
k	Number of logistical site types
l	Logistical site type index
MS_B	Between-groups means square
MS_{Cov}	Covariate means square
MS_W	Within-groups means square
N	Total number of observations
NG	Number of segments
n	Covariate and independent variable index
P	Probability of the outcome for which the elasticity is to be determined
R^2	Coefficient of determination
S_j	Number of observations in logistical sites j
SS_B	Between-groups sum of squares
SS_W	Within-groups sum of squares
SSR_G	Sum of the residual sum of squares of each segment models
t	t-statistic value

W	Levene test statistic
X_{nij}	nth covariate at ith establishment of logistical site type j
x	Vector of explanatory variables in the binary logit's utility function
x_{ijn}	Independent variable n at ith establishment of jth logistical site type
Y_{ij}	Number of trips at ith establishment of jth logistical site type
$\bar{Y_{j.}}$	Mean number of trips of jth logistical site type
y_{ij}	Observed number of trips generated at ith establishment of jth logistical site type
$\bar{y_{ij}}$	Mean of y_{ij}'s
$\hat{y}_{ij}$	Estimated number of trips generated at ith establishment of jth logistical site type
Z_{jl}	Difference between number of trips and mean number of trips of jth logistical site type
$\bar{Z}_{..}$	Overall mean Z_{jl}'s
$\bar{Z}_{j.}$	Group mean Z_{jl}'s
z	Explanatory variables vector of linear regression model

σ_k^2	Variance of logistical site type k
α	Level of significance
α_j	Effect of logistical site type
β	Parameter matrix
β_0	Intercept
β_i	Model coefficient I
β_n	Model coefficient of independent variable n
ε_i	Error for observation i of the total n observations
ε_{ij}	Error of number of trips at ith establishment of jth logistical site type
φ	Common constant for ANCOVA
$\hat{\nu}$	Vector of estimates in the binary logit's utility function

$\hat{\lambda}$	Vector of coefficient estimates of linear regression model
μ_k	Mean number of trips at logistical site type k
ν	Degrees of freedom
ν_1	First degrees of freedom
ν_2	Second degrees of freedom

LIST OF ACRONYMS/ABBREVIATIONS

ActDummy	Dummy Variable for Activity Types
ANOVA	Analysis of Variance
ANCOVA	Analysis of Covariance
FG	Freight Generation
FTG	Freight Trip Generation
ITE	Institute of Transportation Engineers
KOLMAP	Kocaeli Logistics Master Plan
KUAP	Kocaeli Transportation Master Plan
LSD	Least Significant Differences
MAE	Mean Absolute Error
MW-FC	Mid-west Region Furniture Region
NACE	Classification of Economic Activities in the European Community
NAICS	North American Industry Classification System
NCFRP	National Cooperative Freight Research Program
NYC	New York City
NYC-GS	New York City Grocery Stores
NYS-CR	New York State Capital Region
O-D	Origin-Destination
QRFM II	Quick Response Freight Manual II
RMSE	Root Mean Squared Error
SBI	Standard Company Classification
SIC	Standard Industrial Classification
SLM	Spatial lag model
SR-GS	Seattle Region Grocery Stores
SSR	Residual sum of squares of the pooled model
TIR	Tractor Trailer
TIRDummy	Dummy Variable or TIRs
TSF	Total squared feet

TUIK	Turkish Statistical Institute

1. INTRODUCTION

1.1. Problem Statement

Transportation and logistics planning are essential for every city for understanding the problems caused by people and freight transportation, and for finding proper solutions for these problems. The field of freight transportation is as important as passenger transportation for planning of urban areas and their transportation issues as stated by Lindholm and Behrends (2012). However, generally speaking, this area is not covered or understood as well as the passenger transportation; both policy implementation-wise and research-wise. Thus, more research is needed in freight transportation planning and modeling.

Lindholm and Behrends (2012) stress the importance of considering freight and passenger transportation together in planning. However, many cities failed to find the appropriate planning solutions for freight transportation problems. In order to solve this problem, local authorities should give more priority to obtaining information on freight transportation studies and integrate their planning solutions into passenger transportation.

Chatterjee (2004) reported that this area is more complex than passenger transportation and is mainly driven by economics of the region. Ogden, (1992) stated that most of the freight transportation planning models were analogies of passenger transportation models. However, they had many differences. The main differences were decision-making mechanisms, unit of transport, delivery patterns, demand and demand factors. The decision maker was the passenger itself in passenger transportation but firm in freight transportation. Individuals were the units of transport in passenger transportation, but, for freight transportation, units were shipments, commodity flows, or vehicle trips. Furthermore, many tours were involved in delivery patterns for freight transportation since there were usually multi-destinations per vehicle. Finally, the most important difference was the relationship of independent variables with the dependent variable; trip demand. According to Ogden (1992), the travel demand for passenger transportation could be related to land use and socioeconomic factors at either origin or destination. These land use factors could be population, employment, vehicle ownership, average income of the area for example.

However, Ogden (1992) stated that the same argument could not be valid for freight transportation. The demand for goods which creates freight trips was a complex function of social, technological and economic factors and cannot rely on only land use and socioeconomic factors due to technological improvements over time, such as increases in labor productivity and emerging of faster production or processing of goods in establishments.

Quick Response Freight Manual II (QRFM II), prepared by (Cambridge Systematics, 2007), categorized freight transportation planning into four sub-levels: International, national, regional (state-wide) and urban. Many modes were considered in each category, such as maritime, rail, road and air. However, only trucks were considered for planning the freight transportation in urban areas (Cambridge Systematics, 2007). Since this study is at urban level, truck flows are considered.

In terms of modeling methods, Ogden (1992) categorized freight transportation modeling as commodity-based modeling, which models the goods flows, and truck-based modeling. Both models were adopted from classical four-step planning method for passenger transportation with some changes. Yet he indicated that the freight transportation modeling was not well-established; had a poor theoretical basis, a limited amount of data, and a primitive framework.

Although Ogden (1992) stated that the freight transportation models are adopted from traditional four-step modeling, Cambridge Systematics, (2007) argued that the main question about freight transportation planning methods is the issue of building a relationship with this specific transportation field and the more widely covered passenger transportation planning by questioning if the classical four-step transportation approach; trip generation - trip distribution - modal split - route assignment; can actually be adapted to freight transportation, both for state-wide and urban levels. Differences are observed between the passenger and freight transportation planning even in the trip generation part, which is the main scope of this study.

Hensher and Figliozzi (2007) and Chow *et al.*, (2010), contrary to Cambridge Systematics (2007), stressed the importance of changing from classical four-step planning model in urban areas to more supply-chain and logistics oriented approach due to existence of many decision makers such as agents in freight transportation. Hensher and Figliozzi, (2007) also stated that contrary to state-level or international freight, and like Ogden, (1992) and Slavin (1998) explained, urban freight was predominantly dependent on trucking and characterized by shorter trips and multi-stop tours and models should reflect this fact.

Holguin-Veras *et al.*, (2011) stated that, there were two different concepts in trip generation of freight transportation: Freight Generation (FG) and Freight Trip Generation (FTG). FG is about the generation of the commodities while the latter considers the number of freight trips, i.e. truck flows. Considering this together with what Cambridge, Systematics, (2007) stated about urban-level freight transportation planning and truck flows, FTG seems to be the preferred approach rather than FG, which was also the approach used in this research.

Furthermore, Holguin-Veras, *et al.*, (2013) argued that the FTG models which had been developed so far could not explain the FTG phenomenon well, thus, there is a lack of research in this area.

1.2. Goals and Objectives

The main goal of this research is to improve the understanding, methodology and theoretical background of FTG modeling in the urban context. To achieve this main research goal, following research objectives were aimed at:

(i) To do a further literature review to identify the problems in FTG modeling;

(ii) To identify groups (or segments) of logistical site types which have similar FTG characteristics and test the validity of these groups in terms of FTG models;
(iii) To investigate and select the best statistical technique for FTG modeling;
(iv) To recommend further research if needed in this area.

In 2012, a logistics master plan was completed for Kocaeli, Turkey (Kocaeli Logistics Master Plan-KOLMAP) and integrated into the transportation master plan prepared for Kocaeli (Kocaeli Transportation Master Plan-KUAP). The data collected for that project will be used in performing the tasks listed above. The steps selected for investigating the feasibility of the proposed theoretical framework and the reasons for selecting these particular steps will be explained in Chapter 3.

1.3. Scope

As will be explained in the analysis part of the research, not all of the industry sectors and logistical site types in KOLMAP data were used and some were deleted because their sample sizes were not sufficient for modeling purposes. Information about commodity types transported was not provided for every facility, so commodity types were not considered, but the industrial sector types were collected and thus, they were used in modeling. On the other hand, all vehicle types were investigated in terms of their trip patterns. For the reasons explained in Section 1.1 above, only FTG modeling, which was the recommended approach in urban areas (Holguin-Veras *et al.*, 2011 and Cambridge Systematics, 2007), was considered in this research.

In the next chapter, literature review about FTG is provided. Then, in Chapter 3, the methodology of the study is explained with the relevant theory as well as the proposed framework. It is followed by the preliminary data analysis in Chapter 4 and results of the analysis of the study in Chapter 5. Finally, conclusions and recommendations are provided in Chapter 6.

2. LITERATURE REVIEW

2.1. Freight Transportation and Modeling Approaches

Freight transportation can be defined as the transportation of goods or commodities by commercial establishments, and urban freight transportation is the goods transport in urban areas (Dablanc, 2009 and D'Este, 2000). According to Chatterjee (2004), D'Este (2000) and Holguin-Veras *et al.*, (2012), freight transportation does not have a homogeneous nature and is very complex. It is complex because, many different agents affect the generation of freight, which is mainly driven by the economies.

The agents in freight transportation are shippers, carriers, warehouses, receivers, and end-users. Shippers are the origins of freight and carriers are the companies that transport commodities. Warehouses (or distribution centers) are the places where freight is stored, consolidated or split-up. Receivers are the destination agents of freight and end-consumers are the final destinations. Even though receivers and end-users may sound similar, they are slightly different from each other. The difference between receivers and end-consumers is that, a receiver can be a warehouse or a wholesale trader and thus, can ship the freight they receive to another destination. However, end-user does not ship any freight, thus, only receives freight (Holguin-Veras *et al.*, 2012).

Freight is transported by several modes. These modes can be listed as road, air, water, pipeline and rail. Road is preferred for the transport of goods from/to every accessible destination via land, thus, as D'Este (2000) stated, trucking is the only significant mode of urban freight transportation. In the United States, 75 % of freight is carried by trucking, in terms of shipment tons (Holguin-Veras *et al.*, 2012). Rail is the mode of freight transport for heavy and inexpensive products while air transportation carries light and expensive products. Pipelines are used for fluid products such as petroleum. Intermodal transport mechanisms are also used for transport of many product types. Intermodal freight transport is, as can be inferred from the name, transport of goods using several modes (Bogazici Project Engineering Inc., 2012). In this study, the focus was on road mode since the geographical level was urban.

Comi *et al.*, (2014) divided urban freight models as "push" and "pull" models. These names point out the macrobehavior of the retailer. In pull-type behavior, the retailer goes to take the freight and carries it. On the other hand, in push-type behavior, the retailer and end-consumer have the freight arrived to themselves.

In terms of push models, Ogden (1992) categorized freight transportation modeling as commodity-based modeling, which models the goods flows, and truck-based modeling. Commodity-based models are used for macro levels of geography, such as national of regional levels. On the other hand, truck-based models are suitable for urban-level. Both models were adopted from classical four-step planning method for passenger transportation with some changes. Yet he indicated that the freight transportation modeling was not well-established; had a poor theoretical basis, a limited amount of data, and a primitive framework.

Figure 2.1 shows the classical four-step transportation modeling for passenger transportation (Ortuzar and Willumsen, 2011). First step is the trip generation, in which the number of trips produced and attracted in each zone. Then, in trip distribution, the estimated trips are distributed between origins and destination using mathematical models. Third step is the model split, where the trips are allocated to vehicle types by developing mode choice models. In the final step, the trips are assigned to routes in network (Ortuzar and Willumsen, 2011).

The flowchart of the truck-based models is given in Figure 2.2 (Ogden, 1992). Truck-based models do not have a modal split step, since trucks are the only vehicle type considered. Also, second truck-based model shown in Figure 2.2 has the trip distribution step directly done without trip generation step, because O-D patterns are estimated directly. Figure 2.3 shows the flowchart of the commodity-based models. Commodity-based models are different from truck based models, because they have modal split and vehicle loading steps before trip assignment. In vehicle loading step, commodities are assigned to vehicles. Rest of the first model's framework is similar to that of truck-based models. First, generation of commodity flows are estimated, then those flows are distributed and split to transport modes before the vehicle loading step. Second model in Figure 2.3 shows the direct estimation of O-D flows of commodities, it excludes the commodity generation step and commodity distribution is estimated directly. The second model is done for each mode of transport separately.

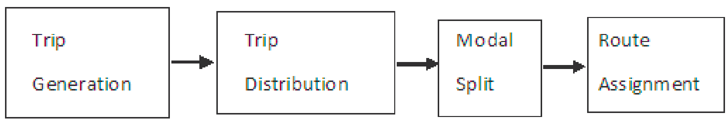


Figure 2.1. Classical Four-Step Transportation Planning Model.

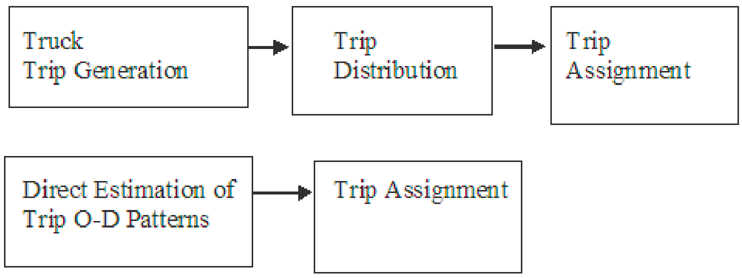


Figure 2.2. Truck-Based Models.

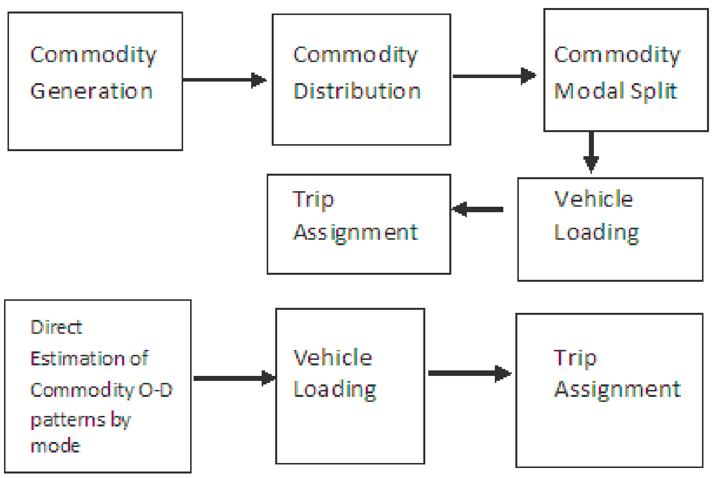


Figure 2.3. Commodity-Based Models.

Comi *et al.*, (2014), Holguin-Veras *et al.*, (2012) and Slavin (1998) stated that the classical models have now tours incorporated, since the freight trips are part of tours, rather than direct trips from origins to destinations. For example, in a network made of one base and five customers, there are five O-D flows (each originating from the base). On the other hand, freight vehicles make a tour and stop at each destination. In the final leg of the tour, the vehicles are empty and they return to the base. It should be also noted that making tours for freight trips reduces the costs. Comi *et al.*, (2014) presented the tour model developed by Hunt and Stefan (2007) as an example. The model was developed for Calgary, and is shown in Figure 2.4. In this model, decisions about each new destination in a tour were assumed to made spontaneously, not beforehand. If the next stop is distant and out of direction, then the decision would be to return to the origin.

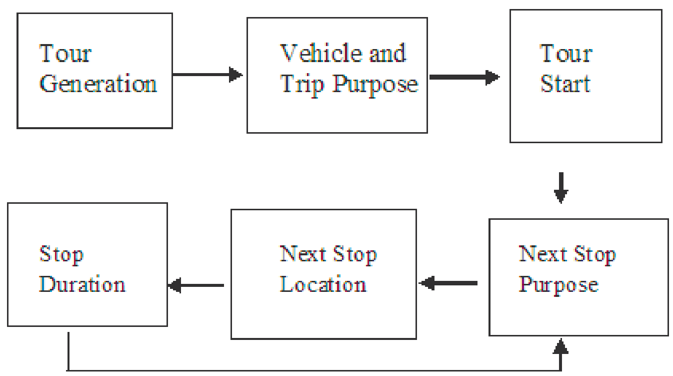


Figure 2.4. Tour Model Development by Hunt and Stefan (2007).

In the model that Slavin (1998) proposed, a trip and tour generation model is the initial step, the destination choice model (where usually a multinomial logit model is used) is the second step, vehicle supply model is the next step which is the determination of vehicle types and the network assignment model is the final step which allows running an assignment model for trucks and cars simultaneously. Thus, it is safe to say that he followed four-step vehicle model with some modifications.

Cambridge Systematics (2007) explained approaches other than commodity and vehicle-based models, which are given in the following:

- Simple Growth Factor Models: These models are applied to estimate the future freight demand using the present freight demand. The method is applied using either the historical freight traffic trends or forecasts of economic activity. This is best suited for the cases where the past relationships of economic activities with freight will be kept constant. However, this method is not recommended for the cases where there would be significant changes in freight activity.

- Hybrid Modeling: This method involves merging the commodity modeling and truck trips for urban areas. Even though commodity-based models are strong in estimated long-distance trips, they usually fail to include trips with short distances and empty trips. In order to account for these missing trips, truck trips in local areas are included using truck-based models. However, accurate conversion between these two types of modeling is critical, which is basically the conversion of commodity flows to truck trips. It should also be noted that this modeling is not multimodal; it only considers trucking as a mode.
- Economic Activity Models: Includes two components; economic/land use model and freight demand model. These two components have an effect on each other, and the effect is handled by an iterative procedure. Development of land uses affects the distribution of freight trips due to locations of new land use areas. It enhances the economic activity in the region, which also increases the freight transportation activities. Also, problems in freight transportation have a negative effect on economic activities. For example, as of 2007, congestion in U.S. has a cost of more than \$ 200 billion/year. These models can be used for multimodal freight transportation planning, unlike hybrid modeling.

Comi *et al.*, (2014) considered the pull models from end-consumer's and retailer's points of view. Models reflecting end-consumer's behavior are usually adaptations of the classical four-step transportation planning framework since they are similar to passenger trips. End-consumers are passengers and the trips they take for freight is shopping trips. However, there are small differences between shopping trips and other passenger trips. These differences are due to the fact that destinations and mode choices are determined according to the characteristics of the purchases, such as the sizes of the goods.

On the other hand, retailer's situation is different from end-consumer's. There are two levels in this modeling framework, and each level contains two steps. First level is the quantity level. In this level, freight flows to each zone are estimated as commodity flows. Then, the locations of the freight to be acquired from are determined using multinomial logit model, which is a discrete choice model. After these two steps, the second level takes place, which is the vehicle-level, where the commodity flows are converted to vehicle trips. This is a complex stage due to existence of tours in trips. In this framework, unlike the tour models in push-behavior, the retailer chooses the stops in tours, and the criterion for selection is the reduction of transport costs. This step can be modeled using touring algorithms. In the final step, paths to be used and time windows for trips are determined. Time windows are important for retailers because time is constrained by regulations to avoid congestion.

In this study, the geographical level of study was urban-level. The focus was on trip generation step of vehicle-based models, which is also called FTG, as mentioned in Chapter 1 and shown with black in Figure 2.2.

2.2. Freight Generation (FG) and Freight Trip Generation (FTG)

Freight transportation planning, modeling in general and FTG in particular, is an area that is not covered as widely as passenger transportation. It is under-researched, usually with limited understanding of the issues involved and limited objectives. For many decades, it has been treated in an inconsistent manner without an overall coordination of all the related activities and modeling parts (Holguin-Veras *et al.*, 2011; Holguin-Veras *et al.*, 2012; Wigan and Southworth, 2006).

One of the differences between freight transportation and passenger transportation is trip generation mechanisms, as mentioned in Chapter 1. The major difference between FTG and passenger trip generation is the trip generators. In passenger trip generation, they are typically the origins of trips whereas for freight trips, they are the receivers such as warehouses, ports or shops, due to economies (Gentile and Vigo, 2013). In addition, passenger trip generation is mainly influenced by income, car ownership, and family structure; while FTG is affected by the performed economic activity, land use type and business size of the establishments (Holguin-Veras *et al.*, 2012).

FG and FTG are two different concepts as already explained in Chapter 1. FG is the generation of goods (or commodities) while FTG deals with the generation of vehicle trips. FG and FTG should be modeled separately. The freight demand governs FG, and FTG is determined by the number of vehicles required to transport, therefore, by FG. In other words, FTG was a result of logistical decisions. Another difference between the two concepts is the proportionality with the business size. An increase in business size may result in a certain increase in generated freight, but this does not necessarily result in the same amount of increase in number of vehicle trips. This situation is due to shipment sizes; a small-sized shipment may be carried by a van while a large shipment may be shipped by a truck. Hence, number of trips may not change although the amount of cargo transported changes (Holguin-Veras *et al.*, 2012).

Another difference between FG and FTG, i.e., commodity flows and vehicle trips, is that commodity flows are represented by origin-destination (O-D) flows while vehicle trips are usually tours (Holguin-Veras *et al.*, 2012; Slavin, 1998).

As stated by Holguin-Veras and Thorson (2003), truck-based modeling, which is FTG modeling, takes into account of empty trips made by trucks. Consideration of empty vehicles is crucial for the urban freight transportation planning and hence for this research. Presence of empty vehicles in models is important because as reported by Holguin-Veras and Patil (2008), empty vehicles made 30 % to 40 % of the total freight traffic in their study.

One of the truck trip categorizations can be named as full truck load (FTL) and less than truck load (LTL) trips. This categorization is important for the trip characteristics. As the names suggest, the truck trip is an FTL trip when the truck is fully loaded and is an LTL trip when the truck is partially loaded. Usually, FTL trips are between the origin and a single destination while LTL trips include a tour. Another categorization is the vehicle type, in sizes. The sizes of vehicles affect the routes they travel. Large trucks usually travel on major routes and avoid narrow streets while vans do not have the physical difficulties of trucks; they can use the whole car network (D'Este, 2000).

Cambridge Systematics (2007) also presented several other truck classifications to be implemented in freight transportation models. One of them is the classification made by Federal Highway Administration (FHWA). There are 13 classes of vehicles, 8 of which are trucks. They are categorized with respect to their number of axles and trailers. Classes are listed in Table 2.1.

Table 2.1. Vehicle Classes Made by FHWA (Cambridge Systematics, 2007).

Class 1	Motorcycles
Class 2	Passenger Cars
Class 3	Other Two-Axle, Four-Tire Single Unit Vehicles
Class 4	Buses
Class 5	Two-Axle, Six-Tire, Single-Unit Trucks
Class 6	Three-Axle Single-Unit Trucks
Class 7	Four-or-More-Axle Single-Unit Trucks
Class 8	Four-or-Fewer-Axle Single-Trailer Trucks
Class 9	Five-Axle Single-Trailer Trucks
Class 10	Six-or-More-Axle Single-Trailer Trucks
Class 11	Five-or-Fewer-Axle Multitrailer Trucks
Class 12	Six-Axle Multitrailer Trucks
Class 13	Seven-or-More-Axle Multitrailer Trucks

Cambridge Systematics (2007) also presented other several truck classifications used in various freight transportation models. All of these models have trucks categorized with respect to their gross vehicle weights, which is equal to sum of the load and weight of empty vehicle. These categories are generally classified as light trucks, medium trucks and heavy trucks; but their weight ranges change from model to model.

Ortuzar and Willumsen (2011) categorized the trip generation concept as production and attraction. In conjunction with this separation, (Holguin-Veras *et al.*, 2014) divided FG and FTG concepts into freight attraction (FA), freight production (FP), freight trip attraction (FTA), and freight trip production (FTP).

2.3. Freight Transportation in Turkey

In Turkey, as of (2010), the logistics potential is \$ 87,000,000,000; which is 12% of the Gross Domestic Product (GDP). Approximately 30-33 % of this potential is used by foreign companies. Between 2002 and 2010, the logistics potential has grown more than three times. Transportation has 39% of the logistics costs in Turkey. The breakdown of costs is shown in Figure 2.1 (Bogazici Project Engineering Income, 2012).

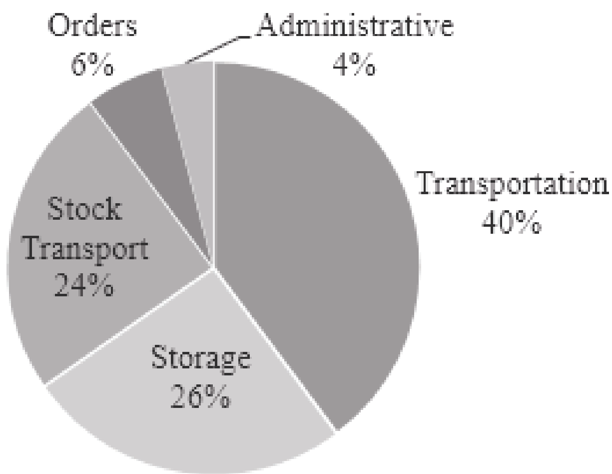


Figure 2.5. Shares of Logistics Costs in Turkey.

Import and export in Turkey are mostly done via sea transport, with 50% share. Road transport has a share of 40%. The remaining 10% is done using rail and air transport; as shown in Figure 2.2. On the other hand, domestic freight transportation is dominated by road transport, with 90% share (Bogazici Project Engineering Income, 2012). It is also known that the freight transported via sea is carried in containers to and from ports. So, tractor trailers (TIR) are used for the transport of containers between ports and destinations on land. Knowing that 50% of import and export are done via sea, and trucking has 90% of domestic freight transport; it is obvious that road transportation for freight is crucial for Turkey.

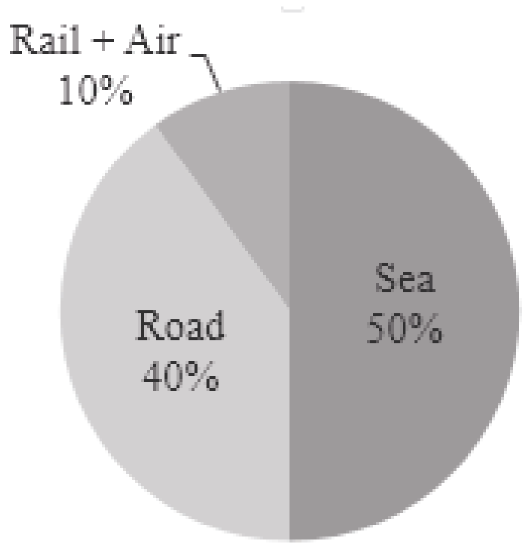


Figure 2.6. Modal Split in Import and Export of Turkey.

2.4. Previous Studies about FTG

As explained in Chapter 1, the study is focused on FTG modeling in urban areas. In this section, information about previous studies is given.

Holguin-Veras *et al.*, (2014) summarized the little amount of FTG modeling schemes developed so far: Trip rates, linear regression, spatial regression, cross - classification method, multiple classification analysis (MCA), and neural networks. Trip rates are the number of trips in a region per an independent variable. They can be per establishment, per area or per employee. Linear regression approach attempts to build a mathematical relationship between the dependent variable (number of trips) and independent variables (Walpole *et al.*, 2012). The so-called “spatial regression” models include locational variables in the model to estimate the locational effects (Sanchez-Diaz *et al.*, 2014). Cross-classification is a non-parametric method and attempts to find the number of trips for cross-categorized variables (University of Idaho, 2003). MCA is about determining the trip rates for multiple independent variables, i.e., it is regression analysis only with dummy variables (UNESCO, 2014). (D’Este, 2000) included economic forecasts and growth factor methods to trip rates and regression models for FTG modeling.

Brogan (1980) investigated the effects of stratification (or disaggregation) on FTG. Truck-based trip generation models were obtained using regression analysis. Three stratification mechanisms were present. The first stratification was in vehicle types, and the author concluded that the vehicle type stratification had not improved the results of non-stratification. However, the other two stratifications had more significant results. Stratification with respect to the trip purpose (service trips and goods-related trips) showed that the independent variables used for each kind of trips can be different, even though there was no significant improvement. On the other hand, trip end stratification, which is related to the land use type of destination, resulted in the most significant improvement. The categories of destination land use were industrial trips and consumer-related trips. The result of trip end stratification showed that there was an improvement over the non-stratified trips.

Fischer and Han, (2001) proposed detailed stratification schemes in land-use categories. The stratification mechanisms were vehicle types, production/attraction rates, land use categories, goods movement vs. non-goods movement, time of day, toured vs. non-toured trips and activity types. Land use categories are such as ports, airport, truck terminals, and warehouses. Production/attraction rates were the fact that the production and attraction of trips from a certain zone or site were different to each other, and they should have been distinguished. Stratification with respect to time of the day was also important since the truck traffic had variations during a given day. The current practice related to the time of day issues was estimating the 24-hour traffic first and then factoring the assignment results with the counts obtained in different time periods. Vehicle types could be classified in terms to their sizes; activity types are such as pick-up and delivery. Movement with respect to load type (goods vs. non-goods) could be explained as some trucks may carry goods while some may be related to services, utilities or be simply empty. The final stratification scheme mentioned was toured vs. non-toured trips. That was as the name sounds, distinguishing whether the trip was a linked trip that made multiple stops or single-destination trip.

Tadi and Balbach, (1994) used a vehicle-type stratification. They determined the trip generation equations for site types such as warehouses and truck terminals at Fontana, California. They classified the vehicle types as passenger cars, two-and-three-axle trucks, and four-five-and-six-axle trucks, and they also modeled all types of trucks as a pooled model. The equations for trip generation were obtained by regression methods. They found that FTG in the morning was more than the afternoon. They also computed the trip rates for land use types and compared them with the ones developed by Institute of Transportation Engineers (ITE). The result of the comparisons indicated that their rates and the rates of ITE are not the same. There were no comments about the regression equations presented, and only a limited assessment was provided by the inclusion of the coefficient of determination (R^2) without performing other statistical tests. Table 2.2 includes the regression models they developed. They reported R^2 values only for some models. They used area of the land use as independent variable, in thousand squared feet (TSF) or acre. It should be noted that the coefficients of the independent variable in models for heavy industrial areas are negative, and FTG at those land uses decreased as the area increased.

Table 2.2. Regression Models Developed by Tadi and Balbach (1994).

Land Use	All Trucks	2, 3 Axle Trucks	4, 5, 6+ Axle Trucks
Warehouse - Light	30.44+0.1785(TSF) R2=0.60	19.02+ 0.0378(TSF)	11.43+ 0.1406(TSF)
Warehouse - Heavy	57.65+ 0.2891(TSF)	19.92 0.0642(TSF)	37.75 0.2249(TSF)
Industrial - Light	13.94+0.1480(TSF) R2=0.98	9.02+ +0.0653(TSF)	3.39 +0.0877(TSF)
Industrial - Heavy	127.30 -1.0900(TSF)	48.30 -0.4350(TSF)	78.00 -0.6520(TSF)
Industrial Park	n.a.[1]	25.80 +0.0480(TSF)	-0.93+0.1600(TSF) R2=0.30
Truck Terminal	-108.00+50.6000(ACRE) R2=0.10	-35.90 +12.3700(ACRE)	-72.00 +38.2000(ACRE)
Truck Sales and Leasing	n.a.	192.20 -3.4200(TSF)	-2.80 +1.89(TSF)

Ben-Akiva and de Jong, (2013), Boerkamps and van Binsbergen, (2000), Chow

[1]Not available.

et al., (2010), Hensher and Figliozzi, (2007), Iding *et al.*, (2002) and Ogden, (1992) pointed out the importance of logistics in FTG in their studies. They stressed that developing models considering these would reveal the behavioral issues at freight transportation. In particular, (Iding *et al.*, 2002) attempted to build a relationship between the FTG and different industrial sectors. According to the authors, there was a dynamic relation between freight transport and economic activities with factors such as company strategies and governmental issues playing a role and freight trips were the results of logistical decisions. They believed that in previous studies, the data had been limited, the sector classification had not been uniform, and the analyses had not contained all branches of industries. The independent variables they used in models were employment and site area occupied by the firm. They built separate regression models for each independent variable and each industry sector. Furthermore, average trip rates were calculated for each industry sector and each site type such as seaports and distribution sites. The authors concluded that the stratification of industry sectors was necessary as there were variations between sectors, furthermore, also between individual firms. They stated that the calculated trip rates could be useful to estimate the trips of a firm for which information about any independent variable was not available. The regression models developed by Iding *et al.*, (2002) for incoming and outgoing directions are given in Table 2.4 and Table 2.4, respectively .

Table 2.3. Models for Incoming Freight Vehicles Built by Idling *et al.*, (2002).

SBI- code		Site area of firm (in m^2)				Number of employees			
		N	R^2	c[1]	b[2]	N	R^2	c	b
15	Food and drinks	45	0.52	3.81	0.07	47	0.28	6.73	0.06
17	Textile	19	0.4	2.4	0.04	19	0.32	2.88	0.04
19	Leather and leather products	16	0	4.39	-0.01	19	0.39	0.45	0.22

[1]Constant.
[2]Coefficient.

Table 2.3. Models for Incoming Freight Vehicles Built by Idling *et al.*, (2002).

SBI- code		Site area of firm (in m2)				Number of employees			
		N	R^2	c^1	b^2	N	R^2	c	b
20	Wood products (excl. furniture)	37	0.68	1.89	0.02	36	0.59	2.46	0.04
22	Printed matter	38	0.03	5.42	0.01	37	0.62	3.53	0.12
24	Chemicals	36	0.71	5.97	0.03	39	0.71	5.39	0.05
25	Products of rubber and synthetics	39	0.32	3.3	0.02	42	0.15	3.67	0.03
26	Glass, pottery etc.	35	0.67	7.19	0.02	38	0.6	6.95	0.06
28	Metal products	66	0.43	4.02	0.04	71	0	6.42	0
29	Machinery	46	0.01	8.43	0.00	46	0.00	8.75	0.00
33	Medical devices and instruments	19	0.00	8.58	0.00	19	0.08	6.38	0.05
34	Cars, trucks, trailers	40	0.32	5.79	0.03	42	0.35	6.53	0.05
36	Furniture and various commodities	24	0.4	3.02	0.02	25	0.32	2.35	0.09
45	Construction	254	0.21	5.76	0.02	264	0.01	6.54	0.01
50	Trading and repair of motor vehicles	78	0.12	3.97	0.06	87	0.09	5.28	0.06
51	Wholesale	241	0.11	6.25	0.02	257	0.03	6.87	0.03
60	Land transport	89	0.15	15.03	0.04	91	0.13	15.98	0.09
63	Services for transport	15	0.88	8.75	0.09	17	0.16	15.14	0.05

Table 2.4. Models for Outgoing Freight Vehicles Built by Idling *et al.*, (2002).

SBI- code		Site area of firm (in m2)				Number of employees			
		N	R^2	c[1]	b[2]	N	R^2	c	b
15	Food and drinks	45	0.24	5.98	0.04	47	0.24	6.67	0.05
17	Textile	20	0.46	3.53	0.01	19	0.7	2.58	0.03
19	Leather and leather products	16	0.00	3.64	0.00	19	0.34	1.25	0.13
20	Wood products (excl. furniture)	36	0.60	1.73	0.02	36	0.39	2.57	0.03
22	Printed matter	38	0.04	5.14	0.02	38	0.73	2.62	0.1
24	Chemicals	36	0.52	5.62	0.02	39	0.43	5.47	0.04
25	Products of rubber and synthetics	40	0.15	354	0.02	42	0.71	0.79	0.13
26	Glass, pottery etc.	37	0.83	5.51	0.04	38	0.68	7.59	0.12
28	Metal products	66	0.41	2.71	0.04	71	0.00	4.83	0
29	Machinery	46	0.02	5.79	0.01	46	0.00	6.45	0.00
33	Medical devices and instruments	19	0.01	4.99	0.00	19	0.14	3.49	0.04
34	Cars, trucks, trailers	40	0.33	2.9	0.03	42	0.4	3.64	0.05
36	Furniture and various commodities	24	0.59	1.68	0.02	25	0.28	1.49	0.08

[1]Constant.

[2]Coefficient.

Table2.4 Models for Outgoing Freight Vehicles Built by Idling *et al.*, (2002).

SBI- code		Site area of firm (in m2)				Number of employees			
		N	R^2	c^1	b^2	N	R^2	c	b
45	Construction	254	0.14	6.29	0.02	264	0.01	6.82	0.01
50	Trading and repair of motor vehicles	77	0.05	3.03	0.03	86	0.15	3.01	0.1
51	Wholesale	240	0.24	4.15	0.08	257	0.02	7.56	0.04
60	Land transport	89	0.35	11.01	0.09	90	0.49	7.89	0.33
63	Services for transport	16	0.72	12.46	0.11	17	0.17	15.45	0.05

DeVries and Dermisi, (2008) investigated the trip generation at regional distribution centers in Chicago area. They found the truck arrivals and departures per employee and per area by time period. Their study concluded that product type and size of the establishment were important and vehicles with empty containers should also have been considered. Furthermore, time of day issues were obvious since some of the distribution activity was done outside of the peak hour traffic. Furthermore, seasonal variations in truck traffic were observed; freight volume increased in summer compared to other periods.

Munuzuri *et al.*, (2011) developed a trip generation model and a trip distribution model for freight transportation and applied it in Seville, Spain. In the trip generation model they developed, the delivery trips were categorized as business-to-business (B2B) trips and home deliveries. Since trip patterns varied from one sector to another, they stratified the trip generation analysis to different sectors.

Ortuzar and Willumsen, (2011) listed the essential explanatory variables of FTG as the number of employees at a firm, the number of sales, and total and roofed areas of the firm. However, they also noted that different products may need different transport mechanisms due to their properties. Thus, different modeling approaches may come up due to differences in products and their transportation.

Holguin-Veras *et al.*, (2011) opposed the idea of using trip generation rates with single independent variables such as employment or gross floor area of the firm. Their reason was that the significance of the variables was not tested, or the functional forms of them were not validated. They discussed that if FTG rates were used, FTG would be underestimated for small businesses and overestimated for large businesses. The authors also argued that small establishments tended to generate more freight trips than large ones did. This is because small firms received a small amount of cargo at one arrival, and that resulted in more freight trips. Therefore, it would not be correct to assume that FTG was proportional to business size even though FG was likely to be proportional, as also explained in Section 2.1. Table 2.5 and Table 2.6 include the FTP and FTA models developed by Holguin-Veras *et al.*, (2011), respectively. They developed the models for various industry types in Standard Industrial Classification (SIC), both for each sub-type and main types. It can be seen that FTP and FTA are constant in some of the industries and increase with employment in others. Mean squared errors (MSE) were also given.

Holguin-Veras *et al.*, (2012) discussed that FTG models that have been developed so far lacked accuracy in explaining the FTG; thus, there was a lack of research in that area. In addition, they argued that the FTG was determined by shipment size, frequency of deliveries and vehicle type. Hence, FTG was a result of the logistical decisions of the establishment since the factors affecting FTG were primarily influenced by logistical decisions. They also stressed that the classification of logistical sites should be standardized. Also, for disaggregate FTG models, aggregations should be conducted carefully since the correct type of aggregation should be chosen. There were three different aggregation procedures for disaggregated models, and those procedures were for FTG rates per employee, constant FTG per company and linear FTG models (combination of both).

[1] Not available.

Table 2.5. FTP Models Developed by Holguin-Veras *et al.*, (2011).

Group	SIC		Trips: Constant	Trips: Employment	Average Trip/est.	Best model
3	All	Construction Industries (15,16,17)				
		n = 10	2.16		2.16	Constant FTG per establishment
		t-statistic	3.965		n.a.[1]	MSE=2.967
	17	Construction - Special Trade Contractors				
		n = 9	2.067		2.067	Constant FTG per establishment
		t-statistic	3.444		n.a.	MSE=3.240
4	All	Manufacturing (21,22,23,24,25,26,27,28,29,30,31,32,33,34,35 36,37,38,39)				
		n = 18	1.611		1.611	Constant FTG per establishment
		t-statistic	5.122		n.a.	MSE=1.781
5	All	Transportation, Communication and Utilities (40,41,42,43,44,45,46,47,48,49)				
		n = 175	2.216	0.072		Variable with intercept and slope
		t-statistic	4.701	4.826		R2=0.12 MSE=21.499
	42	Motor Freight Transportation and Warehousing				
		n = 163	2.151	0.077		Variable with intercept and slope
		t-statistic	4.356	4.668		R2=0.12 MSE=21.263
	47	Transportation Services				
		n = 12	3.917		3.917	Constant FTG per establishment
		t-statistic	2.466		n.a.	MSE=30.265
6	All	Wholesale Trade (50,51)				
		n = 135		0.077		FTG rate per employee
		t-statistic		7.639		R2=0.30 MSE=53.306
	50	Wholesale Trade - Durable Goods				
		n = 70	1.554	0.04		Variable with intercept and slope
		t-statistic	1.852	2.8		R2=0.10 MSE=16.305
	51	Wholesale Trade - Nondurable Goods				
		n = 65		0.089		FTG rate per employee
		t-statistic		4.986		R2=0.28 MSE=91.965
7	All	Retail Trade (52,53,55,56,57,59)				
		n = 10	1.72		1.72	Constant FTG per establishment
		t-statistic	5.306		n.a.	MSE=1.051
8	All	Food (20,54,58)				
		n = 9	1.444		1.444	Constant FTG per establishment
		t-statistic	5.9651		n.a.	MSE=0.528
	20	Food and Kindred Products				
		n = 8	1.5		1.5	Constant FTG per establishment
		t-statistic	5.612		n.a.	MSE=0.571

Table 2.6. FTA Models Developed by Holguin-Veras *et al.*, (2011).

Group	SIC		Deliveries		Average Del./Est.	Best model
			Constant	Employment		
3	All	Construction Industries (15 ,16,17)				
		n = 33	2.467		2.467	Constant FTG per establishment
		t-statistic	10.182		n.a.[1]	MSE=1.937
	15	Building Construction - General Contractors and Operative Builders				
		n = 8				FTG rate per employee
		t-statistic		7.792		R2=0.90 MSE=0.901
	17	Construction - Special Trade Contractors				
		n = 24	2.508		2.508	Constant FTG per establishment
		t-statistic	8.622		n.a.	MSE=2.031
4	All	Manufacturing (21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39)				
		n = 53	3.377		3.377	Constant FTG per establishment
		t-statistic	7.326		n.a.	MSE=11.266
	23	Apparel and Other Finished Products Made From Fabrics and Similar Material				
		n = 9	3.778		3.778	
		t-statistic	8.128		n.a.	MSE=1.944
	24	Lumber and Wood Products, Except Furniture				
		n = 6		0.066		FTG rate per employee
		t-statistic		8.055		R2=0.93 MSE=0.604
	25	Furniture and Fixtures				
		n = 7	1.434	0.027		Variable with intecept and slope
		t-statistic	2.101	1.819		R2=0.40 MSE=1.169
	34	Fabricated Metal Products, Except Machinery and Transportation Equipment				
		n = 8	2.875		2.875	Constant FTG per establishment
		t-statistic	3.752		n.a.	MSE=4.696
	39	Miscellaneous Manufacturing Industries				
		n = 6		0.134		FTG rate per employee
		t-statistic		4.374		R2=0.79 MSE=2.575
6	All	Wholesale Trade (50,51)				
		n = 131	3.071	0.054		Variable with intecept and slope
		t-statistic	5.159	1.937		R2=0.03 MSE=20.233
	50	Wholesale Trade - Durable Goods				
		n= 64	4.931		4.931	Constant FTG per establishment
		t-statistic	6.701		n.a.	MSE=34.663
	51	Wholesale Trade - Nondurable Goods				
		n = 67	1.813	0.074		Variable with intercept and slope
		t-statistic	4.888	4.414		R2=0.23 MSE=4.481
7	All	Retail Trade (52,53,55,56,57,59)				
		n = 83	2.899		2.899	Constant FTG per establishment
		t-statistic	13.766		n.a.	MSE=3.680
	52	Building Materials, Hardware, Garden Supply and Mobile Home Dealers				
		n = 10		0.353		Variable with intercept and slope
		t-statistic		6.887		R2=0.84 MSE=2.853
	56	Apparel and Accessory Stores				
		n = 14	1.314	0.032		Variable with intercept and slope
		t-statistic	3.355	1.675		R2=0.19 MSE=1.107
	57	Home Furniture, Furnishings and Equipment Stores				
		n = 14	3.714		3.714	Constant FTG per establishment
		t-statistic	6.32		n.a.	MSE=4.835
	59	Miscellaneous Retail				
		n = 43	2.902		2.902	Constant FTG per establishment
		t-statistic	10.361		n.a.	MSE=3.374
8	All	Food (20,54,58)				
		n = 84	2.764	0.011		Variable with intercept and slope
		t-statistic	9.315	2.159		R2=0.05 MSE=5.621
	20	Food and Kindred Products				
		n = 7	1.609	0.01		Variable with intercept and slope
		t-statistic	19.851	20.87		R2=0.99 MSE=0.031
	54	Food Stores				
		n = 22	4.155		4.155	Constant FTG per establishment
		t-statistic	5.947		n.a	MSE=10.735
	58	Eating and Drinking Places				
		n = 55	2.017	0.034		Variable with intercept and slope
		t-statistic	5.537	2.666		R2=0.12 MSE=3.549

Regarding the concern about classification of establishments stated by (Holguin-Veras *et al.*, 2012), a study made by Lawson *et al.*, (2012) compared the FTG patterns of two different land use classification types in New York City. To make the comparison, they developed linear regression and multiple classification analysis models. They also compared the models with the trip rates built by ITE. They concluded that the developed models produced better accuracy than the trip rates given by ITE, thus, FTG measures could vary from one classification scheme to another.

Ben-Akiva and de Jong, (2013) pointed out the importance of disaggregation nature of freight transportation planning. The authors stated that the aggregate nature of zonal level planning failed to account for the existence of agents, and they argued that the modeling should have been in agent-level, or in individual firm level. Therefore, the disaggregation could reveal the effects of logistical decisions, i.e. behavioral issues in freight transportation. They developed a model named as "aggregate-disaggregate-aggregate (ADA) model" which connects the production-consumption (P-C) flows; which are the goods flows between zones; firms, shipments and O-D flows to each other. The reason for including an aggregate part is that they believe that some parts of freight transportation were suitable for aggregate planning such as P-C and O-D flows. In the ADA model, the logistic decisions at the firm level reflecting the agent behavior was based on the cost minimization of total logistics costs, like the model proposed by de (Jong and Ben-Akiva, 2007).

The first study explaining FTG using cross-classification analysis was made by Bastida and Holguin-Veras (2009). They investigated the FTA as senders and receivers in New York City metro area using ordinary least squares (OLS) models and cross-classification analysis. They did the modeling for Manhattan and Brooklyn, and for both receivers and carriers. Multiple classification analysis was used for determining the groups of independent variables to construct the cross-classification tables. After the analyses, the statistically significant establishment attributes were found as industry segment, type of commodity, yearly sales and employment in both regression models and cross-classification tables.

Jaller *et al.*, (2014) used a two-step approach for modeling FTP: First, for determining whether the establishment is a pure receiver or an intermediary, they formulated a regression model for estimating the FTP. They did the modeling for each different sector. The first and second parts were modeled with a binary logit model, and with a regression model, respectively. In their binary logit model to determine the intermediaries, they used the employment of the facility, industry sector with each sector as a single dummy variable and interaction terms between industry sector and freight trip attraction. For the regression modeling part, they used the employment of the plant as the explanatory variable. This method produced better estimates for FTP for total trucks, with reduced Root Mean Squared Error (RMSE) values. Also, they compared the relationships between FTP and FTA of various industry sectors in Manhattan, using North American Industry Classification System (NAICS). They found that FTP and FTA rates in deliveries per day of each industry might not be the same.

Holguin-Veras *et al.*, (2013) identified certain premises that are considered to be essential for FTG. The first and perhaps the most important of these arguments is the need to make a distinction between FG and FTG, as explained in Section 2.1. The second important premise given in that study was that the accuracy of the FG/FTG models depended very much on:

(i) the adequacy of the classification system used to group commercial establishments in a set of standardized classes;
(ii) the ability of the measure of business size used to capture the intensity of FG/FTG;
(iii) the validity of the statistical technique used to estimate the model; and,
(vi) the correctness of the aggregation procedure used to estimate aggregate values (if required).

(Holguin-Veras *et al.*, 2013, p. 4-5)

Kulpa (2014) compared trip generation rates, multiple regression and artificial neural networks for modeling FTG in Krakow and Poznan, Poland. He found the FTG rates for light and heavy trucks and divided the commune type into urban and rural for multiple regression, in addition to truck type as light and heavy. He developed four types of neural network models. Models were validated by two sets of communes using traffic measurements from Krakow. He concluded that neural network approach produced around 30% in the first set and better results than multiple regression and trip generation rates. However, the same approach produced more than 100% errors in the second set. Errors for multiple regression and trip generation rates were more reasonable than of artificial neural networks, around 50%. Hence, neural network approach does not guarantee better results for all cases. Regression models built by Kulpa (2014) are given in Table 2.4. R^2 values were high, none of them were below 0.85. In addition, it was assumed that trip production was equal to attraction (P=A). However, model validation indicated high percentage of errors, and they are reported in Table 2.5 .

Table 2.7. Regression Models Built by Kulpa (2014).

Commune type	Truck type	Equation	R^2	Sample size
All	Light	P=A=0.077LM[1] + 0.303LPU[2]	0.93	50
	Heavy	P=A=0.102LPP[3] + 0.406LPU	0.86	
Urban-rural	Light	P=A=0.185LPP + 0.877LPU	0.91	21
	Heavy	P=A=0.085LPP + 0.367LPU	0.85	
Rural	Light	P=A=0.090LM + 0.416LPU	0.93	29
	Heavy	P=A=0.011LM + 0.612LPU	0.93	

Table 2.8. Errors of Regression Models by Kulpa (2014).

Model	Average absolute error Set A	Average absolute error Set B
All commune types	53%	75%
Division into commune types	41%	107%

A further concern about FTG is the transferability of the models. However, literature review regarding FTG transferability revealed that the only study in this area was done by Holguin-Veras *et al.*, (2013). The authors compared the FTG models de-

[1]Number of inhabitants.
[2]Employment in services.
[3]Employment in industry.

veloped in National Cooperative Freight Research Program Report No. (NCFRP) 25, QRFM II, and ITE Trip Generation Manual using five external datasets in the United States. The datasets were NYC (New York City), NYS-CR (New York State Capital Region), NYC-GS (New York City Grocery Stores) MW-FC (Mid-west Furniture Chain), and SR-GS (Seattle Region Grocery Stores) data. They used land use types from different land use classification. The classifications were North American Industry Classification System (NAICS), SIC, ITE and Land Based Classification Standards (LBCS). Two types of assessment for transferability were used. The first one was the application of existing models to data sets and the other one was the economic assessment. Economic assessment was the development trip generation models using pooled FTG data using binary variables and validating the models using statistical tests. The independent variable for models was employment of the facilities. First assessment method revealed that models from NCFRP 25 had lower RMSE values. However, it should also be noted that only 4 models from ITE were available for comparison. Thus, lack of ITE models may result in unreliable comparisons. The models are given in Table 2.6.

For the economic assessment, two different studies were made. First one compared the FTA in furniture industry in Mid-west and Northeastern states in U.S. Dummy variables were used to group the states geographically for modeling. The data was pooled to build models. Using these dummy variables and employment of the facility as independent variable, models were developed. Obtained model was as follows:

$$FTA = 1.10 + 0.90(c) + 0.04(E \cdot mic) \tag{2.1}$$

where c is a dummy variable and equal to 1 if the store sells both regular and children furniture, E is the number of employees and mic is another dummy variable which is equal to 1 if the store is in Michigan. The presence of mic indicates that the FTA was not transferable to everywhere, FTA was different in Michigan (Holguin-Veras *et al.*, 2013).

Second study constituted NYC, NYC-GS and SR-GS data as a pooled data. Using the same modeling approach in first study, the following FTA model was developed:

$$FTA = 4.74 + 0.09(E) \tag{2.2}$$

No presence of any geographical dummy variable indicated that the FTA model for grocery stores was transferable between NYC and Seattle.

Results of the econometric assessment indicated that FTG models could be transferable up to a certain extent. However, the assessment for other industries should be carried out as well since the datasets included a limited amount of sectors. Another result was that the FTG rates in the literature could be corrected synthetically to improve the usage by converting the constant FTG rate into a regression equation. To do this, one needs to obtain the mean values of dependent and independent variables though.

Sanchez-Diaz *et al.*, (2014) investigated spatial effects on FTA of 5 sectors in New York City. They compared spatial econometric models to OLS models to assess the spatial effects. For spatial models, they constructed the spatial effect matrix using the Euclidian distance between locations and then built the spatial lag variable for the independent variable; which was the employment. Adding the spatial lag variable to regression model resulted in a spatial lag model (SLM). They concluded that FTA of all sectors was modeled better with non-linear functions. Furthermore, FTA of retailers, one of the sectors considered in the study, is significantly affected by locational variables, thus, explained better by SLM models. R2 values of SLM models were around 0.77, and it was 0.11 for the OLS model for the retail sector.

This research first aimed to address the stratification topic by grouping the logistical sites having similar FTG characteristics. Second, the study focused on proposing and validating a new modeling technique for FTG. Investigation of the validity of statistical techniques was labeled as a weakness by Holguin-Veras *et al.*, (2013).

Table 2.9. Comparison of NCRFP 25, QRFM II and ITE Models for Transferability, by Holguin-Veras *et al.*, (2013).

		Validation Data			Model Applied					
					NCFRP 25		QRFM		ITE	
Classification	Description	Sample Size	Mean Employment	Dataset	Model	RMSE	Model	RMSE	Model	RMSE
NAICS 72	Accommodation/ Food	5	5.8	NYS-CR	1.307+ 0.081(E)	1.26	1.206(E1)	6.51	n.a.2	n.a.
ITE 816	Hardware/ Paint Stores	8	10	NYC	0.369(E)	1.67	1.206(E)	1.99	53.21(E)	2.04
LBCS	Activity Restaurants	5	5.8	NYS-CR	2.488	1.93	1.206(E)	6.51	n.a.	n.a.
ITE 890	Furniture Stores	12	10	NYC	3.769	2.22	1.206(E)	4.58	12.19(E)	3.39
LBCS	Function Retail	13	8.9	NYS-CR	3.682	2.55	1.206(E)	22.46	n.a.	n.a.
ITE 890	Furniture Stores	58	8.9	MW-FC	3.769	3.42	1.206(E)	5.6	12.19(E)	1.25
ITE 860	Wholesale Markets	102	17.2	NYC	2.272+ 0.07 E	3.66	1.206(E)	12.23	8.21(E)	11.66
SIC 56	Apparel/ Accessory	10	10.2	NYS-CR	1.889+ 0.19 E	4.05	1.206(E)	23.25	n.a.	n.a.
NAICS 44	Grocery Stores	7	15.3	SR-GS	2.458+ 0.08 E	4.1	1.206(E)	32.06	n.a.	n.a.
SIC 58	Eating/ Drinking Places	5	5.8	NYS-CR	4.307+ 0.08 E	4.14	1.206(E)	6.51	n.a.	n.a.
SIC 52	Building Materials Stores	6	18.8	NYS-CR	5.26	4.42	1.206(E)	36.14	n.a.	n.a.
LBCS	Activity Goods	21	13	NYS-CR	2.588+ 0.07 E	4.56	1.206(E)	23.81	n.a.	n.a.
SIC 54	Food Stores	8	19.5	NYS-CR	3+ 0.29 E	5.09	1.206(E)	26.04	n.a.	n.a.
NAICS 44	Grocery Stores	30	78	NYC-GS	2.458+ 0.08 E	7.08	1.206(E)	41.73	n.a.	n.a.
NAICS 44	Retail Trade	21	55	NYS-CR	3.451+ 0.15 E	8.02	1.206(E)	23.42	n.a.	n.a.
LBCS	Function Grocery	8	19.5	NYS-CR	0.217(E)	13.89	1.206(E)	26.04	n.a.	n.a.

3. METHODOLOGY

The methodology followed in this thesis is summarized in the flow chart given in Figure 3.1. In summary, first, a preliminary analysis of the Kocaeli Logistic Master Plan (KOLMAP) data which consists of two parts, namely the driver data which includes interviews made with drivers and the generic data which includes the data obtained from establishments was conducted. This was followed by a factor analysis, which explored the correlational structure of dependent variables and independent variables and groups the correlated variables. Then, for each dependent variable (vehicle type) set constructed by factor analysis, ANCOVA analyses were performed using their FTGs. ANCOVA analysis and the post-hoc comparison tests for comparing the logistical sites in terms of their trip generation characteristics were used to group logistical sites into homogeneous groups in terms of their trip generation characteristics. After forming the groups with the ANCOVA analyses, these groups were further tested using market segmentation analysis for their validity. For market segmentation analysis first, FTG regression models were developed both for logistical site groups (the pooled model), and for each of the logistical sites contained in each group. Then using the developed regression models, the associated statistical tests of market segmentation analysis were employed to understand if grouping (or segmentation) of the logistical site types could be validated, i.e., the pooled model could represent the whole group. If the grouping is valid, then one can say that segments or the groups of the logistical sites are acceptable. If the grouping turns out to be invalid, then revisions should be made for groups in question. Finally, to improve the modeling of the FTG, a new conditional model which combines binary logit (Ben-Akiva and Lerman, 1985) and linear regression to explain the FTG was proposed for the groups containing a high amount of zero trips in some freight trip vehicle categories. The proposed modeling approach was compared with the models built using only linear regression to understand if it had resulted in an improvement. This comparison was made by calculating the root mean square error (RMSE) and mean absolute error (MAE) of the two models used in these two approaches. Details of the theoretical approach, the methodology and the statistical tests used for each part are explained in the sections of this chapter.

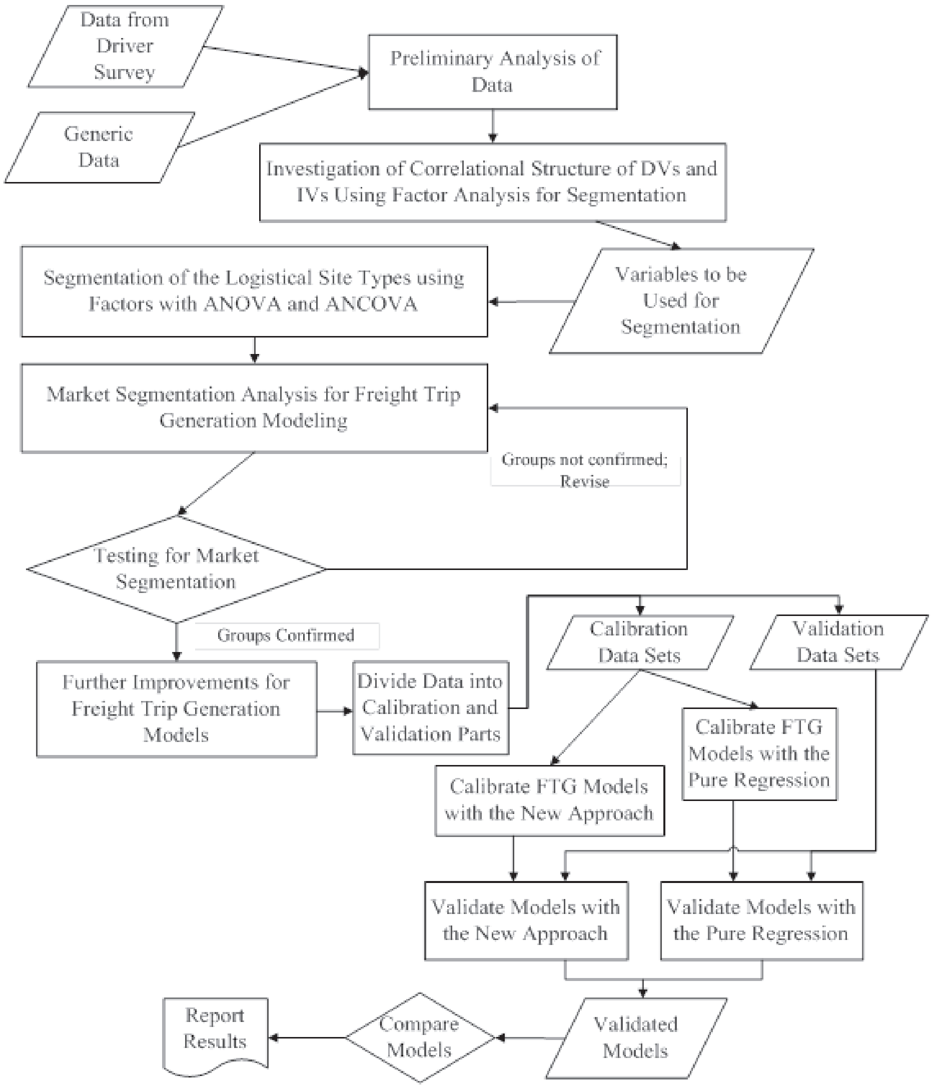


Figure 3.1. Flowchart for the Research Methodology.

3.1. Data Collection and Preliminary Analysis

The data which were obtained from surveys performed for the preparation of KOLMAP (Bogazici Project Engineering Inc. 2012) was investigated, and results were presented as “preliminary analysis” in Chapter 4. The data of subject is composed of generic data and driver data. The “generic” data includes information from site administrations of ports, logistics companies, industrial firms and other firms; while the data obtained from interviews with drivers at various sites were included in the "driver" data. The analyses included the descriptive statistics of the logistical sites, vehicle types and commodity types carried by vehicles. Furthermore, correlations and distributions of dependent and independent variables were also investigated in this part.

3.2. Factor Analysis on Dependent and Independent Variables

Data has several dependent and independent variables; thus, a factor analysis was necessary to reduce the number of variables by grouping them with respect to their correlational structure (Stopher and Meyburg, 1979). However, in order to conduct factor analysis, first, one needs to test the correlation of the variables using Bartlett's test of sphericity. If there is no correlation among the variables used, then there is no need to run a factor analysis. In the test, the null hypothesis is "The correlation matrix is an identity matrix", and hence it cannot be used for conducting a factor analysis. If the correlation matrix is the identity matrix, it means that the number of factors will be equal to the number of variables should a factor analysis is made. The test statistic has a chi-squared distribution.

If the test permits the factor analysis, which shows that there are correlated variables in the analysis, then first, factor extraction is made. Method used for this step was "principal component analysis". Number of the factors was determined by investigating the eigenvalues associated with each factor in SPSS output "Total Variance Explained". When the eigenvalue becomes smaller than 1, it means that each of the factors with eigenvalues lower than 1 explains less than one variable hence there is no point for going for such factors. An SPSS (Nie *et al.*,1975) option which extracts factors with eigenvalues greater than 1 was used in the analysis.

Following extraction, the factor components are rotated using "Varimax" rotation, which is an orthogonal rotation method and it aims to maximize the variance of the loadings (Abdi 2003) as well as making the interpretation of the factors easier. It should also be said that double loadings in factor components is not desirable. Finally, SPSS also produces the factor scores as an output using the factor loadings and values of the variable for each unit of analysis (i.e. logistical sites).

3.3. Segmentation of Logistical Site Types Using Analysis of Covariance (ANCOVA)

It is aimed to determine the logistical site types which are similar to each other in terms of freight trips they generated. To achieve that goal, logistical site types can be grouped using ANOVA, ANCOVA or cluster analysis. However, the initial trials with cluster analysis resulted with establishments of a specific logistical site type separated into different groups and hence, it was decided to use ANOVA or ANCOVA for the determination of logistical site groupings.

In ANOVA, only the factors (categorical independent variables) explain the variances between dependent variable estimates. On the other hand, in ANCOVA, covariates (continuous independent variables) are also used for explaining the variance in the dependent variable as well. Consequently, due to the presence of covariates, one obtains the errors of the ANCOVA model reduced compared to a model built using ANOVA. Thus, ANCOVA was the choice for the grouping of logistical sites. Formulation for ANCOVA, modified from Rutherford (2001), can be written as follows:

$$Y_{ij} = \varphi + \alpha_j + \beta_1 X_{1ij} + \beta_2 X_{2ij} + ... + \beta_n X_{nij} + \varepsilon_{ij} \tag{3.1}$$

where Y_{ij} is the number of trips at ith establishment of jth logistical site type, φ is the common constant, α_j is the effect of the treatment which is the logistical site type effect, β_n is the coefficient of the nth covariate, X_{nij} is the nth covariate at ith establishment of logistical site type j and ε_{ij} is the associated error. The candidate covariates are employment, total area and actively used area of the businesses.

Before constructing the groups in ANCOVA, the equality of variances should be checked using the Levene's test. The null hypothesis in the Levene's test is "Variances among the factor groups are equal to each other". The null hypothesis is rejected when at least two of the variances are not equal to each other. If the hypothesis is rejected, then the corresponding ANCOVA is said to be not robust and it is said that "At least two variances are not equal to each other". The null hypothesis for the Levene's test is given in the following (National Institute of Standards and Technology 2013):

$$H_0 : \sigma_1^2 = \sigma_2^2 = ... = \sigma_k^2 \tag{3.2}$$

The test formulation for the Levene statistic is given in Equation 3.4:

$$W = \frac{(N-k)}{(k-1)} \frac{\sum\limits_{l=1}^{k} N_j (\bar{Z}_{l.} - \bar{Z}_{..})^2}{\sum\limits_{j=1}^{k} \sum\limits_{l=1}^{N_j} (Z_{jl} - \bar{Z}_{j.})^2} \tag{3.3}$$

where j and l are the logistical site type indices, W is the test statistic, N is the total number of observations in data, k is the number of logistical site types and Z_{jl} is defined as:

$$Z_{jl} = \left| Y_{jl} - \bar{Y}_{j.} \right| \tag{3.4}$$

where $\bar{Y}_{j.}$ is the mean of jth logistical site type, $\bar{Z}_{j.}$ is the group mean of Z_{jl}'s and $\bar{Z}_{..}$ is the overall mean of Z_{jl}'s.

Levene's test statistic has an F distribution with $k - l$ and $N - k$ degrees of freedom and α level of significance. If the calculated W statistic is greater than the tabular F-value, then the null hypothesis is rejected.

If the Levene's test does not conclude with the rejection of the null hypothesis, then it can be continued with ANCOVA. ANCOVA tests for the equality of the means of dependent variables. Means are adjusted to the covariate, and the null hypothesis for ANCOVA testing is given mathematically as the following:

$$H_0 : \mu_1 = \mu_2 = ... = \mu_k \tag{3.5}$$

The null hypothesis for ANCOVA is rejected when at least two of the means are not equal to each other. The test to check is the F test which is given as (Horn 2008):

$$F = \frac{\text{Between} \quad - \quad \text{Groups Means Square}}{\text{Within} \quad - \quad \text{Groups Means Square}} = \frac{MS_B}{MS_W} \tag{3.6}$$

where $MS_B = SS_B/(K-1)$ with SS_B being between-groups sum of squares and K being number of groups. $MS_W = SS_W/(N-K-1)$ with SS_W being within-groups sum of squares and N being the number of observations. $(K-1)$ and $(N-K-1)$ are the degrees of freedom for MS_B and MS_W, respectively.

To test the null hypothesis that the model coefficients for covariates are equal to zero F-statistic can be used which can be calculated as follows:

$$F = \frac{\text{Covariate Means Square}}{\text{Within} \quad - \quad \text{Groups Means Square}} = \frac{MS_{Cov}}{MS_W} \tag{3.7}$$

where $MS_{Cov} = SS_{Cov}/1 = SS_{Cov}$ with SS_{COV} being the covariate sum of squares. MS_{COV} has a degrees of freedom equal to 1. The test statistic in Equation 3.5 is F distributed with $K-1$ and $N-K-1$ degrees of freedom while the statistic in Equation 3.6 is again F distributed with 1 and $N-K-1$ degrees of freedom; both with significance level of α.

If the F test for equality of means in ANCOVA is rejected, it means that at least two of the means are not equal to each other. Then, pairwise comparisons for logistical site groups are made using Fisher's least significant differences (LSD) test to construct the logistical site groups. The groups should be homogeneous in terms of estimated vehicle trips. The test statistic follows the student's t-distribution with N-k degrees of freedom. The null hypothesis for LSD test is "Two estimated means are equal to each other", and expressed as follows:

$$H_0 : \mu_j = \mu_l \tag{3.8}$$

where j and l are the logistical site type indices.

The null hypothesis for LSD test is rejected if the following inequality holds true, and the two site type in question will not be placed in the same group (Williams and Abdi 2010):

$$|\mu_j - \mu_l| > LSD = t_{\alpha,\upsilon}\sqrt{MS_W(\frac{1}{S_j} + \frac{1}{S_l})} \tag{3.9}$$

where α is the level of significance, ν is the degrees of freedom, and S_j and S_l are the number of observations in logistical sites j and l, respectively.

Once the groups are formed, validity of the groups was checked again. This is done by ANCOVA again, with the same covariates to determine the groups and group type as the factor. The null hypothesis in ANCOVA test stating the equality of groups should be rejected; since all groups should be different from each other in terms of generated trips. Still, rejection of that hypothesis does not guarantee validation; no similar groups should be observed in LSD test for pairwise comparisons as well. It should also be noted that the Levene's test is conducted again to check the equality of variances for the validation part.

3.4. Regression Models and Market Segmentation Analysis for FTG

In explaining FTG, as explained in Chapter 2, many methods have been used such as FTG rates, ordinary regression models, time series, input-output models, spatial regression models, cross-classification models, multiple classification analysis and neural network models. In this study, the focus is on ordinary regression models as they are the most common practice used in FTG modeling and future demand can be forecasted using these models (Holguin-Veras *et al.*, 2014).

Following the segmentation of logistical sites with ANCOVA, linear regression models are built for each group and each logistical site type (segment). This analysis had two main goals. First of all, through the tests that will be used for the market segment models, the usefulness of the market segmentation for FTG models would be investigated; i.e. that the null hypothesis that the pooled model that is built for the group as a whole is not different from the models built for the members of the group will be tested. Through this test, the fulfillment of the second goal of this effort, which is to check another measure of validity of the grouping that were identified with ANCOVA analysis reported will be tested (the first measure of validity is explained in Section 5.2.3). If the null hypothesis that is tested with the market segmentation is not rejected, this will mean that the groups are homogeneous in terms of their trip generation characteristics. Of course, investigation of this second goal in particular has many practical implications. For instance, if the identified groups are homogeneous, then it will not be necessary to have separate models for each logistical site, and furthermore in future logistical studies, sampling could be made for the groups rather than the individual logistical sites and hence, the sample sizes could be reduced. On the other hand, if the market segmentation test concludes that using the pooled model is inappropriate, then the group should be revised and segment models for each site types in the group should be used.

In linear regression modeling, both for pooled model and segment models, the relationship with dependent and independent variables can be explained as the following (Walpole *et al.*, 2012):

$$\hat{y}_{ij} = \beta_0 + \beta_1 x_{ij1} + \ldots + \beta_n x_{ijn} \tag{3.10}$$

$$y_{ij} = \hat{y}_{ij} + \varepsilon_{ij} \tag{3.11}$$

where y_{ij} and $\hat{y}_{ij}$ are the observed and estimated numbers of freight trips generated at establishment i of logistical site type j, ε_{ij} is the associated error, β_o is the intercept, β_n is the model coefficient of independent variable x_{ijn} and n is the independent variable index.

For each group, regression models having the best fit for the pooled model is chosen and following that, the models for segments are built using the same independent variables of the best pooled model for market segmentation testing.

The validity and goodness of fit of the regression equations can be measured by several statistical measures as well as with the coefficient of determination (R^2). First of all, R^2 indicates how much of the observed data is explained by the built regression model. It takes values between 0 and 1, and is expressed by (Walpole *et al.*, 2012):

$$R^2 = 1 - \frac{\text{Error Sum of Squares}}{\text{Total Sum of Squares}} = 1 - \frac{\sum_{i=1}^{m} (y_{ij} - \hat{y}_{ij})^2}{\sum_{i=1}^{m} (y_{ij} - \bar{y}_{ij})^2} \tag{3.12}$$

where m is the number of establishments for logistical site type j and $\hat{y}_{ij}$ is the mean of y_{ij}'s.

R^2 being close to 1 indicates that the model is a good fit. However, not all regression models having an R^2 value close to 1 mean they are good since adding highly correlated independent variables causes an increase in R^2 value and over fitting; one should not use highly correlated independent variables at once in a regression model (Walpole *et al.*, 2012). Also, making inferences only from R^2 value is not sufficient. The F-test for overall model and t-tests for each model coefficient should be made to statistically check the validity of the model obtained.

The F-test tests the null hypothesis of "All regression coefficients are equal to zero"; i.e., there is no relationship between the dependent variable and the independent variables. The null hypothesis is given as the following (Walpole *et al.*, 2012):

$$H_0 : \beta_0 = \beta_1 = ... = \beta_k = 0 \tag{3.13}$$

The F-statistic is calculated as follows (Walpole *et al.*, 2012):

$$F = \frac{R^2/k}{(1 - R^2)/(n - k - 1)} \tag{3.14}$$

where k is the number of independent variables and n is the number of observations. The F-statistic in Equation 3.17 is distributed with the F distribution with s degrees of freedom of k and $(n - k - 1)$.

If the F-test results in rejection of the null hypothesis of "All regression coefficients are equal to zero", it will mean that at least one independent variable has a coefficient that is significantly different from zero. Then, in order to see which coefficients are significantly different from zero, t-test for each model coefficient is carried out; which tests the null hypothesis of "Coefficient of the variable is equal to zero". This null hypothesis can be expressed as the following, with i being the coefficient index (Walpole *et al.*, 2012):

$$H_0 : \beta_i = 0 \tag{3.15}$$

The t-test, which has a t-distribution with $n - k - 1$ degrees of freedom, is as follows mathematically (Walpole *et al.*, 2012):

$$t = \frac{\beta_i}{st.error(\beta_i)} \tag{3.16}$$

After the linear regression models are developed, then market segmentation tests were made to determine if using the pooled model is valid or segmentation improves the model fit. The null hypothesis for market segmentation is "Segmentation does not improve the fit of the pooled model". This is tested with an F-test with level of significance of α. The null hypothesis for market segmentation is given below (Johnston and DiNardo, 1997):

$$H_0 : \beta_1 = \beta_2 = ... = \beta_G \tag{3.17}$$

where β_1 and β_2 are the model coefficients for first and second segmented models whereas β_G is the model coefficient for the pooled model. The F-test for market segmentation is the following:

$$F = \frac{(SSR - SSR_G)/\upsilon_1}{SSR_G/\upsilon_2} \tag{3.18}$$

where SSR is residual sum of squares of the pooled model, SSR_G is the sum of the residual sums of squares of each segment models, ν_1 is the first degrees of freedom, equal to $K(NG-1)$ and ν_2 is the second degrees of freedom, equal to $N-(KxNG)$ with K is the number of parameters and NG is the number of segments. If the calculated F statistic is greater than the table F value, then the null hypothesis is rejected, and it is said "Segmentation improved the fit.".

3.5. Conditional Model Approach for the Groups with the Lowest Estimated Mean of Vehicles Generated for FTG

For each vehicle type group resulting from factor analysis, a conditional modeling approach was proposed to improve explaining the FTG of the logistical site groups developed by ANCOVA and regression modeling, and validated by market segmentation analysis.

The mathematical theory of the proposed conditional model was influenced by the work of Fletcher *et al.*, (2005); where a combination of binary logit and linear regression model were used for data which was positively skewed with many zero values. They applied this modeling approach on seaweed "Ecklonia radiata" density in Fiordland, New Zealand. Similar to some sites in that study which had zero "Ecklonia radiata" density, the data from KOLMAP for this paper contained many facilities which did not generate any trips for certain vehicle types. A further reason for applying this approach is that when there is zero FTG of a vehicle type in data, using linear regression models is not entirely logical, and hence, one may end up with poor estimates. For instance, the major reason for some facilities not producing any TIR trips is that the goods they produce may not be suitable for transportation with TIRs or shipment sizes are not big enough to fill TIRs. So the assumption, which is made with a regression model and stating that every site might generate TIR trips, is not logical. Hence, it makes sense to build a probabilistic model first, such as the binary logit model, to determine if the facility can generate TIR trips based upon the firm's characteristics. So, this was the starting point for modeling of trips for each vehicle type. The logistical site groups of subject for the proposed modeling approach have the highest amount of zero trip generators for each vehicle type set.

As explained above, the proposed modeling approach consists of two parts: Binary logit part and linear regression part. The data sets of the two parts are different from each other. While binary logit part of the model used all plants in data, linear regression part only considered the plants that generated trips for a certain vehicle type only; i.e. the facilities which do not generate any trips with a certain vehicle type (such as TIR) were excluded.

The model can be expressed as given in Equation 3.19, where T is the number of generated trips for a given type and F is the existence of trips at a given firm (Fletcher *et al.*, 2005):

$$\begin{aligned} & E(T) = \Pr(F = 1)E(T|F = 1) \\ & = ab \end{aligned} \tag{3.19}$$

In Equation 3.19, $E(T)$ is the expected value of the number of trips at the facility, which is the product of a and b with a) being the probability of an establishment generating trips and b being the number of trips generated given that the facility generates trips. First term, a, is calculated using binary logit (Ben-Akiva and Lerman, 1985), and b is estimated using linear regression. Expressions for estimations of a and b are given in Equation 3.20 and Equation 3.21, respectively:

$$\hat{a} = \exp\left(\mathbf{x}'\hat{\nu}\right)/\{1 + \exp\left(\mathbf{x}'\hat{\nu}\right)\} \tag{3.20}$$

$$\hat{b} = \mathbf{z}'\hat{\lambda} \tag{3.21}$$

In Equation 3.20, x is the vector of explanatory variables and $\hat{\nu}$ is the vector of estimates in the binary logit's utility function, making $x'\hat{\nu}$ expression as the utility function. On the other hand, z and $\hat{\lambda}$ are the explanatory variables vector and vector of coefficient estimates, respectively, for the linear regression part of the model; shown by Equation 3.21.

The model was compared with linear regression which is the general modeling approach used for FTG modeling. To avoid confusion with the linear regression part of the proposed conditional model, linear regression model will be defined as "pure linear regression model". For a fair comparison of the modeling approaches, same variables were used in both models. Five random samples were taken from the data for calibration and validation. For each sampling, data for model calibration was selected using SPSS's random sample selection option of "Approximately 75% of all cases". Following that, the models were validated using the remaining data and corresponding observed values by calculating the RMSE and MAE.

Formulations for RMSE and MAE are given in the following (Chai and Draxler, 2014):

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{n}\varepsilon_i^2} \tag{3.22}$$

$$MAE = \frac{1}{N}\sum_{i=1}^{n}|\varepsilon_i| \tag{3.23}$$

where ε_i is the error for observation i of the total N observations.

Improvement of the proposed conditional model over the pure linear regression model for each sample is determined by calculating the percent difference between both models for RMSE and MAE:

$$\%Improvement_{MAE} = \frac{|MAE_{lin.regr.} - MAE_{conditional}|}{MAE_{lin.regr.}} \times 100 \tag{3.24}$$

$$\%Improvement_{RMSE} = \frac{|RMSE_{lin.regr.} - RMSE_{conditional}|}{RMSE_{lin.regr.}} \times 100 \tag{3.25}$$

4. DATA COLLECTION AND PRELIMINARY ANALYSIS

4.1. Information About Kocaeli, Turkey

The data for this study was obtained from Kocaeli Logistics Master Plan (KOLMAP); which was completed in 2012 and part of Kocaeli Transportation Master Plan (KUAP). Kocaeli province has a total population of 1,676,202 as of 2013 (TUIK - Turkish Statistical Institute, 2013) and one of the biggest industrial cities in Turkey. As of 2012, the city's share in production industry is 13% of Turkey, and there are approximately 2200 industrial establishments (ports, depots, logistics companies, factories etc.). It should be noted that 28 of the biggest 100 enterprises of Turkey is in Kocaeli. (Kocaeli Chamber of Industry 2012). Geographically, Kocaeli is 90 km east of Istanbul, Turkey's largest metropolitan area and has one of the major highways of Europe passing through, E-80, connecting Europe to Asia. Figure 4.1 shows the map of Kocaeli province.

Figure 4.1. Map of Kocaeli Province.

Kocaeli has been divided into three regions in KOLMAP as Izmit Region (1^{st}), Gölcük Region (2^{nd}), and Gebze Region (3^{rd}).

4.2. Collection of Data in KOLMAP

In KOLMAP, five types of surveys were conducted, and they can be named as industrial firm survey, port survey, logistics firm survey, site administration survey and driver survey. The first four types were grouped as a whole after collecting the data under the name of “generic” data. The sample sizes at each survey were 84, 9, 160, 36 and 5873, respectively. When the driver data is expanded using weights, the size of the data becomes 34140. The weighted number for driver data represents the daily number of vehicles, and the weights are the resultant factors due to sampling. The surveys were conducted between August and December 2011, during working days of the establishments. Various survey forms used in KOLMAP study are provided in the Appendix.

Driver data was the data obtained from drivers at the entrances of certain logistical sites, where the flow of the vehicles could not be provided by the administrations. Those site types were complex sites such as small industrial sites and organized industrial zones. The aim of collecting driver data was to develop the O-D matrices. Using time segment chunks approach, hours of large amount of traffic at the establishments were determined. Interviews were conducted at those hours and the hours were divided into 5-minute time segments. For each segment, first vehicle arriving at the entrance was stopped for interview to enhance randomization (Bogazici Project Engineering Inc., 2012).

For the surveys with establishments, which constituted the generic data, stratified sampling was applied on the population of logistical sites in Kocaeli province. In stratified sampling method, whole data is first divided into strata and then random sampling is applied for each stratum to determine the samples. This sampling method gives more precise results compared to random sampling since the probability of selecting different site types is increased. (Bogazici Project Engineering Inc., 2012). Generic data includes the number of total, inbound and outbound vehicles for all types at each facility.

For checking the reliability of all data, the collected data was compared with the information formally obtained from various agencies and governmental offices such as TUIK (Bogazici Project Engineering Inc., 2012).

4.3. Data Analysis

4.3.1. Driver Data

There were 1461 interviews made in Izmit region, 409 in Gölcük region and 3997 in Gebze region, including both incoming and outgoing directions of the facilities. Figure 4.2 shows the locations of 54 establishments selected for driver survey. Logistical site types where the driver survey conducted were ports, national depots, regional logistics companies, small industrial sites, large factories and other factories. Before conducting the driver surveys, preliminary interviews were made at the locations selected for driver survey. This was done to understand whether these establishments have information equivalent to a driver survey. As a result, number of the establishments for driver survey was decreased to 27 from the initial 54. Distribution of the 27 establishments over the logistical site types are given in Table 4.1.

Table 4.1. Distribution of the Logistical Site Types for the Driver Survey.

Logistical Site Type	Number of establishments
Port	5
Forwarder Terminal	2
Organized Industrial Zone	6
Small Industrial Site	6
Seafood Market Hall	2
Customs	1
Fruit and Vegetable Market Hall	2
Passenger Car Storage Area	1
Dry Food and Wholesaler Site	1
Free Zone	1
Total	27

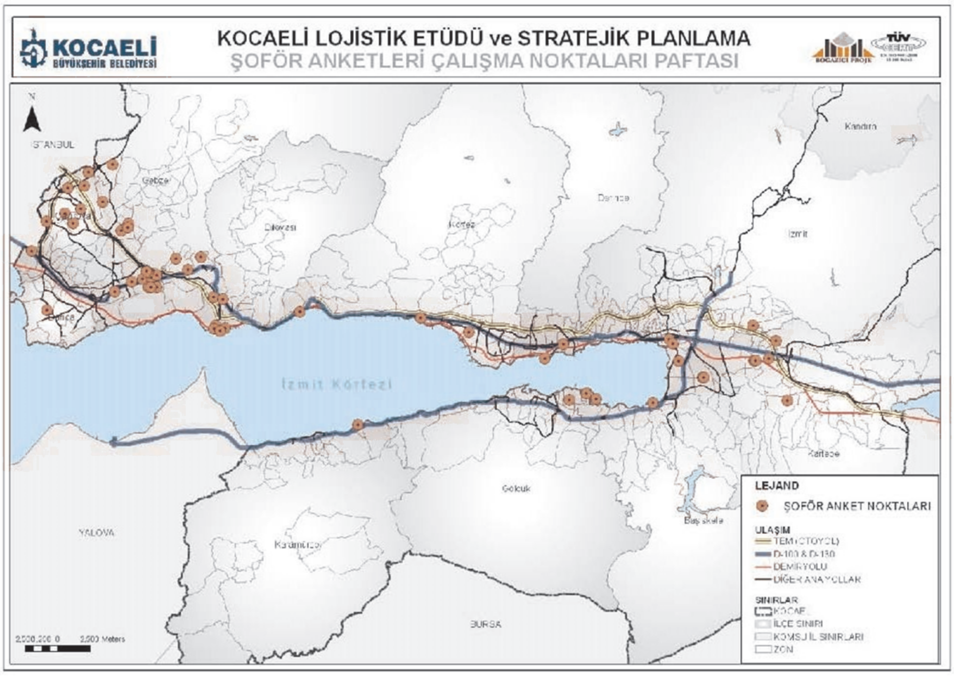


Figure 4.2. Establishments Selected for Driver Survey (Bogazici Project Engineering Inc, 2012).

There are three types of vehicles categorized as van, truck and TIR and thirteen types of cargo in driver data (TUIK - Turkish Statistical Institute, 1967). The frequencies of the categories in each classification in the data are listed in Table 4.2 and Table 4.3. As can be seen from Table 4.2, approximately half of the vehicles are trucks, and vans and TIR each makes up around one-fourth of the traffic in driver survey data.

Table 4.3 gives the distribution of the commodity types, and it seems “machines, transport equipment, parts and containers with various parts” has the highest percentage (25.2) among the types of cargo carried. However, only 36.7 % of the interviewed drivers reported a commodity type, this can be due to either the vehicle is empty or the driver does not have the information about cargo type.

Table 4.2. Distribution of Vehicles (with Weights) in Driver Survey.

	Frequency	%
Van	8805	25.8
Truck	15709	46.0
TIR	9626	28.2
Total	34140	100.0

Table 4.3. Distribution of Cargo Types (with Weights).

	Frequency	%	Valid %
Agricultural Products and Livestock	417	1.2	3.3
Food Products and Animal Seeds	1485	4.4	11.9
Fossil Fuels	1	0.0	0.0
Petroleum Products	488	1.4	3.9
Residuals of Metals and Base metals	431	1.3	3.4
Metal Products	1960	5.7	15.7
Raw and Produced Minerals, Construction Materials	623	1.8	5
Fertilizers	63	0.2	0.5
Chemicals	1308	3.8	10.4
Machines, Transport equipment, parts and Containers with various parts	3159	9.3	25.2
Other Cargo	2588	7.6	20.7
Total	12524	36.7	100
Missing	21616	63.3	
Total	34140	100	

The distribution of the cargo types by the vehicle types is presented in Table 4.3, which is taken from the driver survey. As can be inferred, fertilizers are mostly carried by TIRs, residuals of metals are transported mostly by trucks with 70.8 % and vans transport most of the agricultural products and livestock.

Table 4.4. Distribution of the Cargo Types Between the Vehicle Types.

	Vehicle Type		
	Van	Truck	TIR
Agricultural Products and Livestock	68.20%	26.30%	5.50%
Food Products and Animal Seeds	55.20%	32.10%	12.70%
Petroleum Products	2.00%	48.30%	49.80%
Residuals of Metals and Base metals	16.00%	70.80%	13.20%
Metal Products	18.00%	44.50%	37.50%
Raw and Produced Minerals, Construction Materials	7.20%	51.70%	41.10%
Fertilizers	3.80%	4.60%	91.60%
Chemicals	14.70%	61.00%	24.30%
Machines, Transport equipment, parts and Containers with various parts	19.30%	51.70%	29.10%
Other Cargo	29.10%	43.20%	27.70%

A chi-squared test was applied on the data summarized by Table 4.4 to see whether the cargo types and the vehicle types are independent of each other. Table 4.5 shows the result of this test, and since the significance value of the test is much lower than 0.05 level of significance, it can be concluded that the variables are dependent of each other.

Table 4.5. Chi-Squared Test on Cargo Types-Vehicle Types.

	Value	ν	Significance
Pearson Chi-Square Test Statistic	1999.49	20	0.000

From the driver survey, it was easy to obtain the number and percentage of the loaded and empty vehicles. These values are given in Table 4.6. One can understand that most of the surveyed vehicles are empty and, therefore, should use a model containing the empty vehicles. As indicated in Chapter 2, commodity-based models for freight transportation planning, thus FG, fails to include the empty vehicles. On the other hand, vehicle-based models have the empty vehicles modeled (Holguin-Veras and Thorson, 2003). Thus, using vehicle-based models in this research is essential. It should also be noted that in Table 4.3, the total number of loaded vehicle frequencies were shown as 12524; however, that number in data is bigger; 12635, as shown in Table 4.6. This difference in the number of loaded vehicle data can be due to lack of information about the type of cargo by the drivers.

Table 4.6. Loaded and Empty Vehicles.

	Frequency	%
Empty	21505	63
Loaded	12635	37
Total	34140	100

Table 4.7 gives the distribution of empty and loaded vehicles for each type by the logistical sites in driver survey. It should be noted that the list for logistical sites is limited as the sites in the driver survey do not include all sites, and the ones which have less than eight cases in generic data were omitted. For instance, regional logistics companies only produce loaded TIR trips while small industrial sites (SIS) mostly produce empty vehicles in all types.

Table 4.7. Distribution of the Vehicle Types as Empty and Loaded Vehicles.

	VAN				TRUCK				TIR			
	Empty		Loaded		Empty		Loaded		Empty		Loaded	
	Count	Row %	Count	Row %	Count	Row %	Count	Row %	Count	Row %	Count	Row %
Port	16	45.9	19	54.1	264	36.0	470	64.0	790	57.7	580	42.3
National Depot	9	28.6	23	71.4	9	39.1	14	60.9	19	25.1	57	74.9
Regional Logistics Company	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	61	100.00
Small Industrial Site	3279	72.9	1219	27.1	3734	74.9	1252	25.1	1802	85.0	317	15.0
Large Factory	0	0.0	10	100.0	0	0.0	0	0.0	0	0.0	0	0.0
Other Factory and Production Site	0	0.0	0	0.0	0	0.0	0	0.0	10	46.3	12	53.7

4.3.2. Generic Data

There is a total of twenty-five logistical site subtypes and ten main types in KOLMAP generic data. Main types with the corresponding subtypes are listed in Table 4.8, and the interviewed logistical sites are shown on the map given in Figure 4.3.

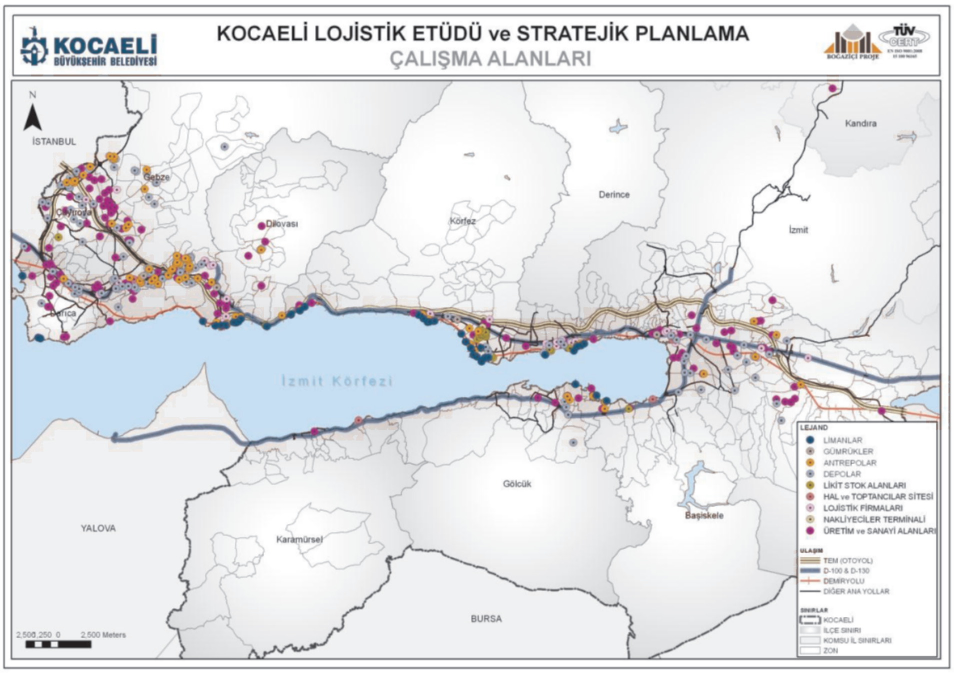


Figure 4.3. Interviewed Logistical Sites in Kocaeli (Bogazici Project Engineering Inc., 2012).

The site subtypes having less than eight firms in the sample are omitted from the analysis to build reasonable models due to sample sizes. The final list of logistical sites included in this study together with their frequencies is listed in Table 4.9.

Table 4.8. Main and Subtypes of Logistical Sites in KOLMAP.

Main Type	Subtype
Ports	Port
	Other Docking Area
Customs	Directorate of Customs
Warehouses	Company-specific Warehouse
	General Warehouse
Depots	National Depot
	Freight Forwarding Center
	Large Manufacturer Depot
	Supermarket Depot
	Coal Storage Depot
	Passenger Car Storage Area
Liquid Storage Area	Liquid Storage Area
Food Halls	Fruit and Vegetable Market Hall
	Seafood Market Hall
	Dry Food and Wholesaler Site
Logistics Company	National Logistics Company Regional Logistics Company
Forwarder Companies and TIR Parks	TIR Park
	Forwarder Terminal
Production and Industrial Zones	Organized Industrial Zone
	Small Industrial Site
	Free Zone
	First 50 Largest Factory
	Other Factory and Production Site
Railway Station for Freight	Railway Station for Freight

Table 4.9. Final List of the Logistical Sites.

	Frequency	%
Port	8	4.3
General Warehouse	13	7.0
National Depot	17	9.1
Large Manufacturer Depot	14	7.5
Coal Storage Depot	19	10.2
Liquid Storage Area	18	9.6
Regional Logistics Company	18	9.6
Small Industrial Site	12	6.4
Large Factory	39	20.9
Other Factory and Production Site	29	15.5
Total	187	100.0

Table 4.3.2 shows the descriptive characteristics of logistical sites. Standard deviation values are high as well as the ranges of employment, total declared area, and actively used area variables, which are three of the candidate independent variables for FTG. Different types of logistical points, various types of industry sectors and diverse business sizes of each sector can explain the reason for the high value of standard variations and large ranges.

Table 4.10. Descriptive Statistics of Logistical Sites in Data.

		Total Declared Area (Decare)	Actively Used Area (Decare)	Employment
Port	Mean	136.32	173.13	187.00
	Standard Deviation	113.84	133.84	224.14
	Maximum	366.00	366.00	672.00
	Minimum	16.82	18.00	25.00

Table 4.10. Descriptive Statistics of Logistical Sites in Data.

		Total Declared Area (Decare)	Actively Used Area (Decare)	Employment
National Depot	Mean	21.69	21.69	40.82
	Standard Deviation	42.01	42.01	49.51
	Maximum	178.00	178.00	170.00
	Minimum	2.60	2.60	3.00
Large Manufacturer Depot	Mean	11.90	11.90	79.86
	Standard Deviation	35.25	35.25	115.99
	Maximum	134.04	134.04	456.00
	Minimum	0.10	0.10	1.00
Coal Storage Depot	Mean	40.00	40.00	29.21
	Standard Deviation	33.02	33.02	13.70
	Maximum	140.00	140.00	55.00
	Minimum	0.31	0.31	3.00
Liquid Storage Area	Mean	23.30	23.30	35.72
	Standard Deviation	21.39	21.39	30.57
	Maximum	97.00	97.00	140.00
	Minimum	6.50	6.50	11.00
Regional Logistics Company	Mean	7.91	7.91	43.06
	Standard Deviation	12.45	12.45	35.96
	Maximum	40.00	40.00	140.00
	Minimum	0.06	0.03	5.00
Small Industrial Site	Mean	93.53	42.90	430.42
	Standard Deviation	171.28	83.65	444.46
	Maximum	612.50	300.00	1500.00
	Minimum	5.05	1.50	20.00

Table 4.10. Descriptive Statistics of Logistical Sites in Data.

		Total Declared Area (Decare)	Actively Used Area (Decare)	Employment
Large Factory	Mean	149.68	123.59	642.05
	Standard Deviation	276.82	264.46	386.83
	Maximum	1443.57	1443.57	2036
	Minimum	7.07	7.82	180.00
Other Factory and Production	Mean	9.89	6.05	71.62
	Standard Deviation	22.74	9.79	89.46
	Maximum	120.00	39.12	300.00
	Minimum	0.09	0.09	3.00

.

Table 4.11 includes the correlations between the independent variables listed in Table 4.3.2. As can be observed, employment is less related to actively used area than total declared area, and the two area variables have a very high correlation of 0.971.

Table 4.11. Correlations between Independent Variables.

		Total Declared Area (Decare)	Actively Used Area (Decare)	Employment
Total Declared Area (Decare)	Pearson Correlation Statistic	1	0.971	0.623
	Significance		0.000	0.000
Actively Used Area (Decare)	Pearson Correlation Statistic	0.971	1	0.548
	Significance	0.000		0.000
Employment	Pearson Correlation Statistic	0.623	0.548	1
	Significance	0.000	0.000	

Correlations between the vehicle types and their directions at sites were also obtained and are given in Table 4.12. This was done in order to understand if the direction of the vehicles makes a difference in vehicle generation of the sites. One can see that the direction does not make any difference as the correlation values are close to 1.0 within each vehicle type. The correlations are lower for between vehicle types; however, the significance values for those pairs reveal that the correlations are significant at the 0.001 significance level.

Table 4.12. Correlations between Inbound, Outbound and Total Vehicle Types.

		Inbound TIR	Inbound truck	Inbound van	Outbound TIR	Outbound truck	Outbound van
Inbound TIR	Pearson Correlation Statistic	1	0.681	0.446	0.942	0.682	0.434
	Significance		0.000	0.000	0.000	0.000	0.000
Inbound truck	Pearson Correlation Statistic	0.681	1	0.799	0.609	0.979	0.797
	Significance	0.000		0.000	0.000	0.000	0.000
Inbound van	Pearson Correlation Statistic	0.446	0.799	1	0.388	0.774	0.996
	Significance	0.000	0.000		0.000	0.000	0.000
Outbound TIR	Pearson Correlation Statistic	0.942	0.609	0.388	1	0.631	0.382
	Significance	0.000	0.000	0.000		0.000	0.000
Outbound truck	Pearson Correlation Statistic	0.682	0.979	0.774	0.631	1	0.777
	Significance	0.000	0.000	0.000	0.000		0.000
Outbound van	Pearson Correlation Statistic	0.434	0.797	0.996	0.382	0.777	1
	Significance	0.000	0.000	0.000	0.000	0.000	

Figure 4.4, Figure 4.5 and Figure 4.6 illustrate the distribution of all candidate independent variables with respect to site types. It is easy to observe that ports have the highest mean of actively used area with 173.13 decares. However, large factories and small industrial sites have more employment and total declared area than ports do. The high amount of standard deviation values of both variables can be explained by their different sizes and different sectors they serve.

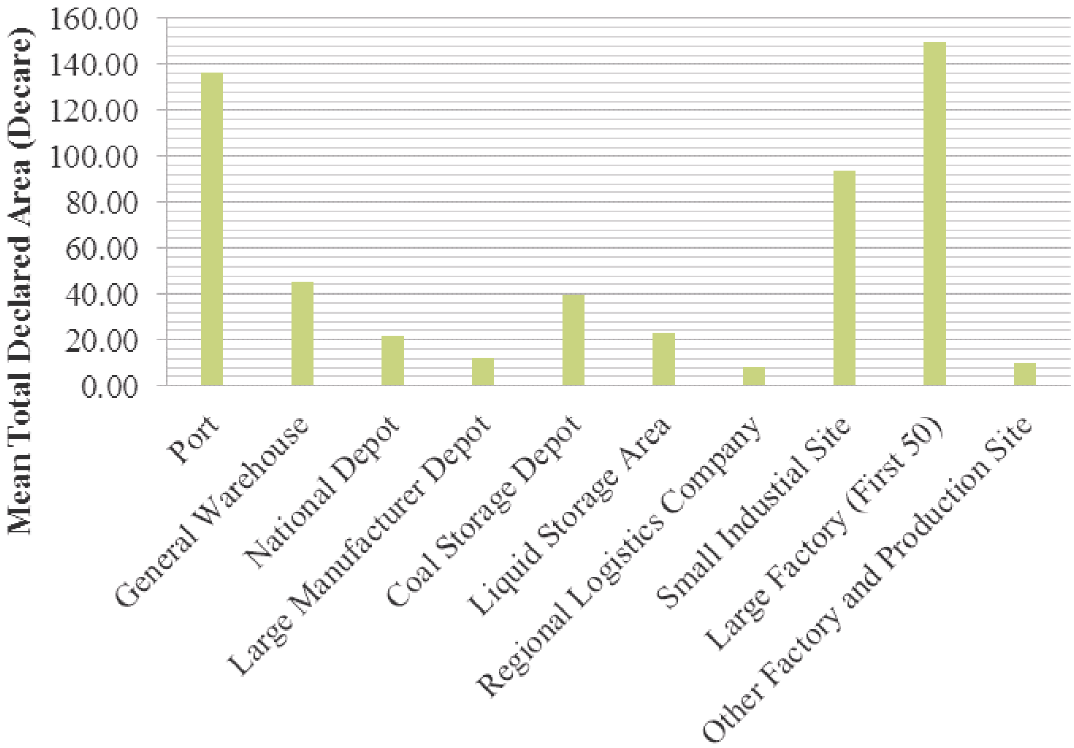


Figure 4.4. Mean Total Declared area in Logistical Sites.

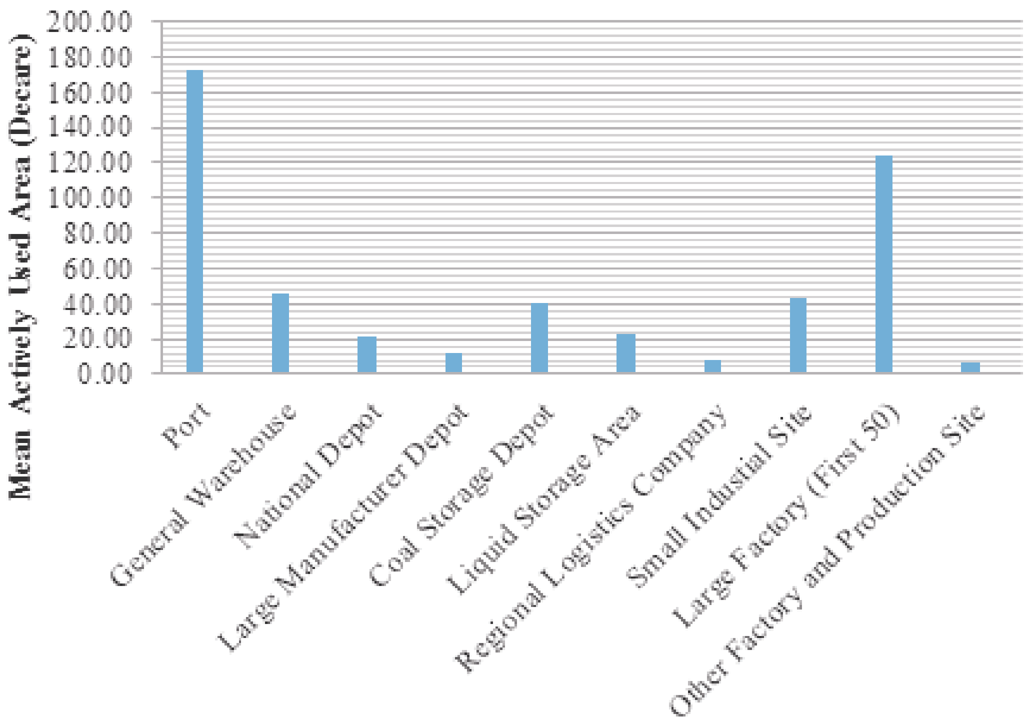


Figure 4.5. Mean Actively Used area in Logistical Site Types.

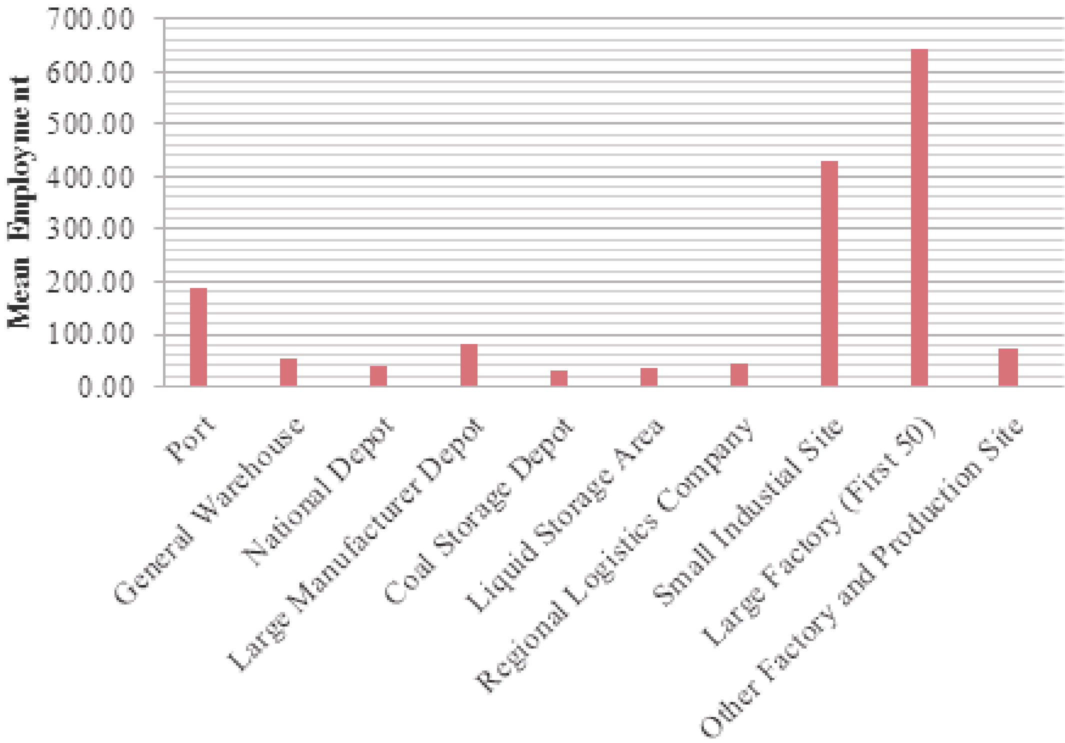


Figure 4.6. Mean Employment in Logistical Site Types.

The means and standard deviations of the number of each vehicle type per day; TIR, truck and van, at logistical site types are presented in Table 4.13. Figure 4.9 shows the distribution of the means of each vehicle type between the logistical focal types. Both from Table 4.13 and Figure 4.7, one can infer that small industrial sites generate very large number of van trips as well compared to that of trucks or TIRs, with mean and standard deviation of 331.92 and 456.67, respectively. Presence of various industries in small industrial sites may explain the very high standard deviation. In addition, small industrial sites generate the highest amount of trucks among the logistical sites with a mean of 119.42 trucks. Furthermore, it is important to mention ports that they generate considerable numbers of truck and TIR trips compared to other logistical site types. Another noticeable fact is that large factories generate TIR trips more than they do for trucks or vans.

Table 4.13. Means and Standard Deviations of Vehicle Types at Logistical Site Types.

	Total TIR		Total Truck		Total Van	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Port	273.50	146.85	118.75	100.45	28.00	48.52
General Warehouse	53.46	55.22	9.00	23.75	8.23	26.73
National Depot	22.82	24.17	16.06	21.77	11.94	23.09
Large Manufacturer Depot	5.07	16.74	18.29	39.98	29.57	26.85
Coal Storage Depot	15.26	17.46	27.47	23.60	0.84	1.68
Liquid Storage Area	45.44	97.50	38.61	47.68	3.94	7.66
Regional Logistics Company	53.94	45.75	11.61	34.64	1.94	5.18
Small Industrial Site	69.17	141.32	119.42	162.01	331.92	456.67
Large Factory	73.44	142.20	47.13	78.87	28.92	109.39
Other Factory and Production Site	7.52	22.78	3.41	5.84	4.55	6.91

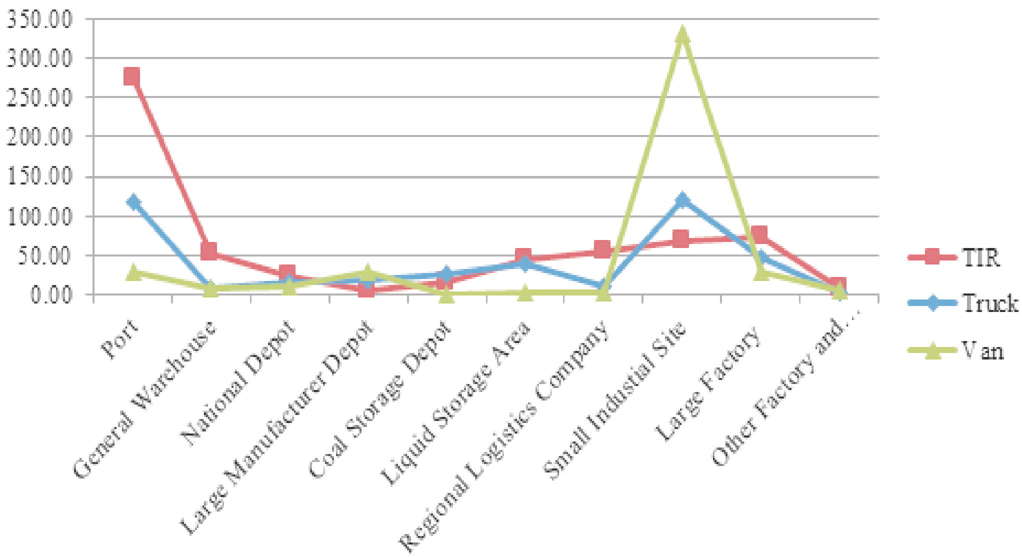


Figure 4.7. Distribution of the Means of Each Vehicle Type between the Logistical Site Types.

Figure 4.8, Figure 4.9 and Figure 4.10 show the frequencies of total numbers of TIR, truck and van. One can observe that the distributions are positively skewed, and most of the establishments generate less than 200 trips for all vehicle types.

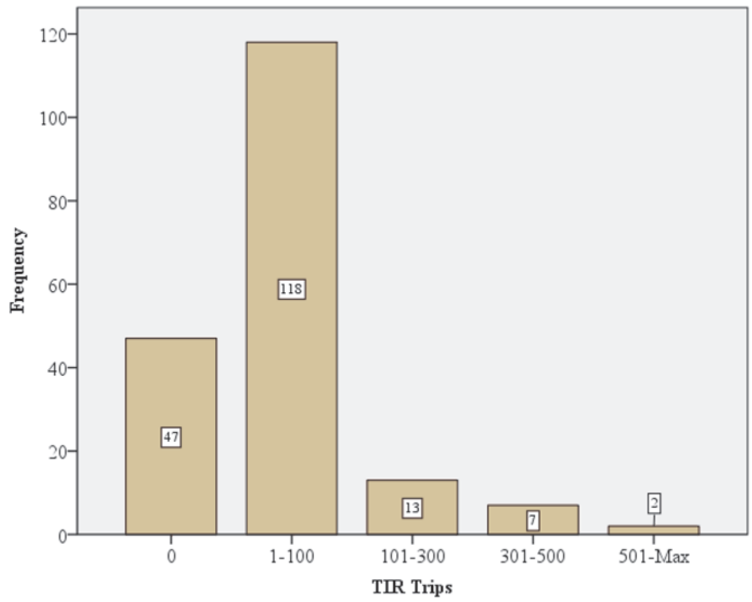


Figure 4.8. Frequencies of Total TIR Trips Generated.

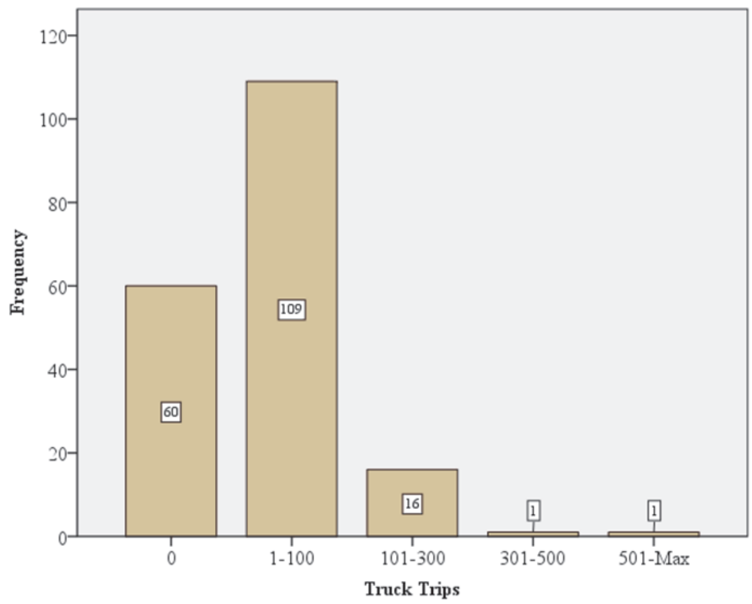


Figure 4.9. Frequencies of Total Truck Trips Generated.

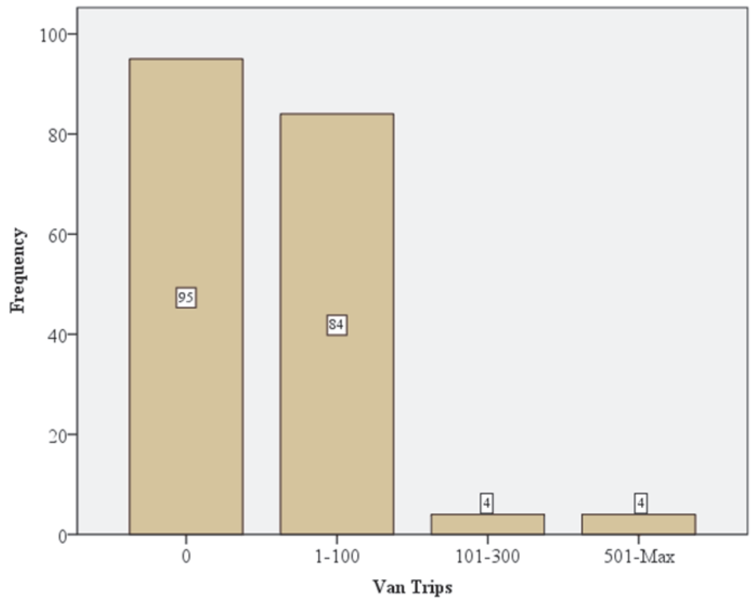


Figure 4.10. Frequencies of Total Van Trips Generated.

Figure 4.11, Figure 4.12 and Figure 4.13 show the frequency distribution of vehicles types without zero-trip generating sites. Again, the distributions of all vehicle types are positively skewed. It is worthy to mention that the set of trip generating sites is different for each vehicle type.

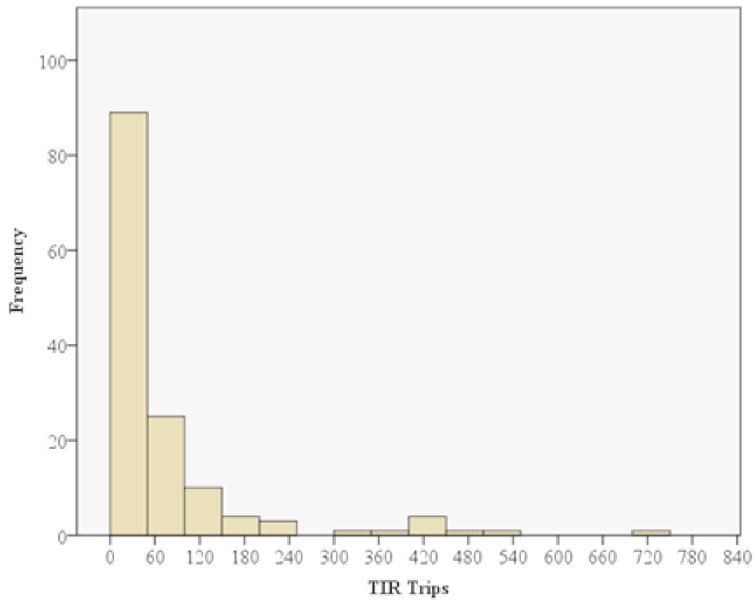


Figure 4.11. Frequencies of Total TIR Trips Generated, with Zero-Trips Excluded (N=140).

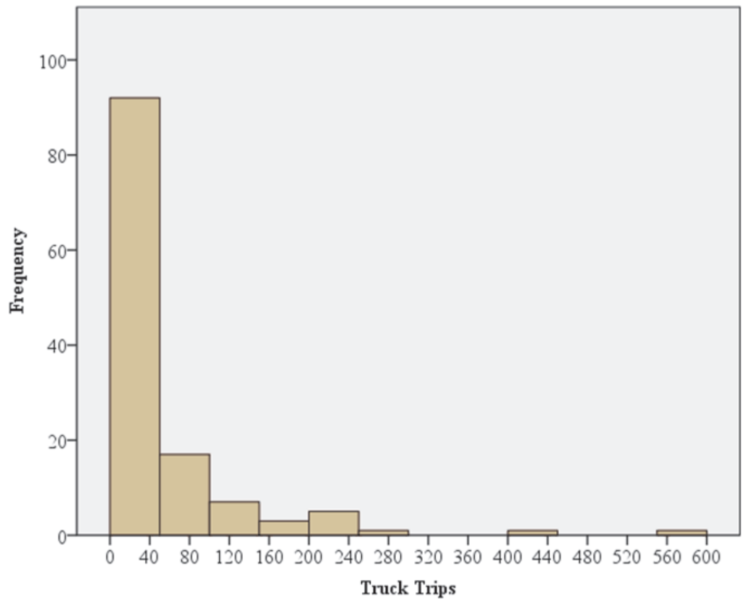


Figure 4.12. Frequencies of Total Truck Trips Generated, with Zero-Trips Excluded (N=127).

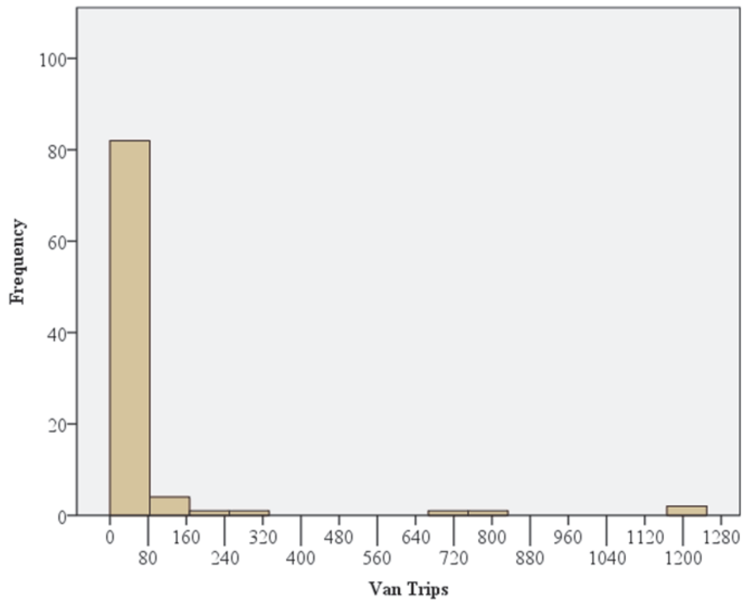


Figure 4.13. Frequencies of Total Van Trips Generated, with Zero-Trips Excluded (N=92).

Figure 4.14, Figure 4.15 and Figure 4.16 show the frequency distribution of firms by their actively used area and employment, respectively. Similar to Figure 4.9, Figure 4.10 and Figure 4.11, positive skewness is also seen in Figure 4.14, Figure 4.15 and

Figure 4.16.

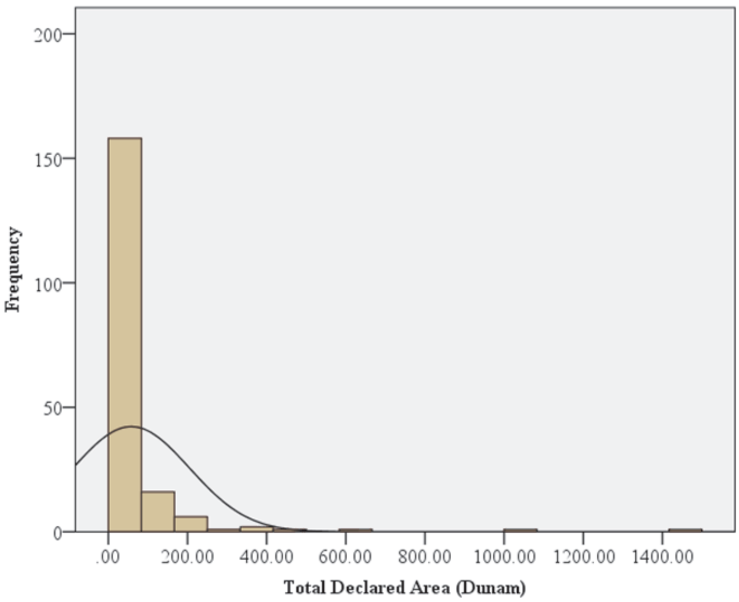


Figure 4.14. Frequencies of Total Declared Area.

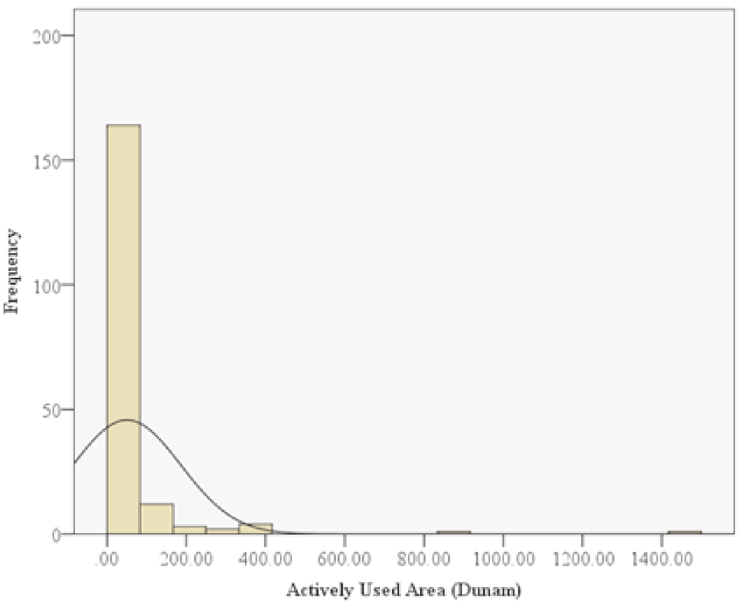


Figure 4.15. Frequencies of Actively Used Area.

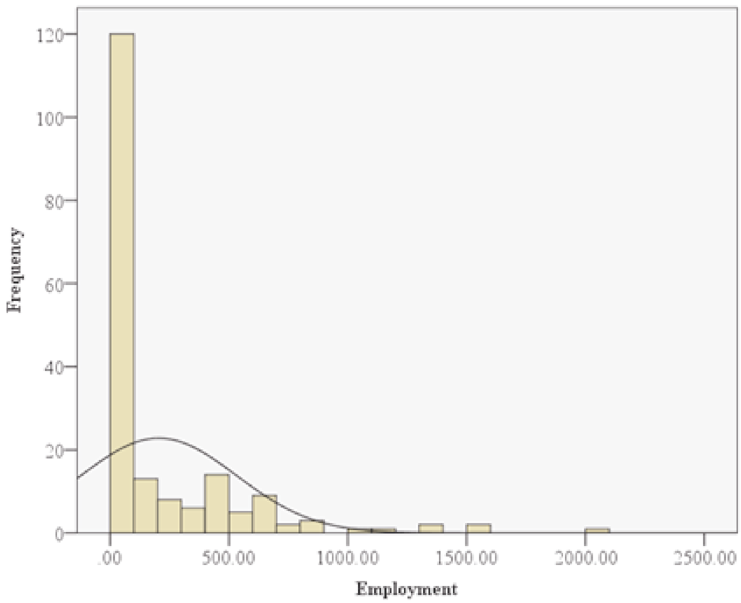


Figure 4.16. Frequencies of Employment.

The skewness values of the numbers of TIRs, trucks, and vans (zero-trips included), actively used area and employment values are shown in Table 4.13. Skewness statistic values for all variables are greater than 1.0; therefore, it can be said that the distributions are highly skewed (Brown, 2012).

Table 4.14. Skewness Values for Variables.

	Skewness Statistic
Total Declared Area (Decare)	6.512
Actively Used Area (Decare)	7.289
Employment	2.631
Total TIR	3.738
Total truck	4.187
Total van	6.764

The positively skewed distributions of the variables can be normalized by logarithmic transformation of the variables. Having normally distributed dependent variables is essential in conducting ANOVA and ANCOVA analyses, which will be explained in Chapter 5. Distributions of transformed variables are given in Figure 4.17, Figure 4.18,

Figure 4.19, Figure 4.20, Figure 4.21 and Figure 4.22. In Figure 4.17, Figure 4.18 and Figure 4.19, zero-trip generating establishments are included for vehicles distributions. A constant of 1 was added to the number of trips to obtain the natural logarithm for zero-trip generators since $ln(0)$ is undefined. As can be observed, zero-trip generators still cause positively skewed distributions for all vehicle types. Figure 4.20, Figure 4.21 and Figure 4.22 show the distributions with zero-trip generators excluded and it can be seen that except vans, transformed variables have distributions close to normal.

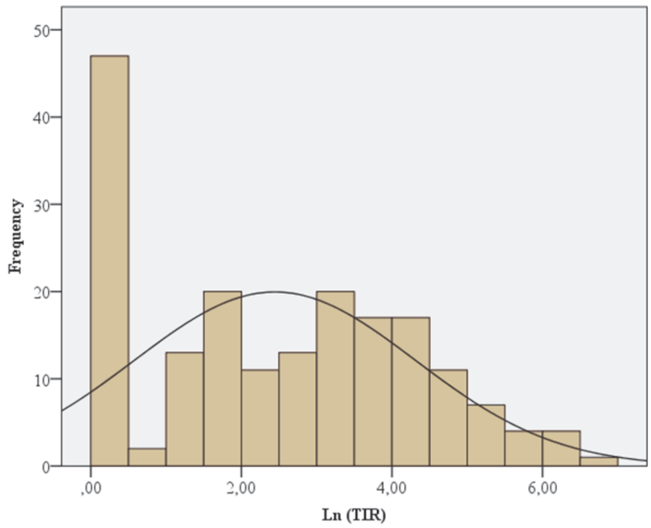


Figure 4.17. Frequencies of Ln (TIR).

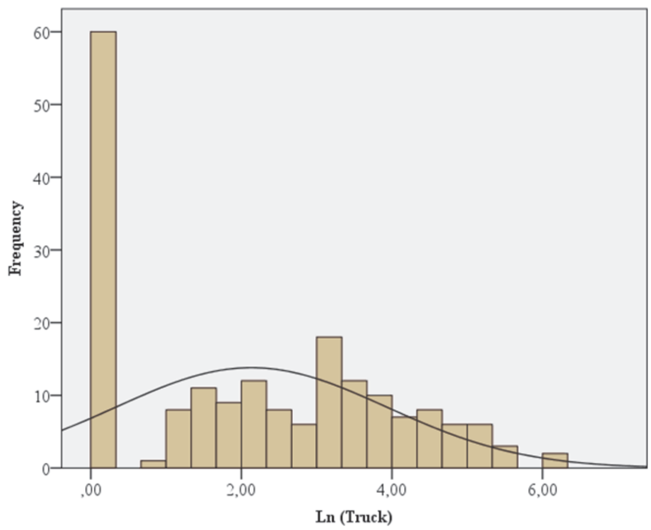


Figure 4.18. Frequencies of Ln (Truck).

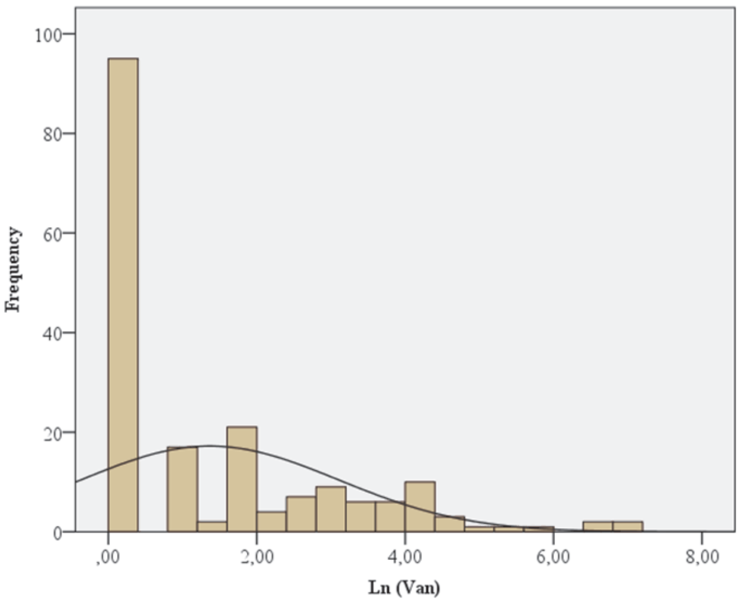


Figure 4.19. Frequencies of Ln (Van).

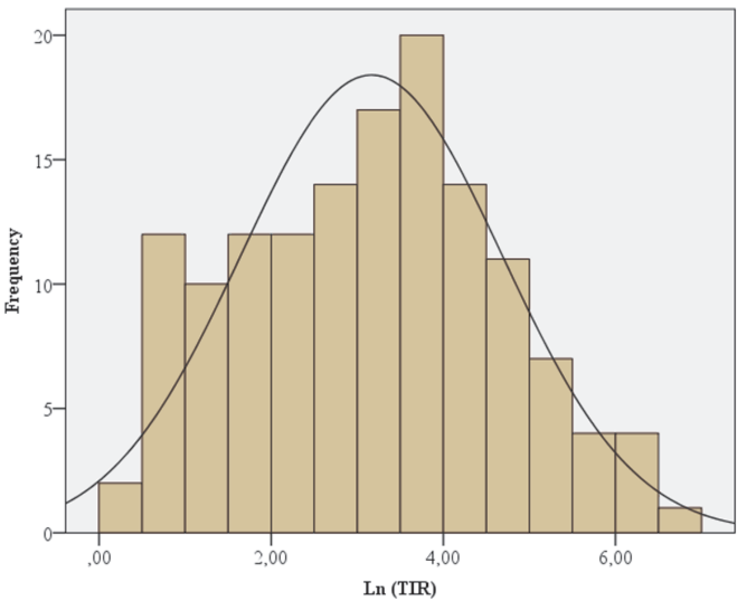


Figure 4.20. Frequencies of Ln (TIR) with Zero-Trips Excluded.

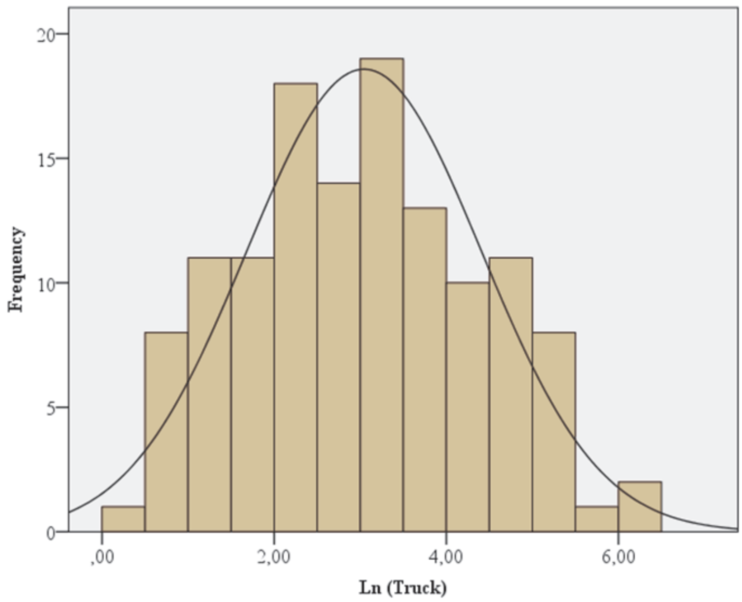


Figure 4.21. Frequencies of Ln (Truck) with Zero-Trips Excluded.

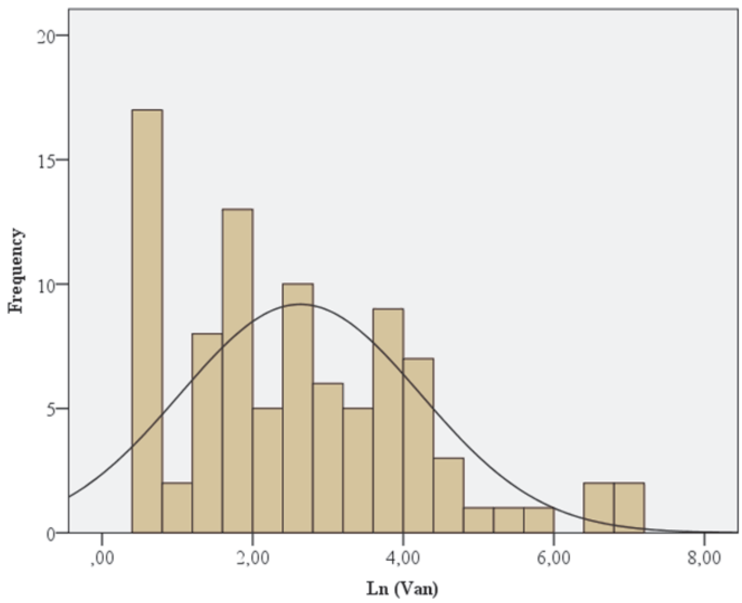


Figure 4.22. Frequencies of Ln (Van) with Zero-Trips Excluded.

Figure 4.23, Figure 4.24 and Figure 4.25 explain the distributions of independent variables; total declared area, actively used area and employment, when their natural logarithms are taken. As can be observed, these distributions are close to normal.

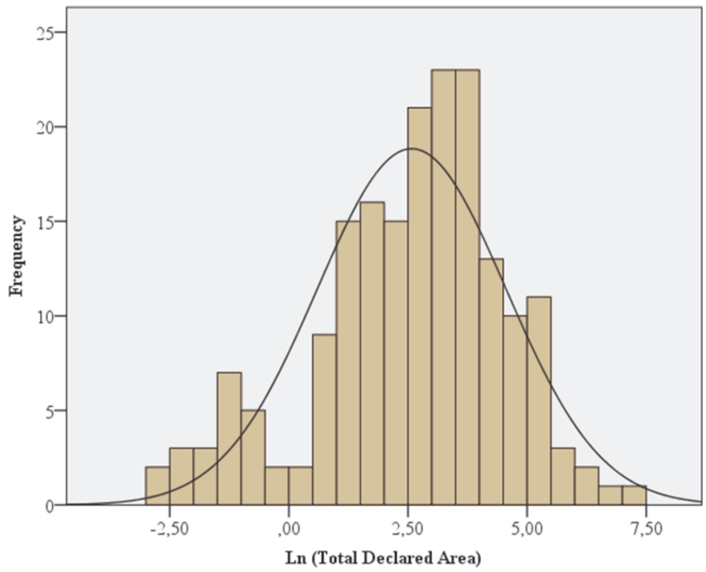


Figure 4.23. Frequencies of Ln (Total Declared Area).

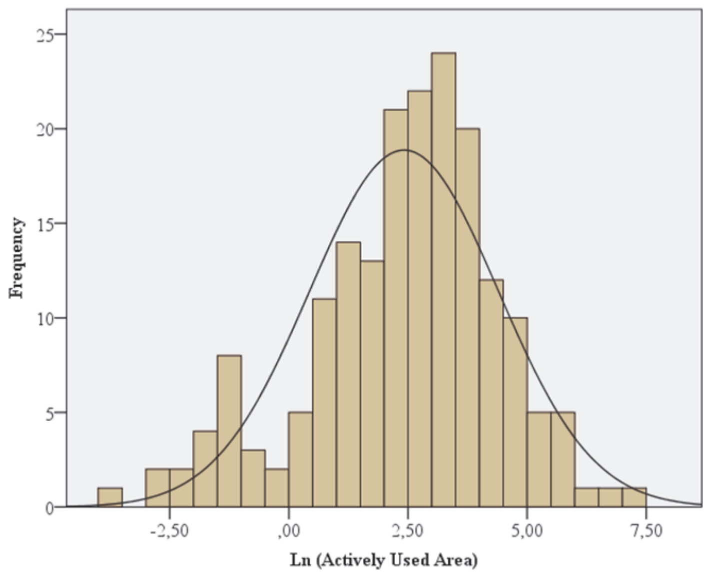


Figure 4.24. Frequencies of Ln (Actively Used Area).

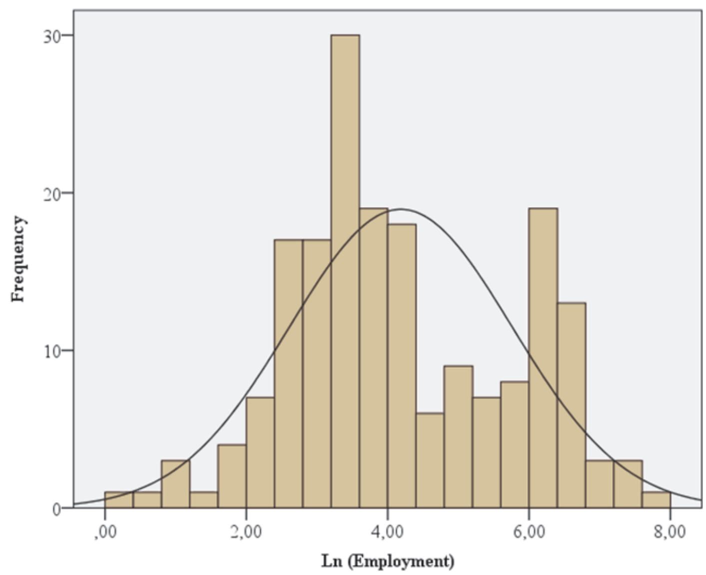


Figure 4.25. Frequencies of Ln (Employment).

From the generic data, business sectors of the logistical sites were also collected. In this study, they are named as “activity type”. Activity types were obtained from Classification of Economic Activities in the European Community (NACE) Rev. 1.1 (European Commission 2002) and recoded for the KOLMAP study. Three categories, namely “Other manufacture types”, “Other types in logistical site survey”, and “Other types in logistics company survey” were added as “Other” by KOLMAP to the list of types in the classification. Those “Other” categories were given for each survey type except the port survey. In port survey, no questions regarding activity type were asked, so, the default activity type was accepted as “Port administration”. The list of activities is given in Table 4.14. Only the observed activities are listed.

Table 4.15. Activity Types.

Activity Code	Activity Name	Number of Establishments
1	Mining of metal ores	2
3	Manufacture of food products and beverages	3
4	Manufacture of textiles	1
7	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	2
9	Publishing, printing and reproduction of recorded media	1
10	Manufacture of coke, refined petroleum products and nuclear fuel	1
11	Manufacture of chemicals and chemical products	4
12	Manufacture of rubber and plastic products	6
13	Manufacture of other non-metallic mineral products	1
14	Manufacture of basic metals	11
15	Manufacture of fabricated metal products, except machinery and equipment	2
18	Manufacture of electrical machinery and apparatus n.e.c.**a**	1
21	Manufacture of motor vehicles, trailers and semi-trailers	2
23	Manufacture of furniture; manufacturing n.e.c.**a**	1
25	Other manufacture types	30
26	Production	3
27	Wholesale and Retail	1
30	Storing	1
41	Other types in logistical site survey	7
42	Port administration	8
43	Customs consulting	2
44	General warehouse administration	16
45	National depot administration	7
47	Large manufacturer depot administration	5
50	Retail distributor main depot	12
51	Bulk material depot	15

Table 4.15. Activity Types.

Activity Code	Activity Name	Number of Establishments
53	Fuel terminal	13
54	Other liquid material storage	2
55	Logistics company	9
57	International road transport	2
58	Domestic road transport	5
61	Other in logistics company survey	11

where is the a not elsewhere classified. Basic information about the logistical sites that were included in generic data are given in the following subsections.

4.3.2.1. Ports. Ports had the lowest number of observations in data with 8 observations. Four of the ports were located in Gebze region, Dilovasi town. 2 ports were in Izmit and the remaining two ports were in Gölcük. Ports generated the highest mean of total TIR trips with 273.50 trips among all logistical sites, and TIR was the most generated vehicle trip type. Trucks had average trips of 118.75 trips while average trips of vans was very low compared to other vehicle types, it was 28.00 trips. Activity type in all ports was “Port administration”.

4.3.2.2. General Warehouses. These are the warehouses of companies where their goods are kept before customs formalities (Bogazici Project Engineering Inc., 2012). There were 47 general warehouses in Kocaeli data, but only 20 of them were interviewed, and 13 of the interviewed warehouses did not have any missing data, so 13 warehouses were investigated in this study. Only one of the warehouses were in Izmit region and the remaining were in Gebze. General warehouses generated a mean of 53.46 TIR trips on the average, lower than ports. Average number of trucks and vans at general warehouses were 9.00 and 8.23 trips, respectively.

4.3.2.3. National Depots. These depots are out of customs regulations (Bogazici Project Engineering Inc., 2012). There were 17 national depots investigated in data. Two depots were in Izmit region and the remaining ones are in Gebze. Distribution of trips with respect to vehicle types for national depots was more evenly distributed; still, TIRs had the highest share of trips with a mean of 22.82 trips. Trucks followed TIRS with 16.06 trips and vans had the lowest share with 11.94 trips in average.

4.3.2.4. Large Manufacturer Depots. 14 large manufacturer depots were analyzed. 8 of these depots were in Izmit region while Gebze and Gölcük regions each had 3 of the depots. This logistical site type generated mostly vans with a mean of 29.57 trips while TIR trips were the lowest with a mean of 5.07 trips. Average of truck trips was 18.29 trips.

8 of these depots had an activity type of vRetail distributor main depot“, followed by 5 depots with “Large manufacturer depot administration”.

4.3.2.5. Coal Storage Depots. Out of 19 coal storage depots, 18 were in Gebze and only 1 was in Izmit region, thus, they were mostly concentrated in Gebze. Coal storage depots generated virtually zero van trips (0.84 mean trips) and trucks had the highest share of trips with a mean of 27.47 trips. TIR trips had an average of 15.26 trips.

Most common activity type in coal storage depots were reported as “Bulk material depot”, with 15 depots.

4.3.2.6. Liquid Storage Areas. There were 25 liquid storage areas with 23 of them in Izmit region. Remaining 2 establishments were in Gebze. Similar to ports and general warehouses, TIR trips had the highest share of vehicle types with a mean of 45.44 trips and van trips were the lowest, with 3.94 trips in average. Average of truck trips was not far from the one of TIR trips, it was 38.61 trips.

Distribution of the activity types in liquid storage ares is shown in Figure 4.26.

It can be seen that most of the liquid storage areas have national depot administration as their main activity.

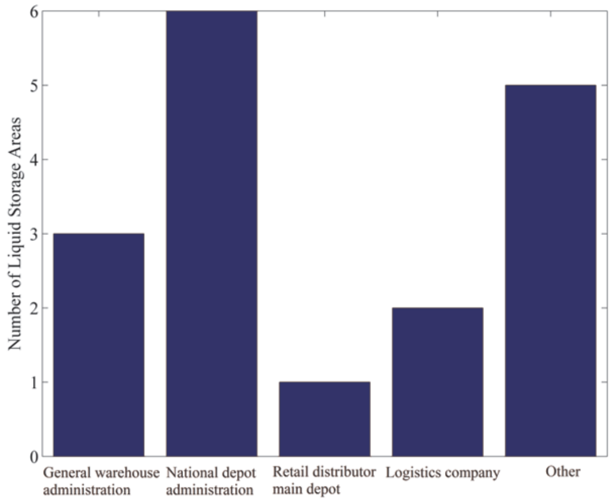


Figure 4.26. Distribution of Activity Types in Liquid Storage Areas.

4.3.2.7. Regional Logistics Companies. Number of interviewed regional logistics companies were 18. These companies were equally distributed between Gebze and Izmit; each having 9 companies. These establishments tend to generate mostly TIR trips with a mean of 53.94 trips and very low number of van trips (1.94 mean trips). Truck trips were also low in average compared to TIRs, the average number of trips was 11.61 trips.

4.3.2.8. Small Industrial Sites. This type of logistical site was mostly concentrated in Gebze with 7 sites out of total 12 interviewed sites. From the remaining sites, 1 was in Gölcük and 4 were in Izmit. Small industrial sites are host to many small establishments and they generated the highest mean trips of vans and trucks (331.92 and 162.01 trips, respectively) among all logistical site types. Furthermore, vans had the highest share of vehicle type in small industrial sites. On the other hand, TIRs had the lowest share of vehicle trips with an average of 69.17 trips. Still, this average is the third highest for TIR trips in all logistical site types included in analysis.

Distribution of the activity types in small industrial sites is shown in Figure 4.27.

It can be seen that the most common activity is “Other”. It can also be observed that only four activity types listed in survey were reported.

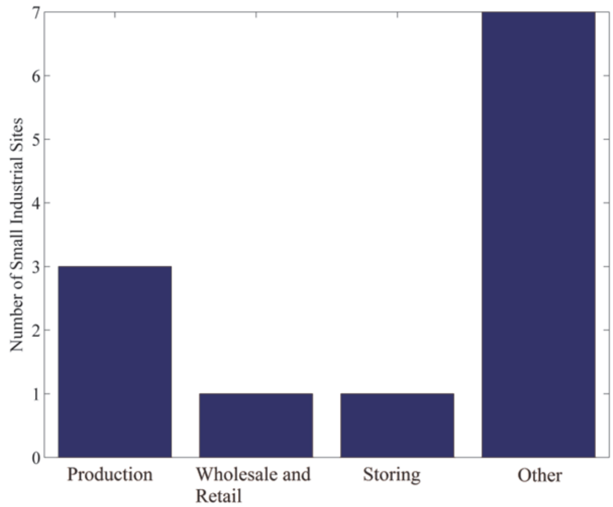


Figure 4.27. Distribution of Activity Types in Small Industrial Sites.

4.3.2.9. Lateral. Large Factories: For preparation of KOLMAP, 50 largest factories in Kocaeli were chosen for interviews as large factories. However, the interviews were concluded successfully with only 39 factories. 23 of these factories were in Gebze, 13 were in Izmit and only 3 were in Gölcük. TIR trips were the most commonly generated trip types with a mean of 73.44 trips. Average trips of trucks and vans followed this by 47.13 and 28.92 trips.

From the activity codes listed in Table 4.14, codes from 1 to 25 belong to factories. Most common activity type in large factories was “Other manufacture types” with 15 establishments.

None of the large factories had logistics services totally served by themselves, and 68 % of them had the logistical services provided totally by logistical companies. Remaining 32 % were doing these services partially themselves.

4.3.2.10. Other Factories and Production Sites. A sample of 29 of the remaining factories were randomly selected for survey. Similar to large factories, most of the other factories were in Gebze with 17 establishments. Izmit is host to 12 of the remaining factories while only 1 factory was in Gölcük. This logistical site type also generated mostly TIR trips, but with a much lower mean of 7.52 trips compared to large factories. In addition, their average van trips were higher than truck trips, unlike large factories. This logistical site type had the lowest average of TIR and truck trips among the all logistical sites types, with 7.52 and 3.41 trips, respectively.

15 of the establishments had the activity type as "Other manufacture types" similar to large factories, and this type is the most common.

5. ANALYSIS AND RESULTS

5.1. Introduction

In this chapter, results of the analysis were given. First, a factor analysis was conducted on the dependent and independent variables. Then, ANCOVA was applied on both variables to obtain the logistical site type groups (or segments). The groups were then validated by conducting ANCOVA between them and market segmentation analysis. In the market segmentation analysis, regression models for each segment (pooled models) and logistical site type were built and it was checked if the pooled models were valid using statistical tests. Finally, the proposed conditional model, which combined binary logit and linear regression, was applied for the groups with high amount of zero trips of the vehicle categories. The conditional model was compared with linear regression modeling approach using RMSE and MAE.

5.2. Factor Analysis on Dependent and Independent Variables

A factor analysis on dependent and independent variables in data was performed in order to reduce the number of variables since there were too many of them. The aim of reducing the dimensions of data and interpreting the correlated variables under factors is because later on, the grouping the logistical sites will be achieved by using these reduced number of factors or the combinations of the variables which are grouped in factors as the dependent variable.

Before conducting the factor analysis, Bartlett's test of sphericity was run, and the result is given in Table 5.1. The significance as 0.000 shows that the hypothesis stating "Correlation matrix is an identity matrix" can be rejected and hence this test shows that factor analysis can be run because there are correlations among the variables.

Table 5.1. Test for Correlations.

Bartlett's Test of Sphericity	Approx. Chi-Square	2222.12
	Degrees of freedom	36
	Significance	0.000

Total declared area, actively used area, employment and numbers of all vehicle types in all directions at the establishment (incoming and outgoing) were used as variables in the factor analysis conducted, making a total of nine variables. Table 5.2 includes the initial eigenvalues and the total variance they explained. The factor analysis stopped when the eigenvalue became lower than 1; i.e. when the eigenvalue explained less than one variable, and with this criterion, as can be observed, the number of factors turned out to be three.

Table 5.2. Eigenvalues and Variances Explained of the Components.

Component Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.247	47.188	47.188	4.247	47.188	47.188	2.880	32.005	32.005
2	2.172	24.132	71.320	2.172	24.132	71.320	2.497	27.743	59.747
3	1.135	12.608	83.928	1.135	12.608	83.928	2.176	24.181	83.928
4	0.666	7.404	91.332						
5	0.458	5.084	96.416						
6	0.199	2.208	98.624						
7	0.103	1.143	99.767						
8	0.016	0.180	99.947						
9	0.005	0.053	100.000						

Scree plot is useful for determining the number of factors using the elbow rule as well, as explained in Section 3.1.Figure 5.1 shows the scree plot of the factor analysis. Using the elbow rule, it can be seen that the number of factors is three.

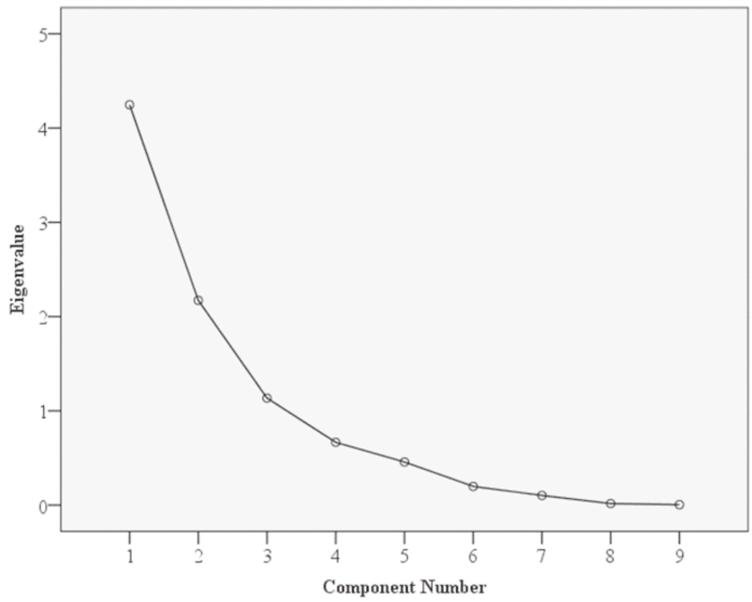


Figure 5.1. Scree Plot.

Varimax rotation was used for the rotation of the components. As can be seen in the rotated factor loadings given in Table 5.3, there are no serious double loadings of variables on factors, and factors came out very clearly.

Table 5.3. Rotated Component Matrix.

	Component		
	1	2	3
Number of incoming van	0.951	0.011	0.014
Number of outgoing van	0.946	0.006	0.001
Number of incoming truck	0.739	0.238	0.392
Number of outgoing truck	0.645	0.238	0.498
Total Declared Area (Decare)	0.028	0.935	0.250
Actively Used Area (Decare)	-0.050	0.900	0.311
Employment (Number of employees)	0.286	0.778	0.046
Number of outgoing TIR	0.067	0.185	0.907
Number of incoming TIR	0.170	0.247	0.889

Factors can be labelled as the following from Table 5.3:

- Factor 1: Number of Truck+Van trips
- Factor 2: Site characteristics: Total declared area, actively used area and employment
- Factor 3: Number of TIR trips

Since the sum of the incoming and outgoing vehicles is the total vehicles, the variables for the vehicles will be the total number of vehicles. According to the results of the factor analysis, it seems that as one dependent variable in the grouping the total number of TIR trips and as the second dependent variable the total number of total trucks plus total vans can be used for grouping of the logistical sites. The second factor is a factor where the potential independent variables were gathered.

5.3. Segmentation of Logistical Site Types Using Analysis of Covariance (ANCOVA)

In order to understand if the logistical sites have similar trip generation patterns, analysis of covariance (ANCOVA) (Rutherford, 2001) was conducted. In ANCOVA analyses, the variables used were as follows:

- Dependent variables: 1) Sum of the total number of incoming and outgoing TIR trips and 2) Sum of the total number of incoming and outgoing truck and van trips
- Factor: Logistical site type
- Covariates: Actively used area and employment

Total declared area was not used as a covariate due to two reasons: First, it had a correlation value of 0.971 with actively used area. Second, the alternative of using employment and total declared area as covariates produced inferior results compared to using actively used area and employment. Therefore, total declared area was omitted from the analysis.

The analyses were made for number of total TIR trips and sum of truck and van trips. As also explained in Section 3.3, ANOVA was not conducted since in ANCOVA, the errors are much less than ANOVA due to the presence of covariates; therefore, ANCOVA was made directly. Also, since the sample sizes of logistical sites are different, the design is non-orthogonal.

During the analyses, first, the homogeneity of the variances should be checked using Levene's test. One of the assumptions of the ANOVA and ANCOVA is that the scores should have equal variances, in other words, be homoscedastic (Rutherford, 2001), and if the variances appear to be heterogeneous, then ANOVA and ANCOVA analysis will not be very reliable (Walpole *et al.*, 2012). The Levene's test for the ANCOVA is presented in Table 5.4. It can be inferred that the variances are not equally distributed since the significance values are very close to 0.000 in Table 5.4.

Table 5.4. Levene's test for Dependent Variables in ANCOVA.

	Levene Statistic	ν_1	ν_2	Significance
TIR Trips	3.232	9	177	0.001
Truck+Van Trips	22.122	9	177	0.000

The result shown in Table 5.4 could be due to the skewed distributions of the variables as shown in Section 4. This necessitates some "variance stabilizing transformations" (Walpole *et al.*, 2012). Natural logarithms of the variables were taken. As can be observed in Figure 4.23 and Figure 4.24, the distribution of the actively used area and employment are close to normal when their natural logarithms were used. With this transformation, except the distribution of total vehicles, distributions of other variables became close to normal distribution, which were given previously in Figure 4.14, Figure 4.15 Figure 4.16, Figure 4.17 and Figure 4.18. Figure 5.2 shows the distribution of ln(Truck+Van). As can be seen, and due to zero trip generating establishments it is still positively skewed but has a much better distribution than the (Truck+Van) variable.

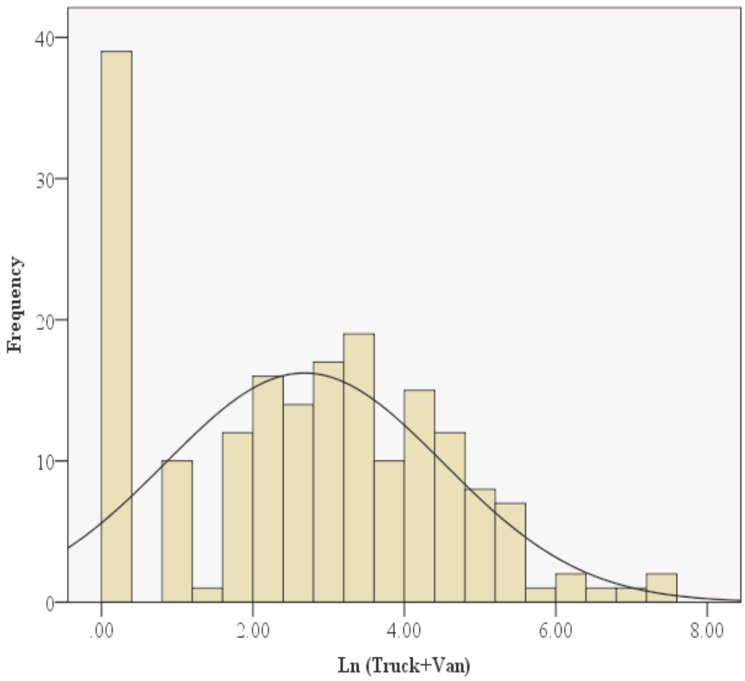


Figure 5.2. Distribution of ln (Truck+Van).

After the variance stabilizing transformation of the variables had been performed, two dependent variables emerged: ln(TIR) and ln(Truck+Van). The Levene's test of homogeneity had been applied for these transformed variables. The significance of the Levene test of homogeneity of equal variances for ln(TIR) is 0.070; while it is 0.002 for ln(Truck+Van), as shown in Table 5.5. Thus, it can be concluded that the hypothesis of equality of variances for ln(TIR) cannot be rejected, but the variances are not equally distributed for ln(Truck+Van) and the hypothesis for this case can be rejected at the 0.05 level. Therefore, ANCOVA can be safely applied with the ln(TIR) variable, but ANCOVA results using ln(Truck+Van) variable should be interpreted more cautiously.

Table 5.5. Levene's Test for Transformed Dependent Variables in ANCOVA.

	Levene Statistic	ν_1	ν_2	Significance
ln(TIR)	1.806	9	177	0.070
ln(Truck+Van)	3.038	9	177	0.002

5.3.1. Segmentation Using TIR Trips with ANCOVA

This section explains the groups obtained from the ANCOVA of TIR trips. Results of ANCOVA for ln(TIR) are presented in Table 5.6. As indicated by the F statistic of the corrected model, the factor and the covariates have a jointly significant effect on the dependent variable. When the significances of each variable are checked using the F statistics, it can be seen that the hypothesis of equality of intercept to zero cannot be rejected while the coefficients for logistical site type, ln(Actively Used Area) and ln(Employment) are not zero, i.e. both the factors and the covariate significantly affect the dependent variable ln(TIR).

Table 5.6. ANCOVA for ln (TIR).

Source	Type III Sum of Squares	ν	Mean Square	F statistic	Significance
Corrected Model	358.942	11	32.631	19.623	0.000
Intercept	0.345	1	0.345	0.207	0.649
Logistical Site Type (Factor)	171.395	9	19.044	11.452	0.000
ln (Actively Used Area)(Covariate)	21.580	1	21.580	12.978	0.000
ln(Employment) (Covariate)	20.049	1	20.049	12.057	0.001
Error	291.002	175	1.663		
Total	1.767.691	187			
Corrected Total	649.944	186			

Pairwise comparisons of the logistical sites for TIR trips were made by post-hoc tests for multiple comparisons ANCOVA analysis provided by SPSS (Nie *et al.*, 1975). LSD test, which assumes equality of variances and is provided by SPSS among various ad-hoc tests results are given in Table 5.7. If the LSD test result indicates a significant difference between pairwise comparisons, then those sites cannot be placed in the same group; but if they are not significantly different, then they can be joined in the same group. So, those logistical sites which resulted with insignificant differences were grouped together. In order to see the groups clearly the logistical sites were ordered as given in Table 5.7.

Figure 5.3 shows the estimated means which were adjusted for the factor and the covariates for ln(TIR). The results obtained from Table 5.7 and Figure 5.3 indicates that there are three groups which are shown on Figure 5.3 and these are given below:

- Group 1: “Ports” and “regional logistics companies”: This group generates the highest number of TIR trips.
- Group 2: “General warehouses”, “national depots” and “liquid storage areas”
- Group 3: “Large manufacturer depots”, “coal storage depots”, “small industrial sites”, “Large factories” and “other factories”. This group produces the lowest number of TIR trips.

Table 5.7. Pairwise Comparisons for TIR Trips at Logistical Sites.

			GROUP 1		GROUP 2			GROUP 3				
	Logistical Site Type	Mean ln (TIR Trips) Estimates	Regional Logistics Company	Port	General Warehouse	National Depot	Liquid Storage Area	Small Industrial Site	Coal Storage Depot	Large Factory	Other Factory and Production Site	Large Manufacturer Depot
GROUP 1	Regional Logistics Company	4.512		0.015 (0.981)	1.137 (0.035)	1.476 (0.002)	1.744 (0.000)	2.386 (0.000)	2.507 (0.000)	2.828 (0.000)	2.880 (0.000)	3.218 (0.000)
	Port	4.497	-0.015 (0.981)		1.122 (0.063)	1.461 (0.013)	1.730 (0.003)	2.372 (0.000)	2.492 (0.000)	2.813 (0.000)	2.865 (0.000)	3.203 (0.000)
GROUP 2	General Warehouse	3.375	-1.137 (0.035)	-1.122 (0.063)		0.338 (0.486)	0.607 (0.201)	1.249 (0.040)	1.370 (0.004)	1.691 (0.003)	1.743 (0.001)	2.081 (0.000)
	National Depot	3.036	-1.476 (0.002)	-1.461 (0.013)	-0.338 (0.486)		0.269 (0.541)	0.911 (0.098)	1.032 (0.020)	1.352 (0.007)	1.405 (0.001)	1.742 (0.001)
	Liquid Storage Area	2.768	-1.744 (0.000)	-1.730 (0.003)	-0.607 (0.201)	-0.269 (0.541)		0.642 (0.241)	0.763 (0.075)	1.084 (0.028)	1.136 (0.011)	1.474 (0.001)
GROUP 3	Small Industrial Site	2.125	-2.386 (0.000)	-2.372 (0.000)	-1.249 (0.040)	-0.911 (0.098)	-0.642 (0.241)		0.121 (0.829)	0.442 (0.312)	0.494 (0.304)	0.832 (0.123)
	Coal Storage Depot	2.005	-2.507 (0.000)	-2.492 (0.000)	-1.370 (0.004)	-1.032 (0.020)	-0.763 (0.075)	-0.121 (0.829)		0.321 (0.524)	0.373 (0.412)	0.711 (0.175)
	Large Factory	1.684	-2.828 (0.000)	-2.813 (0.000)	-1.691 (0.003)	-1.352 (0.007)	-1.084 (0.028)	-0.442 (0.312)	-0.321 (0.524)		0.052 (0.901)	0.390 (0.422)
	Other Factory and Production Site	1.632	-2.880 (0.000)	-2.865 (0.000)	-1.743 (0.001)	-1.405 (0.001)	-1.136 (0.011)	-0.494 (0.304)	-0.373 (0.412)	-0.052 (0.901)		0.338 (0.422)
	Large Manufacturer Depot	1.294	-3.218 (0.000)	-3.203 (0.000)	-2.081 (0.000)	-1.742 (0.001)	-1.474 (0.001)	-0.832 (0.123)	-0.711 (0.175)	-0.390 (0.422)	-0.338 (0.422)	

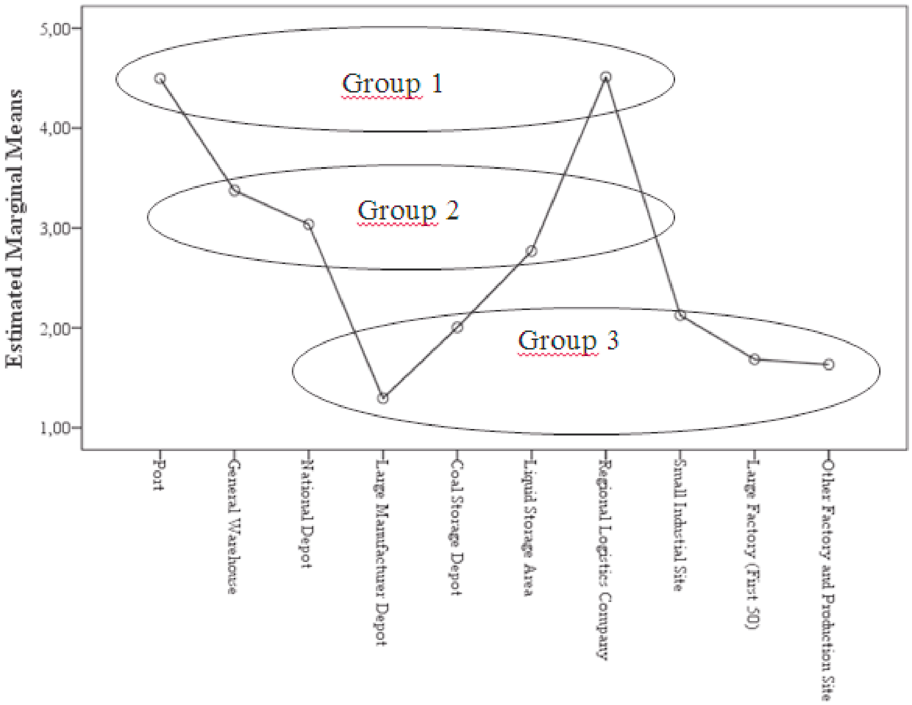


Figure 5.3. Means Plot for ln (TIR).

It should be noted from Table 5.7 that small industrial sites and liquid storage areas also showed similar TIR trip generation characteristics; however, since small industrial sites did not have the generation similarities with other logistical sites of Group 2, they were considered in Group 3.

5.3.2. Segmentation Using Truck and Van Trips with ANCOVA

This section explains the groups obtained from the ANCOVA of truck and van trips. Results of ANCOVA for ln(Truck+Van) are presented in Table 5.8. When the significances of the F statistics of each variable are checked, it can be seen that the hypothesis of equality of intercept and the coefficient of ln(Actively Used Area) to zero cannot be while the coefficients for logistical site type and ln(Employment) are not zero. Therefore, the analysis has been repeated with only ln(Employment) as a covariate, and the results are given in Table 5.9. Also, significance of the F statistic of the corrected model indicates that the factor and the covariates have a jointly significant effect on the dependent variable.

Table 5.8. ANCOVA for ln(Truck+Van).

Source	Type III Sum of Squares	ν	Mean Square	F statistic	Significance
Corrected Model	282.102	11	25.646	12.946	0.000
Intercept	4.698	1	4.698	2.372	0.125
Logistical Site Type (Factor)	141.972	9	15.775	7.963	0.000
ln(Actively Used Area) (Covariate)	0.073	1	0.073	0.037	0.848
ln(Employment) (Covariate)	30.709	1	30.709	15.502	0.000
Error	346.677	175	1.981		
Total	1970.873	187			
Corrected Total	628.779	186			

Table 5.9. ANCOVA for ln(Truck+Van) without ln(Actively Used Area).

Source	Type III Sum of Squares	ν	Mean Square	F statistic	Significance
Corrected Model	282.03	10	28.203	14.315	0.000
Intercept	5.165	1	5.165	2.622	0.107
Logistical Site Type (Factor)	147.077	9	16.342	8.295	0.000
ln(Employment) (Covariate)	45.361	1	45.361	23.024	0.000
Error	346.749	176	1.97		
Total	1970.873	187			
Corrected Total	628.779	186			

Table 5.10 and Figure 5.4 give the pairwise comparisons and means for ln (Truck + Van), respectively. They were constructed using the same methodology of Table 5.7 and Figure 5.3. The level of significance for the data in Table 5.10 is 0.10 and here, similar to the case of TIR trips, three groups were observed as can also be seen in Table 5.10 and Figure 5.4. In addition, it should be noted that, the groups are different for ln(Truck+Van) from ln(TIR). The groups are the following:

- Group 1: "Ports", "large manufacturer depots", "coal storage depots", "liquid storage areas" and "small industrial sites": This group produces the most truck and van trips.
- Group 2: "National depots", "large factories" and "other factories".
- Group 3: "General warehouses" and "regional logistics companies": This group generates the lowest amount of truck and van trips.

Table 5.10. Pairwise Comparisons for Truck and Van Trips at Logistical Sites.

			GROUP 1					GROUP 2			GROUP 3	
	Logistical Site Type	Mean ln(Truck +Van Trips) Estimates	Small Industrial Site	Large Manufacturer Depot	Port Port	Coal Storage Depot	Liquid Storage Area	National Depot	Large Factory	Other Factory and Production Site	General Warehouse	Regional Logistics Company Company
GROUP 1	Small Industial Site	4.219		0.322 (0.580)	0.696 (0.282)	0.732 (0.199)	0.803 (0.159)	1.601 (0.006)	1.816 (0.000)	2.172 (0.000)	2.555 (0.000)	3.075 (0.000)
	Large Manufacturer Depot	3.897	-0.322 (0.580)		0.374 (0.555)	0.410 (0.411)	0.480 (0.339)	1.278 (0.013)	1.494 (0.005)	1.850 (0.000)	2.333 (0.000)	2.752 (0.000)
	Port	3.523	-0.696 (0.282)	-0.374 (0.555)		0.036 (0.953)	0.107 (0.862)	0.905 (0.149)	1.120 (0.051)	1.476 (0.011)	1.859 (0.005)	2.379 (0.000)
	Coal Storage Depot	3.487	-0.732 (0.199)	-0.410 (0.411)	-0.036 (0.953)		0.071 (0.879)	0.869 (0.065)	1.084 (0.036)	1.440 (0.001)	1.823 (0.000)	2.752 (0.000)
	Liquid Storage Area	3.417	-0.803 (0.159)	-0.480 (0.339)	-0.107 (0.862)	-0.071 (0.879)		0.798 (0.095)	1.014 (0.048)	1.370 (0.001)	1.753 (0.001)	2.272 (0.000)
GROUP 2	National Depot	2.619	-1.601 (0.006)	-1.278 (0.013)	-0.905 (0.149)	-0.869 (0.065)	-0.798 (0.095)		0.216 (0.684)	0.572 (0.187)	0.955 (0.067)	1.474 (0.002)
	Large Factory	2.403	-1.816 (0.000)	-1.494 (0.005)	-1.120 (0.051)	-1.084 (0.036)	-1.014 (0.048)	-0.216 (0.684)		0.356 (0.431)	0.739 (0.191)	1.259 (0.013)
	Other Factory and Production Site	2.047	-2.172 (0.000)	-1.850 (0.000)	-1.476 (0.011)	-1.440 (0.001)	-1.370 (0.001)	-0.572 (0.187)	-0.356 (0.431)		0.383 (0.417)	0.902 (0.034)
GROUP 3	General Warehouse	1.664	-2.555 (0.000)	-2.333 (0.000)	-1.859 (0.005)	-1.823 (0.000)	-1.753 (0.001)	-0.955 (0.067)	-0.739 (0.191)	-0.383 (0.417)		0.519 (0.312)
	Regional Logistics Company	1.145	-3.075 (0.000)	-2.752 (0.000)	-2.379 (0.000)	-2.752 (0.000)	-2.272 (0.000)	-1.474 (0.002)	-1.259 (0.013)	-0.902 (0.034)	-0.519 (0.312)	

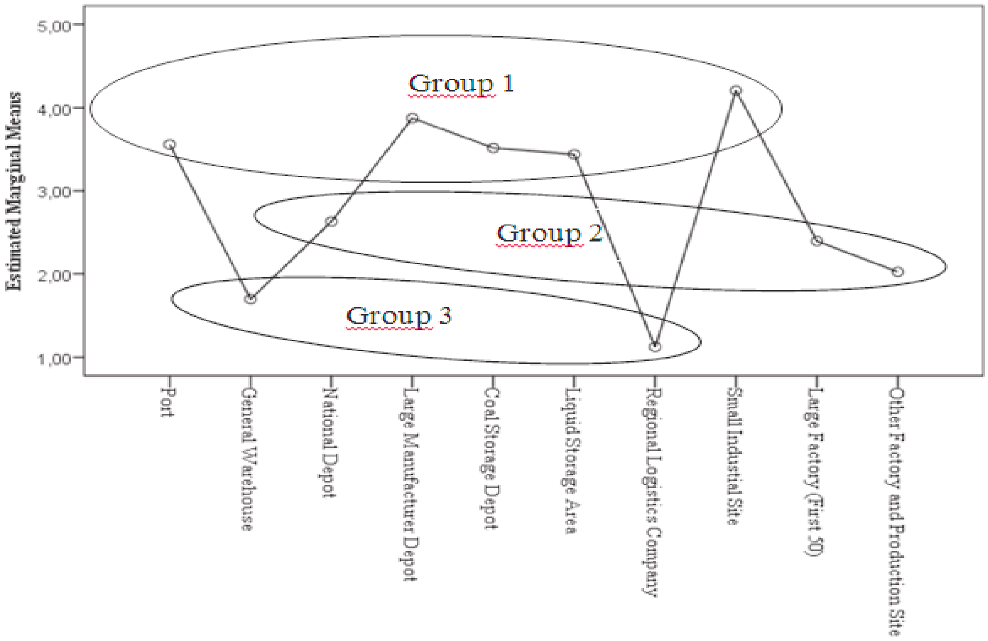


Figure 5.4. Means Plot for ln(Truck+Van).

General warehouses are also similar to large and other factories in terms of truck and van trip generation, however, they are different from national depots. Since they are not similar to national depots, they are grouped with regional logistics companies to form Group 3.

It should be noted that ANCOVA analysis using TIR trips and Truck+van trips resulted in a quite different set of groups. This is also an indication that trip generation of these categories of vehicle trips behave quite independently.

5.3.3. Checking the Validity of Logistical Site Groups

After the construction of the logistical site groups using both TIR and truck+van trips, the groups were further checked if they are statistically different. This was done using ANCOVA with one analysis for TIR trips and another one for truck+van trips, with the same covariates used to determine the groups. The factor in these ANCOVA analyses was the group type. However, it is also required that all the groups should be different from each other as well. Therefore, Tukey LSD post-hoc test was conducted for pairwise comparisons.

For TIR trips, the ANCOVA output is given in Table 5.11. As can be observed, the significance of F statistic of "Group for TIR" is 0.000; thus we can say that group type of logistical sites has an effect on number of TIR trips. The Levene's test statistics is shown in Table 5.12, and it can be said that the variances can be equal to each other since the significance of test statistic is 0.367; greater than the 0.05 level of significance. So, ANCOVA in Table 5.11 is said to be robust. From the pairwise comparisons given in Table 5.13, it can be seen that none of the pairs of groups are statistically similar to each other: The significance values of the mean difference statistics are 0.000. Thus, groups built using ANCOVA for TIR trips are valid.

Table 5.11. ANCOVA between the Logistical Site Groups for ln(TIR).

Source	Type III Sum of Squares	ν	Mean Square	F statistic	Significance
Corrected Model	350.799	4	87.7	53.356	0.000
hline Intercept	7.762	1	7.762	4.723	0.031
Group for TIR (Factor)	163.251	2	81.625	49.661	0.000
Ln (Actively Used Area) (Covariate)	51.075	1	51.075	31.074	0.000
Ln (Employment) (Covariate)	33.197	1	33.197	20.197	0.000
Error	299.145	182	1.644		
Total	1767.691	187			
Corrected Total	649.944	186			

Table 5.12. Levene's test for ANCOVA in Table 5.7.

Levene Statistic	ν_1	ν_2	Significance
1.007	2	184	0.367

Table 5.13. Pairwise Comparisons of TIR Groups.

Group	Mean ln(TIR Trips) Estimates	1	2	3
1	4.52		1.549 (0.000)	1.776 (0.000)
2	2.971	-1.549 (0.000)		1.228 (0.000)
3	1.744	-1.776 (0.000)	-1.228 (0.000)	

Similar to the case of TIR trips, the groups built using truck and van trips also are statistically different from each other as a result of ANCOVA, which is shown in Table 5.14. As shown in Table 5.15, Levene's test revealed that the variances can be equal to each other, since the significance of the test is 0.195. Pairwise comparisons of the groups for truck and van trips are given in Table 5.16. It can be observed that all of the significances of mean differences between groups are lower than 0.05. So, it can be concluded that none of the groups are statistically similar to each other in terms of generated truck and van trips, and the groups are valid.

Table 5.14. ANCOVA between the logistical site groups for ln(Truck+Van).

Source	Type III Sum of Squares	ν	Mean Square	F statistic	Significance
Corrected Model	270.574	3	90.191	46.077	0.000
Intercept	0.454	1	0.454	0.232	0.631
Ln (Employment) (Covariate)	124.03	1	124.03	63.364	0.000
Group for Truck+ +Van (Factor)	135.621	2	67.811	34.643	0.000
Error	358.205	183	1.957		
Total	1970.873	187			
Corrected Total	628.779	186			

Table 5.15. Levene's test for ANCOVA in Table 5.10.

Levene Statistic	ν_1	ν_2	Significance
1.649	2	184	0.195

Table 5.16. Pairwise Comparisons of Truck and Van Groups.

Group	Mean ln(Truck +Van Trips) Estimates	1	2	3
1	3.692		1.393 (0.000)	2.290 (0.000)
2	2.299	-1.393 (0.000)		0.898 (0.004)
3	1.401	-2.290 (0.000)	-0.898 (0.004)	

5.4. Regression Models and Market Segmentation for FTG

In this section, FTG models using regression models were built for the logistical site groups obtained from ANCOVA results in Section 5.2. This analysis had two main goals: Investigation of the usefulness of market segmentation for FTG and checking another measure of validity of the grouping that were identified with ANCOVA analysis reported (the first measure of validity is explained in Section 5.2.3). That is, if the null hypothesis tested with the market segmentation is not rejected, this would mean that the groups are homogeneous in terms of their trip generation characteristics. Of course, investigation of this second goal in particular has many practical implications. For instance, if the identified groups are homogeneous, then it will not be necessary to have separate models for each logistical site, and furthermore in future logistical studies, sampling could be made for the groups rather than the individual logistical sites and hence the sample sizes could be reduced.

5.4.1. Preliminary Analysis of Model Variables

In order to investigate the relationships among the dependent and independent variables, scatter plots shown in Figure 5.5 to Figure 5.12 were obtained. Scatter plots in this section consisted of all sites in data with 187 observations. Two independent variables; actively used area and employment; and two dependent variables; number of TIR trips and sum of truck and van trips were the subject of regression model development and market segmentation analysis.

Figure 5.5 and Figure 5.6 show the scatter plots of TIR trips with actively used area and employment, respectively. R^2 values of the linear fits for both plots indicate that actively used area has a better relationship with TIR trips compared to employment, since it has a higher R^2 value with 0.229, but these relationships seem to be weak.

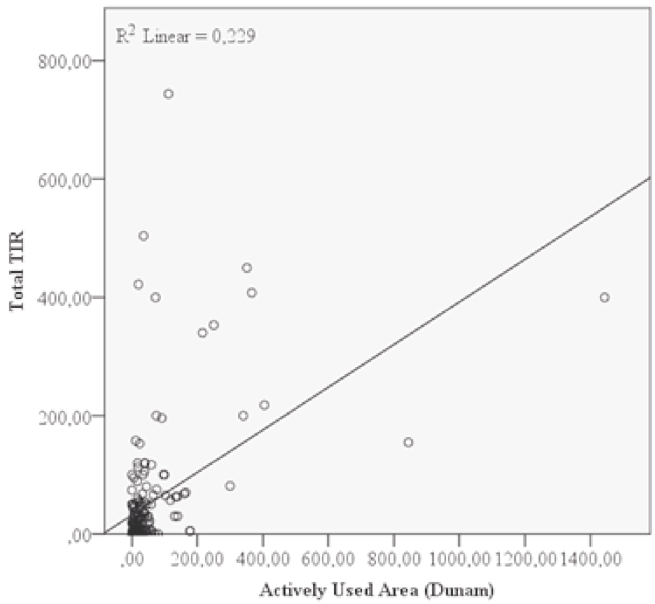


Figure 5.5. Scatter Plot of Total TIR Trips and Actively Used Area.

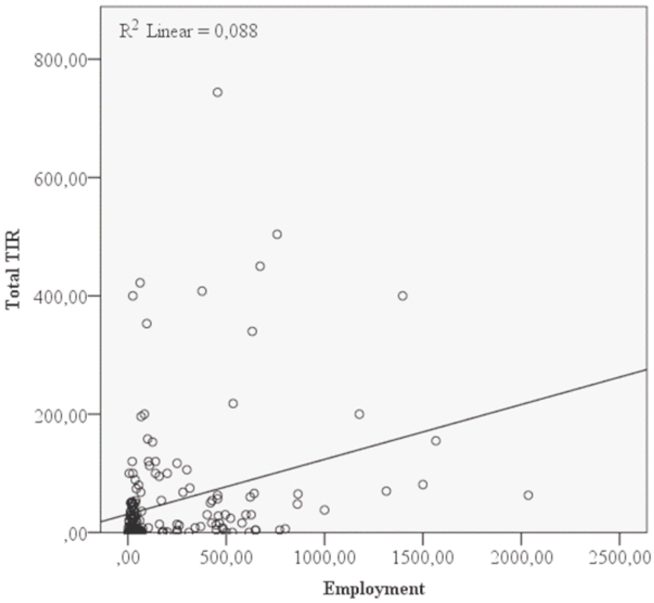


Figure 5.6. Scatter Plot of Total TIR Trips and Employment.

From Figure 5.7 and Figure 5.8, it can be observed that employment and actively used area have even poorer relationships with number of truck and van trips with R^2 values of 0.105 and 0.013, respectively. One of the reasons for these very poor relationships were the extreme skewnesses that were observed in these variables. As explained in both Chapter 4 and Section 5.2, to correct for this and normalize the distributions as much as possible, natural logarithms of the variables were taken as a transformation, and scatter plots among the dependent and independent variables were obtained again. Figure 5.9 and Figure 5.10 show the scatter plots of ln(TIR Trips) with ln(Actively Used Area) and ln(Employment), respectively. As can be observed in both figures, and also be inferred from R^2 values, better relationships wer obtained using the logarithmic transformations.

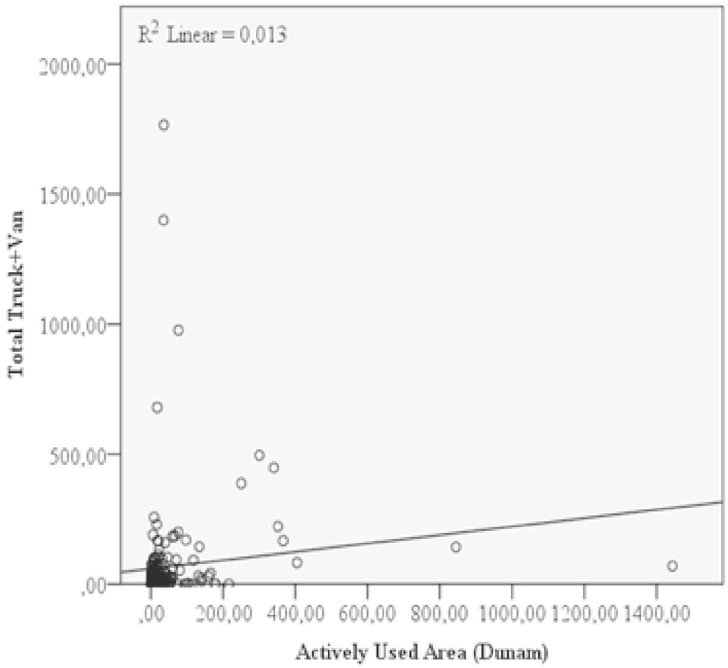


Figure 5.7. Scatter Plot of the Total Truck and Van Trips and Actively Used Area.

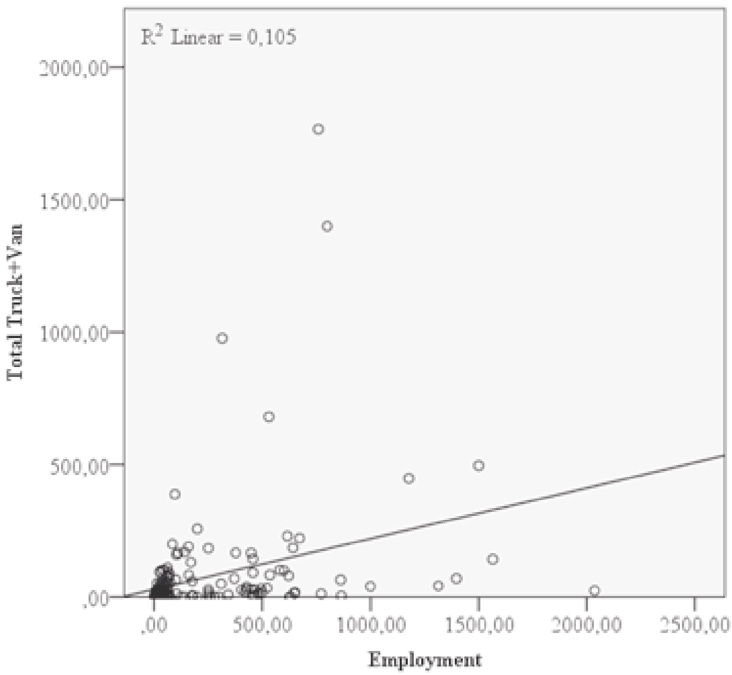


Figure 5.8. Scatter Plot of the Total Truck and Van Trips and Employment.

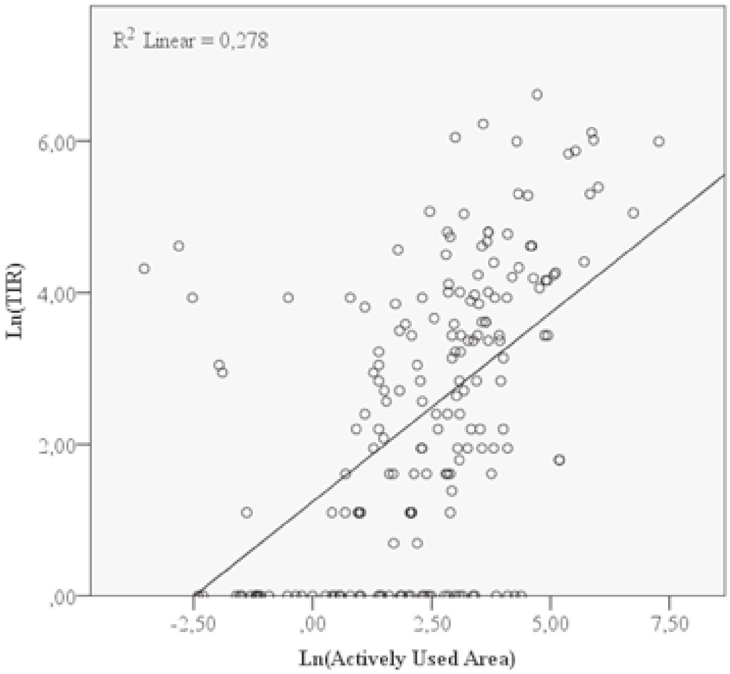


Figure 5.9. Scatter Plot of ln(TIR trips) and ln(Actively Used Area).

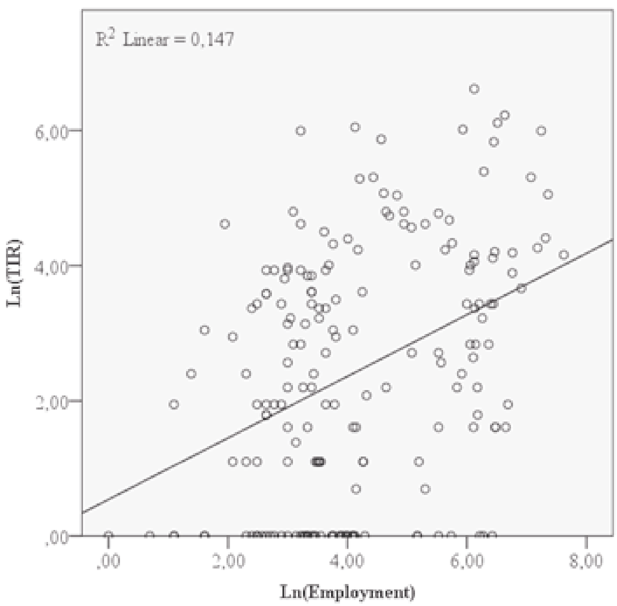


Figure 5.10. Scatter Plot of ln(TIR trips) and ln(Employment).

The same logarithmic transformation was also applied for truck and van trips. The plots with logarithmically transformed variables for truck and van trips with actively used area and employment are given in Figure 5.11 and Figure 5.12, respectively. Again, ln(Employment) and Ln(Actively Used Area) show better linear relationships with R^2 values of 0.215 and 0.113 respectively, compared to non-transformed cases.

It can be concluded that the trip generation of TIRs are more related to the logistical site's actively used area while truck and van trip generation is more affected by the employment at the facility.

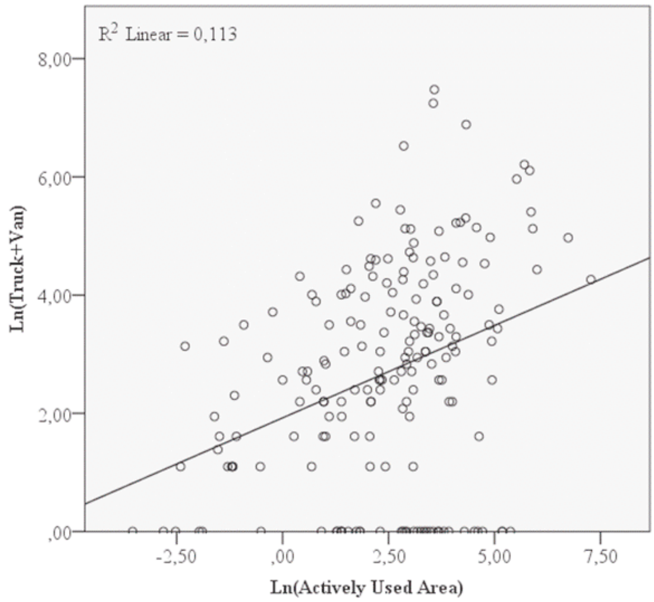


Figure 5.11. Scatter Plot of ln(Truck+Van trips) and ln(Actively Used Area).

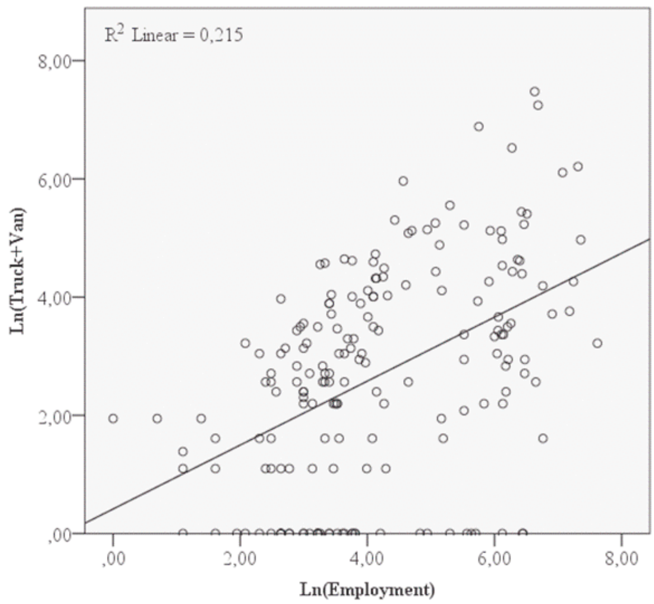


Figure 5.12. Scatter Plot of ln(Truck+Van trips) and ln(Employment).

5.4.2. Market Segmentation Analysis for TIR Trips

Regression analysis with the market segmentation approach for the three logistical site groups obtained from ANCOVA analysis for TIR trips was conducted. First, the best fit for the pooled model were chosen and then using the same variables, regressions were made for each segment in each group. Next, the hypothesis of "market segmentation did not improve the fit" was tested using the F-test explained in Section 3.4. The level of significance for the market segmentation's F-test is 0.05 while it is 0.10 for the t-tests of validity of model coefficients.

5.4.2.1. Group 1. Table 5.17 shows the regression model output for Group 1 in which the dependent variable was the number of TIR trips and the independent variable was the actively used area of the facility. Total employment was insignificant as an independent variable. The null hypothesis for market segmentation for Group 1 is given below:

$$H_0 : \beta_1 = \beta_2 = \beta_G \tag{5.1}$$

where β_1 and β_2 are the model coefficients for first and second segmented models whereas β_1 is the model coefficient for the pooled model. The null hypothesis for the hypothesis has an F-distribution and is tested with level of significance of 0.05 by:

$$F = \frac{(SSR - SSR_G)/\nu_1}{SSR_G/\nu_2} \upsilon \tag{5.2}$$

where SSR is residual sum of squares of the pooled model, SSR_G is the sum of the residual sum of squares of each segment models; ν_1 is the first degrees of freedom, equal to $K(NG - 1)$ and ν_2 is the second degrees of freedom, equal to $N - (KxNG).K$ is the number of parameters and NG is the number of segments.

The calculations for Group 1 are given as an example in the following:

$$K = 2; NG = 2; = 2\,(2-1) = 2; = 26 - (2x2) = 22; = 105503 \tag{5.3}$$

$$F_{calculated} = \frac{(133579 - 105503)/2}{105503/22} = 2.93 F_{\alpha,\nu_1,\nu_2} = 3.44 \tag{5.4}$$

The F-test resulted in the inability of rejection of the null hypothesis since $F_{calculated}$ is lower than the table F value, and concluded that market segmentation did not improve the fit, and one could use the pooled model. This is a further support for the homogeneity of the group in terms of trip generation. It should be noted that for Group 1, no logarithmic transformations were applied since it provided better R^2 values compared to the transformed case. In addition, F statistics of all models in Table 5.17 show that there is a positive relationship with actively used area and TIR trip generation.

Table 5.17. Regression Output for Group 1 of TIR Trips.

TIR Group 1	Model Coefficients (Significance)		R^2	Sum of Squares		N	F-statistic (Significance)
	Constant	Actively Used Area		Regression	Error		
Pooled Model	58.614 (0.000)	1.070 (0.000)	0.705	319949	133579	26	57.485 (0.000)
Port	146.462 (0.085)	0.734 (0.070)	0.447	67511	83452	8	4.854 (0.070)
Regional Logistic Company	36.023 (0.003)	2.266 (0.006)	0.38	13533	22051	18	9.820 (0.006)
Market Segmentation Test							
F calculated	2.93						
F table	3.44						

5.4.2.2. Group 2. The situation was different for Group 2; when the variables were transformed using natural logarithm, the relationship for pooled models became better. In Group 2, the best fit was obtained by including ln(Actively used area) and ln(Employment) as independent variables and ln(TIR) as the dependent variable; as shown in Table 5.18. However, it should be noted that these variables did not give a proper model for segment of national depot since both independent variables turned out to be insignificant in that segment's model. This segment was covered only by the pooled model. Thus, this also showed that grouping the logistical sites was a useful method since the pooled model can be used for all the segments. It should also be mentioned that the F-test for market segmentation with the level of significance of 0.05 again could not reject the null hypothesis.

Table 5.18. Regression Output for Group 2 of TIR Trips.

TIR Group 2	Model Coefficients (Significance)			R^2	Sum of Squares		N	F-statistic (Significance)
	Constant	ln(Actively Used Area)	ln (Employment)		Regression	Error		
Pooled Model	-0.319 (0.659)	0.367 (0.055)	0.629 (0.003)	0.301	33.851	78.608	48	9.689 (0.000)
General Warehouse	0.974 (0.379)	-0.220 (0.482)	0.951 (0.002)	0.633	17.931	10.378	13	8.639 (0.007)
National Depot	1.006 (0.346)	0.259 (0.349)	0.304 (0.319)	0.155	4.072	22.249	17	1.281 (0.308)
Liquid Storage Area	-3.400 (0.074)	1.339 (0.030)	1.037 (0.316)	0.483	25.853	27.686	18	7.004 (0.007)
Market Segmentation Test								
F calculated	2.12							
F table	2.33							

5.4.2.3. Group 3. Similar situation to Group 2 was also observed in Group 3: Transformed variables were used, and the segment model for coal storage depot had the independent variable insignificant, which was ln(Actively used area). The F-test for market segmentation shows that one cannot reject the null hypothesis for market segmentation with a level of significance of 0.05 as shown in Table 5.19. Thus, it can be said that pooled model can be used for Group 3 for TIR trips. On another note, it should be noted that this group generated the least amount of TIR trips; 41 out of 113 facilities did not generate any TIR trips.

Table 5.19. Regression Output for Group 3 of TIR Trips.

TIR Group 3	Model Coefficients (Significance)		R^2	Sum of Squares		N	F-statistic (Significance)
	Constant	ln(Actively Used Area)		Regression	Error		
Pooled Model	0.369 (0.055)	0.650 (0.000)	0.507	196.658	190.883	113	114.359 (0.000)
Large Manufacturer Depot	0.234 (0.345)	0.493 (0.003)	0.544	10.113	8.476	14	14.316 (0.003)
Coal Storage Depot	0.404 (0.672)	0.446 (0.119)	0.137	6.537	41.157	19	2.700 (0.119)
Small Industrial Site	0.751 (0.517)	0.729 (0.000)	0.282	11.481	29.255	12	3.925 (0.076)
Large Factory	-0.795 (0.261)	0.992 (0.000)	0.472	55.11	61.715	39	33.040 (0.000)
Other Factory and Production Site	0.522 (0.012)	0.500 (0.000)	0.432	19.886	26.144	29	20.537 (0.000)
Market Segmentation Test							
F calculated	1.86						
F table	2.04						

5.4.3. Market Segmentation Analysis for Truck and Van Trips

The analysis made for groups of TIR trips were also conducted for the groups developed for truck and van trips. The level of significance for the F-test of market segmentation is again 0.05 and for the t-test of model coefficients is 0.10. As explained in Section 5.2, there are three groups (segments) of logistical sites for truck and van trips as well.

5.4.3.1. Group 1. From Table 5.20, it can be seen from the table F and calculated F values that segmentation cannot be said to improve the fit. The significance of the F statistic of the segment model for “small industrial sites” shows that, the model coefficients may be equal to zero.

Table 5.20. Regression Output for Group 1 of Truck and Van Trips.

Truck+Van Group 1	Model Coefficients (Significance)		R^2	Sum of Squares		N	F-statistic
	Constant	ln(Employment)		Regression	Error		(Significance)
Pooled Model	0.475 (0.348)	0.786 (0.000)	0.371	71.823	121.783	71	40.694 (0.000)
Port	-3.373 (0.376)	1.519 (0.084)	0.417	17.545	24.498	8	4.297 (0.084)
Large Manufacturer Depot	1.784 (0.000)	0.504 (0.000)	0.8	6.46	1.61	14	48.138 (0.000)
Coal Storage Depot	0.637 (0.578)	0.733 (0.047)	0.213	4.412	16.326	19	4.594 (0.047)
Liquid Storage Area	-2.741 (0.053)	1.713 (0.000)	0.552	21.511	17.428	18	19.748 (0.000)
Small Industrial Site	1.879 (0.493)	0.548 (0.276)	0.117	6.064	45.693	12	1.327 (0.276)
Market Segmentation Test							
1lF calculated	1.17						
F table	2.09						

5.4.3.2. Group 2. As indicated by the F-statistic of the market segmentation test in Table 5.21, segmentation improved the fit in Group 2; hence, the null hypothesis of the market segmentation can be rejected. Thus, information about other variables should be collected and investigated. Actively used area was not investigated as an independent variable in this group since the pooled model produced better results with employment. From the F statistics of segmented models, it can be observed that for "large factories" and "other factories", it is not possible to build a linear regression model using ln(Employment) as the independent variable. However, pooled model is valid as its significance of F statistic is 0.000 and it explains "large factories" and "other factories" as well; hence, using pooled model for this group is appropriate.

Table 5.21. Regression Output for Group 2 of Truck and Van Trips.

Truck+Van Group 2	Model Coefficients (Significance)		R^2	Sum of Squares		N	F-statistic
	Constant	ln(Employment)		Regression	Error		(Significance)
Pooled Model	0.384 (0.380)	0.469 (0.000)	0.263	55.253	155.421	85	29.651 (0.000)
National Depot	-1.039 (0.390)	0.993 (0.013)	0.346	19.026	35.987	17	7.930 (0.013)
Large Factory	-0.871 (0.754)	0.690 (0.121)	0.064	4.654	68.323	39	2.520 (0.121)
Other Factory and Production Site	2.209 (0.000)	- 0.131 (0.380)	0.029	0.741	25.12	29	0.797 (0.380)
Market Segmentation Test							
F calculated	3.97						
F table	2.49						

5.4.3.3. Group 3. In Group 3, models were developed without transformation of the variables because they resulted in better fits. From the calculated and tabular F values for market segmentation test in Table 5.22, it can be inferred that segmentation did not improve the fit for Group 3 and pooled model explained the trip generation better than segmented models did. Significance values of model coefficients imply that employment explains the truck and van trip generation at general warehouses and regional logistics companies. However, it should also be noted that as can be seen in Section 6, this group generates the lowest number of truck and van trips and out of 31 observations, 22 facilities do not generate any truck or van trips.

Table 5.22. Regression Output for Group 3 of truck and Van Trips.

Truck+Van Group 3	Model Coefficients (Significance)		R^2	Sum of Squares		N	F-statistic
	Constant	Employment		Regression	Error		(Significance)
Pooled Model	-7.065 (0.395)	0.459 (0.000)	0.382	21899	35435	31	17.922 (0.000)
General Warehouse	-6.231 (0.639)	0.423 (0.009)	0.475	14441	15979	13	9.941 (0.009)
Regional Logistics Company	-12.308 (0.352)	0.601 (0.020)	0.296	7933	18879	18	6.723 (0.020)
Market Segmentation Test							
F calculated	0.22						
F table	3.35						

5.5. Conditional Model Approach for the Groups with the Lowest Estimated Mean of Vehicles Generated for FTG

A conditional model was proposed to model the FTG of each vehicle type, as explained in Section 3.5. Results for both vehicles types were given in this section.

5.5.1. TIR

Group 3 of the logistical sites for TIR trips has the highest number of zero-TIR trip generators with 41 out of 113 establishments. Thus, the proposed conditional model was applied to this group only since the other two groups have a much lower amount of zero-TIR trip generators: Group 2 had 6 and Group 1 had 0 of them. So, for Groups 1 and 2, it was assumed that using pure linear regression model for FTG of TIRs would be sufficient.

In addition to the variables related to logistical site characteristics, such as total area, actively used area and employment, a dummy variable related to the activities, "ActDummy", was introduced to help explain if the TIR trip generation depends on the activity type of an establishment. If more than 50% of the establishments for a given activity generate TIR trips, then that activity is considered to be a TIR trip-generating activity. Including activity types in modeling efforts is important since some of the activities result in TIR trip generation while others do not; so, this dummy variable helped for explaining the role of the activity in producing TIR trips. Fischer and Han (2001) stated the importance of stratification in activity types. The introduced dummy variable of subject is formulated as follows:

$$\text{ActDummy} = \begin{cases} 1, & \text{if the activity causes generation of TIR trips} \\ 0, & \text{otherwise} \end{cases} \tag{5.5}$$

Similarly, for the linear regression part of the proposed model, another dummy variable was introduced, "TIRDummy", which was formulated as follows:

$$\text{TIRDummy} = \begin{cases} 1, & \text{if only TIR trips are generated} \\ 0, & \text{otherwise} \end{cases} \tag{5.6}$$

This variable was created because an establishment is expected to generate more TIR trips when there are no truck or van trips generated. Existence of only TIR trips at an establishment is related to logistics of the establishment and with this variable, it has been aimed to develop a connection between the logistical decisions and FTG. Five of the facilities had this dummy variable equal to 1.

For model calibration, five groups of 84 cases each out of the 113 total cases in Group 3 were randomly chosen using "Exactly 84 cases of the first 113 cases" sampling option in SPSS software and the remaining data for each sample was used for validation.

Since the models include the natural logarithms of both number of TIR trips and actively used area; in order to model the zero-trip producing factories in pure regression model, a constant of 1 was added to the number of TIR trips, as ln(0) is undefined.

The coefficients and statistics obtained from the calibration of five samples for both modeling approaches are given in Table 5.23. As one can observe from the F-statistics of the pure regression models, the null hypothesis stating that all variables are equal to zero can easily be rejected with at least 95% level of confidence. Furthermore, all coefficients of explanatory variables, except constants for Samples 1 and 3 individually are statistically different from 0 with at least 95% level of confidence. All models have R2 values higher than 0.500, which means that more than 50% of the total variance in the dependent variable is explained by the independent variables in the models.

For the binary logit part of the conditional model, significance values of the chi-squared test statistic for all samples are very close to 0, therefore, it can be concluded that the null hypothesis stating that all variables in the utility function of the binary logit model are equal to zero can be rejected with at least 95% level of confidence. Cox and Snell R^2, Nagelkerke R^2, McFadden's R^2 (ρ^2) and Adjusted McFadden's R^2 ($\bar{\rho}^2$) values, which are measures of pseudo R^2, show that the fits of the binary logit are decent, and all models have correct percent prediction around 84%. Examining the significance values of all variables and constants, it can be seen that the null hypothesis that the coefficients being equal to zero can be rejected with at least 95% level of confidence.

Similar to pure regression models, linear regression parts of the conditional models of all samples are meaningful, which can again be seen from the significances of the F-statistics. R^2 values for all samples except Sample 4 are higher than the ones of pure regression model. This situation can be attributed to the fact that in conditional models' linear regression parts, there are no zero-TIR trip producing facilities. The constants in linear regression parts of the models are not significantly different from zero which simply means that the regression line goes through the origin. The coefficients of explanatory variables are all significantly different from zero since all the significance values less than a threshold value of 0.05.

Table 5.23. Calibration of Samples for Both Pure Linear Regression and Conditional Models.

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
	Pure Linear Regression Model				
	Model Coefficients (Significances)				
Constant	0.258 (0.229)	0.414 (0.043)	0.294 (0.174)	0.451 (0.028)	0.447 (0.041)
Ln(ActDec)	0.641 (0.000)	0.588 (0.000)	0.633 (0.000)	0.619 (0.000)	0.598 (0.000)
TIRDummy	1.658 (0.003)	1.702 (0.001)	1.663 (0.001)	1.556 (0.002)	1.903 (0.002)
	Model Statistics				
N_a	84	84	84	84	84
F-statistic (Significance)	54.611 (0.000)	53.515 (0.000)	55.412 (0.000)	55.909 (0.000)	46.231 (0.000)
R^2	0.574	0.569	0.578	0.58	0.533
	Conditional Model				
Binary Logit Part	Model Coefficients (Significances)				
ActDummy	3.112 (0.000)	3.197 (0.000)	4.244 (0.000)	4.294 (0.000)	3.515 (0.000)
Ln(ActDec)	0.937 (0.000)	0.955 (0.000)	1.160 (0.000)	1.170 (0.000)	0.846 (0.000)
Constant	-2.849 (0.000)	-2.826 (0.001)	-3.744 (0.000)	-3.645 (0.000)	-2.722 (0.001)
	Model Statistics				
N_a	84	84	84	84	84
-2Log Likelihood	57.152	54.549	45.786	43.115	51.956
Chi-Sq. test statistic (Significance)	52.343 (0.000)	56.070 (0.000)	63.709 (0.000)	65.152 (0.000)	56.311 (0.000)
Cox and Snell R^2	0.464	0.487	0.532	0.54	0.488
Nagelkerke R^2	0.637	0.665	0.73	0.745	0.674
ρ^2	0.478	0.507	0.582	0.602	0.52
$\bar{\rho}^2$	0.423	0.453	0.527	0.546	0.465
Percent Correct Predictions	79.8	85.7	85.7	88.1	83.3
Linear Regression Part	Model Coefficients (Significances)				
Constant	0.230 (0.476)	0.438 (0.204)	0.082 (0.811)	0.398 (0.260)	0.343 (0.325)
Ln(ActDec)	0.774 (0.000)	0.716 (0.005)	0.820 (0.000)	0.744 (0.000)	0.754 (0.000)
TIRDummy	1.167 (0.011)	1.185 (0.000)	1.170 (0.005)	1.124 (0.014)	1.470 (0.005)
	Model Statistics				
N_a	54	53	54	55	55
F-statistic (Significance)	43.146 (0.000)	34.490 (0.000)	44.117 (0.000)	33.554 (0.000)	34.367 (0.000)
R^2	0.629	0.58	0.634	0.563	0.569

a= Number of observations (establishments)

The outputs of the conditional model parts, i.e. the binary logit model explaining the probability of existence of TIR trips and the abundance of TIR trips, which is the product of the probability obtained with the binary model and the regression part output for abundance of the TIR trips, plotted against ln(Actively used area) are given in Figure 5.13. The predictions are for establishments where ActDummy=1 and TIRDummy=0. As can be observed, the plot shown in Figure 5.13 has an "s-shape", as it should be for a binary logit model. Figure 5.13 has a logarithmic curve, since number of TIR trips has a positively skewed distribution.

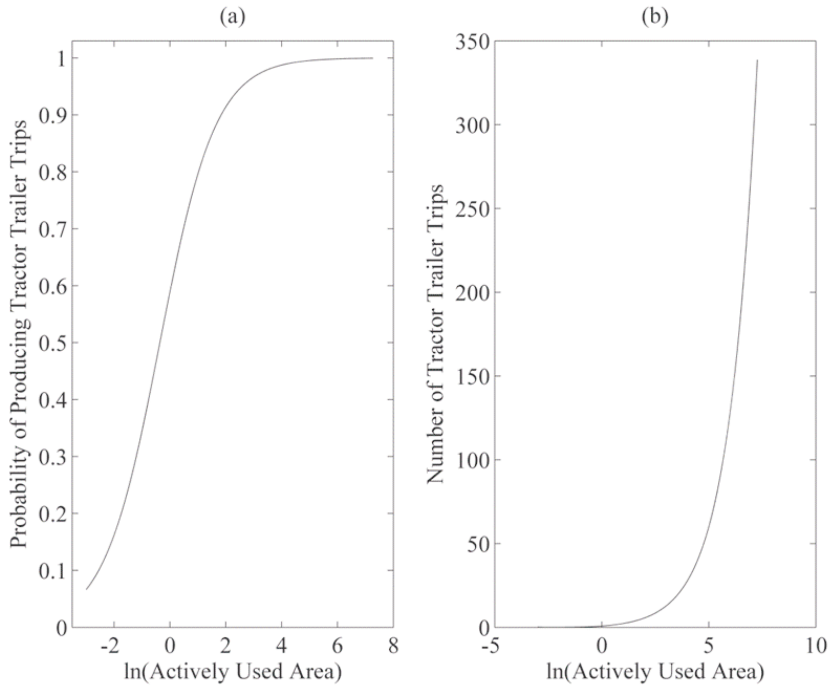


Figure 5.13. Estimates of (a) Probability of the Presence of TIR Trips, (b) Expected Abundance of TIR Trips, Plotted Against ln(Actively Used Area).

These models were then applied to forecast the TIR trips of the validation data. Table 5.24 shows the validation and comparison of the models. Two measures have been used to compare and validate the modeling approaches: RMSE and MAE: They were calculated for the validation data of the five samples. Improvements in percentages were calculated to assess the improvements by the conditional model over the pure regression model.

From Table 5.24, it can be seen that for all samples, the conditional model had smaller RMSE and MAE values than the pure regression model. When the averages of RMSE and MAE of all samples for both modeling approaches are taken, 29.58% improvement for RMSE and 23.57% improvement for MAE over the pure regression model have been observed. Thus, it can be said that the conditional model is the better modeling approach.

Table 5.24. Comparison of Pure Regression Model and Conditional Model.

	Pure Regression Model RMSE	Conditional Model RMSE	Pure Regression Model MAE	Conditional Model MAE
Sample 1	38.091	27.029	19.367	14.853
Sample 2	98.814	93.077	33.926	28.948
Sample 3	36.753	33.475	17.448	17.114
Sample 4	56.742	23.717	22.422	12.858
Sample 5	57.162	25.192	22.278	14.455
Average	57.512	40.498	23.088	17.646
Average Improvement (%)		29.58		23.57

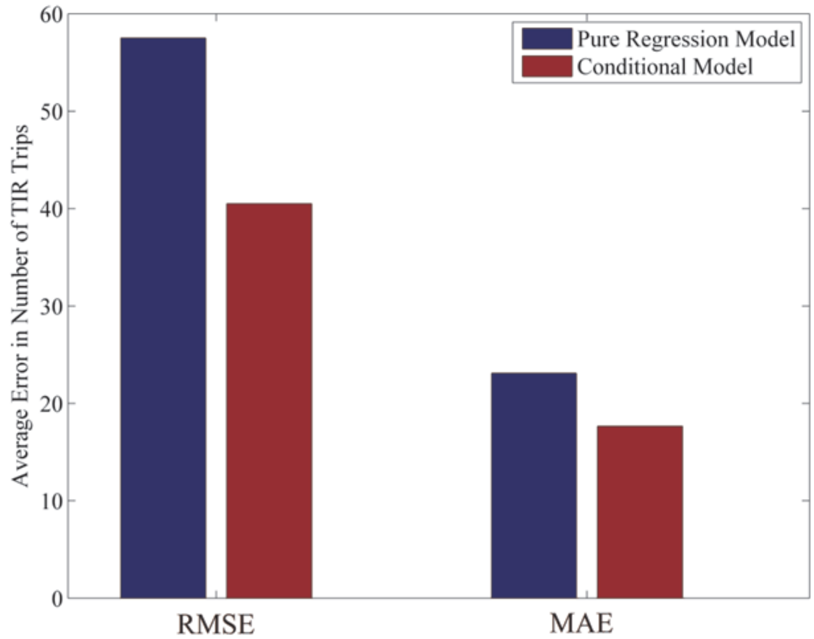


Figure 5.14. Comparison of Modeling Approaches in RMSE and MAE.

<u>5.5.1.1. Elasticity Analysis for Binary Logit for TIR Trips.</u> Elasticity of a binary logit model is the percent change in probability of an outcome when one of the attributes in the model changes one percent. Elasticity can be given as follows (Ben-Akiva and Lerman, 1985):

$$E_H(P) = \frac{H}{P}\frac{\partial(P)}{\partial(H)} \tag{5.7}$$

where H is the attribute in the model and P probability of the outcome for which the elasticity is to be determined. For the binary logit, Equation 5.7 becomes the following:

$$E^{P_{iu}}_{H_{iun}} = \beta_{in} H_{iun}(1 - P_{iu}) \tag{5.8}$$

where P_{iu} is the probability of outcome u at establishment i, β_{in} is the coefficient of independent variable n at establishment i and H_{iun} is the value of independent variable n at establishment i for outcome u.

$$E^{F=1}_{\ln(ActDec)} = 0.937 \times \ln(38) \times (1 - 0.637) = 1.24 \tag{5.9}$$

Thus, it means that 1 % change in actively used area in an establishment leads to a 1.24 % change in probability of TIR trip generation in Sample 1. Table 5.25 shows the elasticity values for all samples, with the same value of independent variable; 38 decare of actively used area. It can be seen that an average of 1.34 % change in probability of TIR trip existence was found.

Table 5.25. Elasticities of the Conditional Model.

	Ln(ActDec)	Elasticity
Sample 1	0.937	1.24
Sample 2	0.955	1.26
Sample 3	1.16	1.53
Sample 4	1.17	1.54
Sample 5	0.846	1.12
	Average:	1.34

5.5.2. Truck and Van

The conditional modeling approach was also tried for the group with highest amount of zero-trip generators of truck and van trips, which is Group 3. As shown in Section 5.2.2, Group 3 of truck and van trips consists of "General warehouses" and "regional logistics companies", and the group has 31 establishments, 22 of which generate zero truck and van trips. Group 1 of truck and van trips had 6 zero-trip generators out of 71 facilities while Group 2 had 11 of them out of 85 establishments. So, for Groups 1 and 2, similar to TIR trips, it was assumed that using pure linear regression model for FTG of truck and van trips would be sufficient.

Conditional approach could be applied to Group 3, and the results for this group are given in Table 5.26. Mostly because of the small size of the available data (only 22 establishments out of 31 had zero trips), binary logit models for Group 3 for trucks and vans could not be built successfully as shown in Table 5.26. Although the significance of the chi-squared test statistic show that the model is significant, the significances of model coefficients indicate that the hypothesis of each variable's coefficient being equal to zero cannot be rejected. Percent correct prediction is 71.0%, but the model is not successful in predicting the trip-generating facilities, as that percent correct prediction is only 11.1%. More data is needed for calibrating binary log it models for this group.

Table 5.26. Binary Logit Model.

Model Coefficients (Significances)	Ln(Employment)	0.170 (0.652)
	ActDummy	20.965 (0.999)
	Constant	-21.805 (0.999)
Model Statistics	-2Log Likelihood	28.477
	Chi-Sq. test statistic (Significance)	8.874 (0.012)
	Cox and Snell R^2	0.249
	Nagelkerke R^2	0.355
	ρ^2	0.238
	$\bar{\rho}^2$	0.077
	Percent Correct Predictions	71.0
	N	31

Developing linear regression models for the 9 establishments in the group which generate truck and van trips was possible as given in Table 5.13. In Section 5.3.3.3, it was shown that the segmentation had not improved the fit for Group 3 of truck and van trips with employment as the independent variable. So, the same variable was used to model the FTG for the 9 establishments. Significance of the F-statistic shows that the hypothesis of equality of the independent variables to 0 can be rejected with 99% level of confidence. Also, it can be seen from the R^2 value of 0.831 that the variance in dependent variable is explained by the independent variable; employment. When all establishments were considered in regression model, as shown in Section 5.3.3.3, the model is still significant as can be observed from the F statistic, but R^2 value was reduced to 0.382, thus the goodness of fit of the model decreased, due to the presence of zero-trip generators.

Table 5.27. Regression Models for Group 3.

Truck+Van Group 3	Model Coefficients (Significance)		R^2	Sum of Squares		N	F-statistic (Significance)
	Constant	Employment		Regression	Error		
Non-Zero Trip Generators Only	1.820 (0.896)	0.808 (0.001)	0.831	33289	6775	9	34.395 (0.001)
All Establishments	-7.065 (0.395)	0.459 (0.000)	0.382	21899	35435	31	17.922 (0.000)

It can be concluded that modeling truck and van trips for this group can only be made when zero-trip generators are excluded from the data. However, considering that the majority of the establishments in this group are zero-trip generators (22 of 31 establishments); it seems that with a higher sample size for this group conditional models could probably be built successfully.

5.6. Discussion of Theoretical and Practical Implications of the Results

A discussion of theoretical and practical implications of the results of this research, in relation to the past research when possible, is summarized below:

- Factor analysis in this study showed that the number of vehicles can be considered as total number of vehicles, thus, there was no need to separate them is incoming or outgoing. However, Iding *et al.*, (2002) and Holguin-Veras *et al.*, (2011) developed models for each direction of travel separately. On the other hand, Tadi and Balbach (1994) and Kulpa (2014) did not make any separation.
- Tadi and Balbach (1994) and Kulpa (2014) built models using truck classifications. In this paper, the truck types in data were grouped using factor analysis. However, Holguin-Veras *et al.*, (2011, 2013) and Iding *et al.*, (2002) had not made any vehicle-type stratification; i.e., they used one type of vehicle for all vehicles as trucks.
- Conditional model for TIR trips was compared with the regression models built by Tadi and Balbach (1994). As was given above in Table 2.2, Tadi and Balbach (1994) separated industrial establishments as “light” and “heavy”. In addition, they separated the truck types as “2, 3 axle trucks” and “4, 5, 6+ axle trucks”. This is similar to the separation made in this study for factories as “large” and “other”, and for truck types as TIR and Truck+Van. It is known that TIRs are under the category of “4, 5, 6+ axle trucks”. Also, conditional model is valid for both type of factories in this study, since they are in Group 3 for TIR trips. Thus, all validation samples of conditional model was compared with the Tadi and Balbach (1994) models for large factories and other factories separately. The results are given in Table 5.28. It can be observed that the conditional model performs better than Tadi and Balbach (1994) models in all samples and all

type of factories. In addition, as it can be seen from Table 2.2, coefficient of independent variable for heavy industries is negative. When the heavy industry model is applied to validation samples of this study, illogical results were also obtained since some of the calculated TIR trip values were negative. As a result, errors of the heavy industry models are higher than of light industries.

Table 5.28. Comparison of the Conditional Model with Regression Models of Tadi and Balbach (1994).

	Sample 1		Sample 2		Sample 3	
	RMSE	MAE	RMSE	MAE	RMSE	MAE
Conditional Model - Large Factories	31.798	20.284	37.68	25.693	51.838	33.29
Tadi and Balbach (1994) - Large Factories	145.687	89.618	243.711	133.283	273.402	153.109
Conditional Model - Other Factories	4.054	2.433	3.182	2.089	2.57	1.375
Tadi and Balbach (1994) - Other Factories	20.744	9.58	3.507	3.274	3.592	3.461
	Sample 4		Sample 5		Average	
	RMSE	MAE	RMSE	MAE	RMSE	MAE
Conditional Model - Large Factories	38.716	25.154	41.461	27.532	40.299	26.391
Tadi and Balbach (1994) - Large Factories	462.423	218.046	496.417	261.526	324.328	171.117
Conditional Model - Other Factories	1.585	1.278	3.028	2.001	2.884	1.835
Tadi and Balbach (1994) - Other Factories	3.311	3.026	3.212	3.041	6.873	4.476

- It was not possible to compare the conditional model with other models given in Chapter 2. This was because the models in Chapter 2 had different stratification schemes from this study. Iding et al. (2002) and Holguin-Veras *et al.*, (2011,

2013) built models for each industry sector separately. Kulpa (2014) on the other hand made the stratification as urban and rural areas as well as light and heavy trucks. Since the conditional model in this study did not consider those stratification types, it would not be logical to make any comparisons with the mentioned models.

- Engineering-wise, since TIRs affect the traffic more than trucks and vans do, some improvements for the roads can be made nearby the logistical sites where TIR trip generation is high ("ports" and "regional logistics companies"). From Figure 5.14, it can be seen that four of the eight ports are located in Dilovasi. On the other hand, regional logistics companies are more evenly distributed in Kocaeli, as might be needed in Dilovasi. In conjunction with this, it is also known that the new Northern Marmara Highway (under construction) will be connected to E-80, D-100, and Izmit Bay Bridge at Dilovasi (Bogazici Project Engineering Inc., 2012). These investments will be useful for Dilovasi about TIR trips at least in the short term. Map of the Dilovasi region with the Northern Marmara Highway is given in Figure 5.15. In addition, the recommended intersection improvements on the short and long term at Gebze region are shown in Figure 5.16 by red and white, respectively (Bogazici Project Engineering Inc., 2012).

Figure 5.15. Analyzed Ports in Kocaeli Province.

Figure 5.16. Analyzed Regional Logistics Companies in Kocaeli Province.

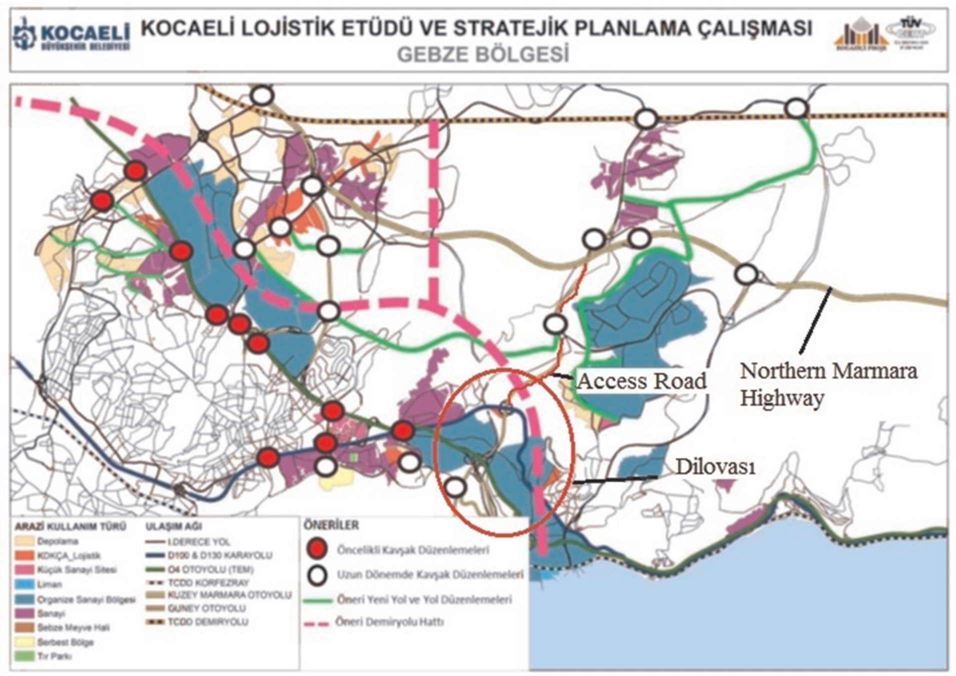


Figure 5.17. Map of Gebze and Dilovasi with the Northern Marmara Highway Implemented (Bogazici Project Engineering Inc., 2012).

6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

Results of this study reveal many theoretical and practical conclusions about FTG modeling in urban areas. In this study, a new segmentation method to group the logistical site types according to their FTG patterns using ANCOVA was presented, segments were checked using market segmentation analysis, and a new modeling scheme named "conditional modeling" was applied to explain the FTG of the segments which have many zero-trip generating establishments in Kocaeli. The main conclusions of the study are summarized below:

- Preliminary analysis of data indicated that almost all of the dependent and independent variables have positively skewed distributions. Hence, to obtain normal distribution for the variables in analyses, which is an assumed condition for many of the statistical techniques used in this research, logarithmic transformations were applied to them.
- Factor analysis on the trips to/from various logistical sites by different vehicle types formed two vehicle sets, trips by TIR vehicles and trips by trucks and vans together. Hence freight trip generation modeling was performed using these two vehicle categories. This result is significant in the way that it is not necessary to build separate models for each vehicle type, forming vehicle sets will reduce the modeling efforts.
- It was shown that using ANCOVA and and its associated post hoc tests; it was possible to group (or segment) the logistical site types for which consistent models can be calibrated. With the help of segmentation, future survey efforts and costs can be reduced since similar site types could be grouped together for FTG modeling.
- For each vehicle set, it was also proved with another ANCOVA analysis that FTG characteristics of each group were significantly different from each other. This is important since this was one way of validation of the segment formation.

- Market segmentation analysis results for regression models also confirmed the validity of the groups for all vehicle sets, except one logistical site type group of trucks and vans which included “national depots”, “large factories” and “other factories”. For this segment, the pooled regression model for FTG of trucks and vans and the models built for the different logistical sites forming this group were significantly different from each other statistically. Thus, for this segment, FTG should be modeled separately for each logistical site type. For the remaining segments, pooled models can be used.
- Logistical site types of “large manufacturer depots”, “coal storage depots”, “small industrial sites”, “large factories” and “other factories” show similar FTG patterns and form Group 3 for TIRs; and this group had the highest amount of zero-TIR trip generators in Kocaeli.
- The group consisting of “regional logistics companies” and “general warehouses” mostly generates zero-trips of trucks and vans in Kocaeli. Trip patterns of the site types in this segment for this vehicle set are similar.
- A new modeling approach, which was named “Conditional FTG Modeling” was proposed for this study. The conditional model consisted of two parts: The first part is a binary logit model which is used to estimate the probability of the logistical group producing the freight trips for the vehicle category. The second part is a linear regression model which is calibrated to estimate the “abundance” of the trips created by the logistical group, given that it is capable of producing trips with the vehicle category under consideration. The final estimate of the trips produced can be found by the product of the results of these two models which is the “Expected Number of Trips” for the vehicle category.
- The proposed conditional model was applied to the TIR group (Group 3 of TIR), and to Truck+Van group (Group 3 of Truck+Van) with the highest amount of zero trips of TIRs or Trucks+Vans. The conditional modeling applied to Group 3 of TIRs resulted in an improvement over the pure regression modeling approach in explaining the FTG of TIRs at establishments. The error reductions were 29.58% in RMSE and 23.57% in MAE. However, mostly because of the small sample size, it was not possible to calibrate the binary logit model for identifying the probability of producing Truck+Van model for the conditional model. This

could be tried in the future with larger sample sizes.

- It was found that the FTG of TIRs was governed by the actively used area, activity type, and the existence of FTG of other freight vehicle types at establishments. Furthermore, the binary logit part of the conditional model showed that the probability of TIR selection depends on actively used area and activity type of the establishment.
- For Groups 1 and 2 of TIR trips, the conditional model was not applied since no zero-trip generators were present in Group 1 and only 6 of 48 were zero-trip generators in Group 2. So, for these groups, using pure linear regression model for FTG of TIRs would be sufficient.
- Although conditional model could not be built for Group 3 of trucks and vans, it was possible to model the FTG using linear regression only. For those facilities, it was shown that FTG of trucks and vans was governed by employment. From these results, it seems that FTG of van and truck trips may be different than of TIR trips.
- For the other groups of trucks and vans, the conditional model was not applied. This was because, in Groups 1 and 2, only 8 of 71 and 14 of 85 facilities were zero-trip generators, respectively. So, for these groups, using the regression model for FTG was deemed to be sufficient.

6.2. Recommendations

Recommendations for future studies are given below:

- It is felt that there is room for improvement in the developed models if data on more variables can be collected. In particular, collection of information about the destinations of trips, thus distances, trip costs, the quantity of shipment per shipment (shipment size) from the sites, commodity types, and frequency of shipments may improve the modeling of FTG since FTG depends on the logistical decisions which are affected by these variables.
- Different classifications of vehicle types and logistical site types may result in different FTG models in Kocaeli. For instance, categorization of TIRs might have

been different, such as 4-axle vehicles and 6-axle vehicles. Furthermore, main types of logistical sites might have been analyzed instead of subtypes. Investigation of this topic can be a future work.

- For different regions, factor analysis results, thus vehicle type sets, and segments obtained using ANCOVA might be different. Thus, transferability of these results to other cities, regions could be investigated in future work.
- Dependent variables were taken as number of daily total trips in and out of the establishments. Peaking characteristics of the FTG can be investigated in future work.

APPENDIX A: INDUSTRIAL FIRM SURVEY

KOCAELİ BÜYÜKŞEHİR BELEDİYESİ

LOJİSTİK MASTER PLANI SANAYİ FİRMALARI SORU KÂĞIDI

İyi Günler, Kocaeli İli sınırları içinde yer alan Sanayi ve Lojistik Hizmetlerin sorunsuz ve çevreyle uyumlu bir şekilde yürütülebilmesi amacıyla Kocaeli Büyükşehir Belediyesi, Kocaeli Lojistik Master Planı çalışmasını başlatmıştır. Bu çalışmanın ana amacı, daha yaşanılır bir kent, sürdürülebilir bir sanayileşme ve karlılığı daha yüksek bir endüstri yapısına ulaşmaktır. Bu nedenle, çalışmanın belirtilen hedeflerine ulaşabilmesi, yapacağımız firma ve aktör görüşmeleriyle ihtiyaç duyduğumuz bilgilerin toplanabilmesine bağlıdır. Bu yapacağımız görüşmelere katılımınız ve bu konudaki işbirliğiniz Kocaeli için çok önemlidir. Toplanılan bilgiler sadece istatistiksel analizlerde kullanılacak olup gizli tutulacaktır. Anketimiz yaklaşık yarım saat sürecektir. Şimdiden katılımınız için çok teşekkür ederiz. İrtibat için
Kocaeli Büyükşehir Belediyesi Ulaşım Daire Başkanlığı Ulaşım Planlama Müdürlüğü: 0262 321 22 77 /3620

ADRES VE ÖRNEKLEME BİLGİLERİ

A1. İL	:	A6. BİNA / DIŞKAPI NO	:
A2. İLÇE	:	A7. BİNA İÇ KAPI NO (DAİRE NO)	:
A3. BUCAK (BELDE)	:	A9. ALT BÖLGE (ODAK VS NO)	:
A4. KÖY / MAHALLE	:	A10. ÖRNEK BİRİM NO	:
A5. CADDE/ SOKAK	:		

ZİYARET SAYISI	1	2	3	4
GÖRÜŞMECİNİN ADI SOYADI KODU				
TARİH	GÜN AY	GÜN AY	GÜN AY	GÜN AY
BAŞLAMA SAATİ	SAAT DAK.	SAAT DAK.	SAAT DAK.	SAAT DAK.
BİTİŞ SAATİ	SAAT DAK.	SAAT DAK.	SAAT DAK.	SAAT DAK.
ZİYARET SONUCU	SORUKAĞIDI TAMAMLANDI 1	SORUKAĞIDI TAMAMLANDI 1	SORUKAĞIDI TAMAMLANDI 1	SORUKAĞIDI TAMAMLANDI 1
	GÖRÜŞME YARIM KALDI 2	GÖRÜŞME YARIM KALDI 2	GÖRÜŞME YARIM KALDI 2	GÖRÜŞME YARIM KALDI 2
	YETKİLİ YERİNDE YOK 3	YETKİLİ YERİNDE YOK 3	YETKİLİ YERİNDE YOK 3	YETKİLİ YERİNDE YOK 3
	GÖRÜŞME ERTELENDİ 4	GÖRÜŞME ERTELENDİ 4	GÖRÜŞME ERTELENDİ 4	GÖRÜŞME ERTELENDİ 4
	GÖRÜŞME REDDEDİLDİ 5	GÖRÜŞME REDDEDİLDİ 5	GÖRÜŞME REDDEDİLDİ 5	GÖRÜŞME REDDEDİLDİ 5
	DİĞER (Belirtin)____ X	DİĞER (Belirtin)____ X	DİĞER (Belirtin)____ X	DİĞER (Belirtin)____ X
SORUKAĞIDININ DOLDURUL MASI TAMAMLAN MAMIŞ İSE SONRAKİ GÖRÜŞMENİN RANDEVU GÜNÜ VE SAATİ	GÜN SAAT DAK.	GÜN SAAT DAK.	GÜN SAAT DAK.	GÜN SAAT DAK.

EKİP BAŞI (ALAN EDİTÖRÜ)	ADI SOYADI :	KOD
DENETÇİ	ADI SOYADI :	KOD
TELEFONDA CEVAPLAYAN KİŞİ	ADI SOYADI :	

CEVAPLAYAN KİŞİ________________ GÖREV
ÜNVANI

FIRMA SAHİBİ______________01
ORTAĞI______________02
ÜST DÜZEY YÖNETİCİ______________03
DİĞER(Belirtiniz):.................................

Figure A.1. Industrial Firm Survey, Page 1.

GENEL BİLGİLER

1. Firmanızın kimliği

Adı / Unvanı	
Telefon Numarası	
E-mail Adresi	
Faks	

2. Yapılan işi <u>detaylı olarak ayrıntılı bir şekilde</u> tanımlayınız

3. Bulunduğumuz mahalde ana faaliyet alanınız nedir?

(SADECE TEK BİR SEÇENEK İŞARETLENECEKTİR)

Metal cevherler madenciliği	1
Diğer madencilik ve taş ocakçılığı	2
Gıda ürünleri ve içecek imalatı	3
Tekstil imalatı	4
Giyim eşyası imalatı, kürkün işlenmesi	
Derinin tabaklanması ve işlenmesi, bavul, el çantası, vb	6
Ağaç ve mantar ürünleri, mobilya hariç	7
Kâğıt hamuru, kağıt ve kağıt ürünler imalatı	8
Basım ve yayın, plak, kaset ve benzeri kayıtlı medyanın çoğaltılması	
Kok kömürü, rafine edilmiş petrol ürünleri ve nükleer yakıt	10
Kimyasal madde ve ürünlerin imalatı	11
Plastik ve kauçuk ürünleri imalatı	12
Metalik olmayan diğer mineral ürünlerin imalatı	13
Ana metal sanayi	14
Makine ve teçhizatı hariç; fabrikasyon metal ürünleri imalatı	15
Başka yerde sınıflandırılmamış makine ve teçhizat imalatı	16
Büro makineleri ve bilgisayar imalatı	17
Başka yerde sınıflandırılmamış elektrikli makine ve cihazların imalatı	18
Radyo, televizyon, haberleşme teçhizatı ve cihazları imalatı	19
Tıbbi aletle; hassas ve optik aletler ile saat imalatı	20
Motorlu kara taşıtı, römork ve yarı römork imalatı	21
Diğer ulaşım araçlarının imalatı	22
Mobilya imalatı; başka yerde sınıflandırılmamış diğer imalat	23
Geri dönüşüm	24
Diğer (Beli tiniz...)	25

Figure A.2. Industrial Firm Survey, Page 2.

4. Ana faaliyet dışında hangi faaliyetlerde bulunuyorsunuz ? (BİRDEN FAZLA SEÇENEK İŞARETLENECEKTİR)	Metal cevherler madenciliği	1
	Diğer madencilik ve taş ocakçılığı	2
	Gıda ürünleri ve içecek imalatı	3
	Tekstil imalatı	4
	Giyim eşyası imalatı, kürkün işlenmesi	5
	Derinin tabaklanması ve işlenmesi, bavul, el çantası, vb	6
	Ağaç ve mantar ürünleri, mobilya hariç	7
	Kâğıt hamuru, kağıt ve kağıt ürünler imalatı	8
	Basım ve yayın, plak, kaset ve benzeri kayıtlı medyanın çoğaltılması	9
	Kok kömürü, rafine edilmiş petrol ürünleri ve nükleer yakıt	10
	Kimyasal madde ve ürünlerin imalatı	11
	Plastik ve kauçuk ürünleri imalatı	12
	Metalik olmayan diğer mineral ürünlerin imalatı	13
	Ana metal sanayi	14
	Makine ve teçhizatı hariç; fabrikasyon metal ürünleri imalatı	15
	Başka yerde sınıflandırılmamış makine ve teçhizat imalatı	16
	Büro makineleri ve bilgisayar imalatı	17
	Başka yerde sınıflandırılmamış elektrikli makine ve cihazların imalatı	18
	Radyo, televizyon, haberleşme teçhizatı ve cihazları imalatı	19
	Tıbbi aletle; hassas ve optik aletler ile saat imalatı	20
	Motorlu kara taşıtı, römork ve yarı römork imalatı	21
	Diğer ulaşım araçlarının imalatı	22
	Mobilya imalatı; başka yerde sınıflandırılmamış diğer imalat	23
	Geri dönüşüm	24
	Diğer (Belirt niz...)	25

5. Firmanızda şu an kaç kişi çalışmaktadır?	☐☐☐☐ ***Kişi***
6. Firmanızda son mali yıl içerisinde (2010 yılı) aylık ortalama kaç kişi çalışmaktadır?	☐☐☐☐ ***Kişi***
7. Firmanın tam kapasitede çalışırken ulaşabileceği en yüksek istihdam sayısı nedir?	☐☐☐☐ ***Kişi***

				Araç Türü	*Adedi*
8. Firmanızda Lojistik Hizmetler Nasıl sağlanmaktadır?	Tamamen kendi imkanları ile sağlıyor	01 →	**Yük taşıma araçlarınızın sayısını türlerini söyler misiniz?** ÇOK ARAÇ VAR İSE KAYITLARA BAKARAK CEVAP VERMESİNİ İSTEYİNİZ	**TIR**	☐☐
	Kısmen kendi imkanları ile kısmen dışardan hizmet alıyor.	02 →		**Kamyon**	☐☐
	Tamamen dışardan hizmet alıyor.	03 ↓		**Kamyonet**	☐☐
				Diğer (Belirtiniz)	☐☐
				Toplam	☐☐

Figure A.3. Industrial Firm Survey, Page 3.

9.
Firmanızın alansal kapasiteleri ve kullanım oranları nedir? ..... Kadar kişi çalıştırdığınız söylediniz bu sayacağım alanlara dağıtınız. (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	Alan (m^2)	Yükseklik	Kapasite Kullanım Oranı (%)	Çalışan sayısı
Ayrı Yönetim Binası	0	1→				
Üretim Binası	0	1→				
Depo	0	1→				
Konteyner Deposu	0	1→				
Nakliye Deposu	0	1→				
Soğuk Hava Deposu	0	1→				
Antrepo	0	1→				
İskele/Yana ma alanı	0	1→				
Yükleme Boşaltma Alanı	0	1→				
Binek Araç Otopark Alanı	0	1→				
Yük Aracı Otopark Alanı	0	1→				
Sosyal Donatı Alanı (yeşil alan, cami, sağlık tesisi, vb.)		1→				
Ortak Kullanım Alanı (Ya akhane, Yemekhane, vb.)	0	1→				
Yönetim Ofisi	0	1→				
Tamir Bakım Servisi	0	1→				
Diğer		1→				
TOPLAM (parsel)						

Figure A.4. Industrial Firm Survey, Page 4.

YÜK AKIŞI

GİRDİ TABLOSU

GÖRÜŞMECİNİN DİKKATİNE AŞAĞIDAKİ PARAGRAFI MUTLAKA OKUYUNUZ !!!

10. **Şimdi size geçtiğimiz bir yılın yük akışı ile ilgili sorular soracağım bu cevabı verirken son mali yılı düşünerek cevap vermenizi istiyorum. Öncelikle firmanıza gelen hammadde, yan ürün gibi girdilerin geldiği bölge – şehir – mahalle** *(mahalle Kocaeli içinde ise)* **girdi miktarı** *(ton, kg, litre, metreküp cinsinden alınması gerekmektedir. Eğer adet verilir ise, 1 adedin ortalama ağırlığından kg, veya ton cinsine dönüştürülecektir)* **Ürün türü** *(makine, kimya demir vb,)* **gibi sorular soracağım.**
Verilen bilgiler bir yıldan kısa bir süre için ise lütfen süreyi belirtiniz.

GÜNLÜK	1	AYLIK	2	YILLIK	3	DİĞER________________	4

Üretiminizde kullandığınız girdileri geçen yıl nerelerden getirdiniz. (Kocaeli içinde ise mahalle bilgisini alınız)	Bu bölgeden ne tür ürün getiriyorsunuz		Ürün Miktarı							
			Karayolu (ton,kg,lt,m³)		Denizyolu (TEU, ton,kg,lt,m³)		Demiryolu (ton,kg,lt,m³)		Havayolu (ton,kg,lt,m³)	
Ülke – Şehir - Mahalle	Ürün Adı	Ürün Kodu	Miktarı	Birimi	Miktarı	Birimi	Miktarı	Birimi	Miktarı	Birimi
1.										
2.										
3.										
4.										
5.										
6.										
7.										
8.										
9.										
10.										
11.										
12.										
13.										
14.										
15.										

11. Yukarıdaki veriler yıldan az bir periyodda ise yıllık ortalamanın ne kadar altında ve üstündedir?	%______________________________ALTINDA %______________________________ÜSTÜNDE

Figure A.5. Industrial Firm Survey, Page 5.

ÇIKTI TABLOSU

GÖRÜŞMECİNİN DİKKATİNE AŞAĞIDAKİ PARAGRAFI MUTLAKA OKUYUNUZ !!!

12. **Şimdi size geçtiğimiz bir yılın yük akışı ile ilgili sorular soracağım bu cevabı verirken son mali yılı düşünerek cevap vermenizi istiyorum. Öncelikle firmanızda üretmiş olduğunuz ürünleri gönderdiğiniz** **bölge – şehir – mahalle** *(mahalle Kocaeli içinde ise)* **çıktı miktarı** *(ton, kg, litre, metreküp cinsinden alınması gerekmektedir. Eğer adet verilir ise, 1 adedin ortalama ağırlığından kg, veya ton cinsine dönüştürülecektir)* **Ürün türü** *(makine, kimya demir vb,)* **gibi sorular soracağım.**
Verilen bilgiler bir yıldan kısa bir süre için ise lütfen süreyi belirtiniz.

GÜNLÜK	1	AYLIK	2	YILLIK	3	DİĞER________________	4

Üretiminiz sonucu elde ettiğiniz ürünleri (çıktıları) geçen yıl nerelere gönderdiniz. (Kocaeli içinde ise mahalle bilgisini alınız)	*Bu bölgeye ne tür ürün gönderiyorsunuz ?*		*Ürün Miktarı*							
			Karayolu (ton,kg,lt,m³)		*Denizyolu (ton,kg,lt,m³)*		*Demiryolu (TEU, ton,kg,lt,m³)*		*Havayolu (ton,kg,lt,m³)*	
Ülke – Şehir - Mahalle	*Ürün Adı*	*Ürün Kodu*	*Miktarı*	*Birimi*	*Miktarı*	*Birimi*	*Miktarı*	*Birimi*	*Miktarı*	*Birimi*
1.										
2.										
3.										
4.										
5.										
6.										
7.										
8.										
9.										
10.										
11.										
12.										
13.										
14.										
15.										

13. **Yukarıdaki veriler yıldan az bir periyodda ise yıllık ortalamanın ne kadar altında ve üstündedir?**	%________________________ALTINDA %________________________ÜSTÜNDE

Figure A.6. Industrial Firm Survey, Page 6.

LOJİSTİK FAALİYET SORUNLARI

14. Firmanızın Lojistik Operasyonlarını olumsuz etkileyen, kentsel altyapı ve üstyapı kaynaklı eksiklik ve sorunlar nelerdir? *(Örnekleri ihtiyaç dışında kullanmayın yolların, kavşakların, Sinyalizasyon, Depo, Antrepo yetersizliği gibi)*

15. Bu sorunları/eksiklikleri giderebilmek için Kocaeli Yerel Yönetim Birimlerinin Ne yapmasını önermektesiniz? *(örneğin ışık konması ilave kamyon/tır parkları yapılması gibi)*

16. Firmanızın lojistik operasyonlarını kolaylaştırma ve/veya kapasitesini arttırmak üzere önümüzdeki orta ve uzun vadeli planlamış olduğunuz yatırımlar nelerdir?

Figure A.7. Industrial Firm Survey, Page 7.

GÖRÜŞMECİNİN DİKKATİNE AŞAĞIDAKİ PARAGRAFI MUTLAKA OKUNUZ !!!

17. Aşağıda belirtilen Kocaeli Lojistik Sektörüne yönelik potansiyel sorunlara yönelik ifadeleri sizi etkileme derecesine göre (1 kesinlikle katılmıyorum, 2 katılmıyorum, 3 bir şey söyleyemem, 4 katılıyorum 5 kesinlikle katılıyorum) 1 ile 5 arasında değerlendiriniz

Karayolu altyapısına yönelik sorunlar	Kesinlikle Katılmıyorum	Katılmıyorum	Bir Şey Söyleyemem	Katılıyorum	Kesinlikle Katılıyorum
Kocaeli kent içi yolları ve otoyol bağlantılarındaki trafik sıkışıklığı yük taşımasını engelleyecek düzeyde çok fazladır.	1	2	3	4	5
Kocaeli'ndeki karayolları kamyon operasyonlarını kısıtlayacak şekilde kötüdür.	1	2	3	4	5
Kocaeli'ndeki karayollarının fiziksel kalitesi oldukça kötüdür.	1	2	3	4	5
Kocaeli'nde yeterli kamyon ve araç parkı bulunmamaktadır.	1	2	3	4	5
Diğer sorunlar (açıklayınız) ____________	1	2	3	4	5

Demiryolu Taşımacılığında Yaşanan Sorunlar	Kesinlikle Katılmıyorum	Katılmıyorum	Bir Şey Söyleyemem	Katılıyorum	Kesinlikle Katılıyorum
Demiryolu ağı ve modernizasyonu yetersizdir.	1	2	3	4	5
Demiryolu taşımacılığında vagon temini zor olmaktadır.	1	2	3	4	5
Demiryolu taşımacılığında Kocaeli'nde ciddi yönetim sorunları bulunmaktadır.	1	2	3	4	5
Diğer sorunlar (açıklayınız) ____________	1	2	3	4	5

Kocaeli Limanlarında Yaşanan Sorunlar	Kesinlikle Katılmıyorum	Katılmıyorum	Bir Şey Söyleyemem	Katılıyorum	Kesinlikle Katılıyorum
Kocaeli Limanın depolama sahaları yetersizdir.	1	2	3	4	5
Kocaeli Limanında boşaltma yükleme ekipmanları yetersizdir.	1	2	3	4	5
Kocaeli Limanında yanaşma ücretleri yüksektir.	1	2	3	4	5
Kocaeli Limanında gümrükleme hizmetleri yetersizdir.	1	2	3	4	5
Kocaeli Limanında yükleme ve boşalma ücretleri yüksektir.	1	2	3	4	5
Kocaeli Limanında araç park sahaları yetersizdir.	1	2	3	4	5
Kocaeli Limanında gemiler yanaşabilmek için uzun süre bekletilmektedir.	1	2	3	4	5
Kocaeli Limanı kombine taşımacılık olanakları açısından yetersizdir.	1	2	3	4	5
Diğer sorunlar (açıklayınız). ____________	1	2	3	4	5

Figure A.8. Industrial Firm Survey, Page 8.

Havayolu Taşımacılığı ile ilgili Sorunlar	Kesinlikle Katılmıyorum	Katılmıyorum	Bir Şey Söyleyemem	Katılıyorum	Kesinlikle Katılıyorum
Havayolu taşımacılığına erişim sorunludur.	1	2	3	4	5
Kocaeli çevresindeki hava meydanları kargo taşımacılığı için yeterli filo kapasitesine ve donanıma sahip değildir.	1	2	3	4	5
Kocaeli çevresinde havayolu taşımacılığında gümrükleme sorunları yaşanmaktadır.	1	2	3	4	5
Kocaeli çevresindeki havayolu taşımacılığında gereksiz bürokrasi zaman ve kaynak kaybına neden olmaktadır.	1	2	3	4	5
Diğer sorunlar (açıklayınız). ____________	1	2	3	4	5

Gümrüklerde Yaşanılan Sorunlar	Kesinlikle Katılmıyorum	Katılmıyorum	Bir Şey Söyleyemem	Katılıyorum	Kesinlikle Katılıyorum
Kocaeli gümrüklerindeki elemanların ciddi bir eğitim eksikliği bulunmaktadır.	1	2	3	4	5
Gümrüklerindeki bürokrasi olması gerekenden fazladır	1	2	3	4	5
Kocaeli gümrüklerdeki teknik altyapı olanakları oldukça düşüktür.	1	2	3	4	5
Kocaeli gümrüklerindeki personel sayısı yetersizdir.	1	2	3	4	5
Kocaeli gümrüklerinde haksız taleplerde bulunulmaktadır.	1	2	3	4	5
Diğer sorunlar (açıklayınız). ____________	1	2	3	4	5

Depolarda karşılaşılan sorunlar	Kesinlikle Katılmıyorum	Katılmıyorum	Bir Şey Söyleyemem	Katılıyorum	Kesinlikle Katılıyorum
Soğutmalı depo temininde güçlük çekilmektedir.	1	2	3	4	5
Kapalı depo bulmakta zorluklar yaşanmaktadır.	1	2	3	4	5
Depolardaki elleçleme araçları ve altyapısı yetersizdir.	1	2	3	4	5
Depo lokasyonları erişimi, trafik nedeniyle zor yerlerde kalmaktadır.	1	2	3	4	5
Depo düzenlemeleri ve lokasyonları kamyon manevralarına uygun değildir.	1	2	3	4	5
Depolarda yönetim ve organizasyon sorunları yaşanmaktadır.	1	2	3	4	5
Depolardaki emtia kötü koruma koşullarından ötürü zarar görebilmektedir.	1	2	3	4	5

Figure A.9. Industrial Firm Survey, Page 9.

Diğer Sorunlar	Kesinlikle Katılmıyorum	Katılmıyorum	Bir Şey Söyleyemem	Katılıyorum	Kesinlikle Katılıyorum
Kocaeli'de lojistik sektöründe kalifiye eleman bulma sıkıntısı yaşanmaktadır.	1	2	3	4	5
Kocaeli'de kalifiye eleman maaşları olması gerekenden yüksektir.	1	2	3	4	5
Kocaeli'de bir lojistik sürekli eğitim merkezi kurulmalıdır.	1	2	3	4	5
Sizin işaret etmek istediğiniz başka sorunlar var mıdır? (açıklayınız).					

18. Firmanızın 2010 yılı cirosu ne kadardır *(yazarken virgülleri almayın 1000 ' ayracı nokta olarak kullanın örnek 98.295)*	

Figure A.10. Industrial Firm Survey, Page 10.

EK-TRAFİK ÜRETİM TESPİT FORMU

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 Sayılarını Firmanıza Giriş Saatlere Göre Doldurunuz

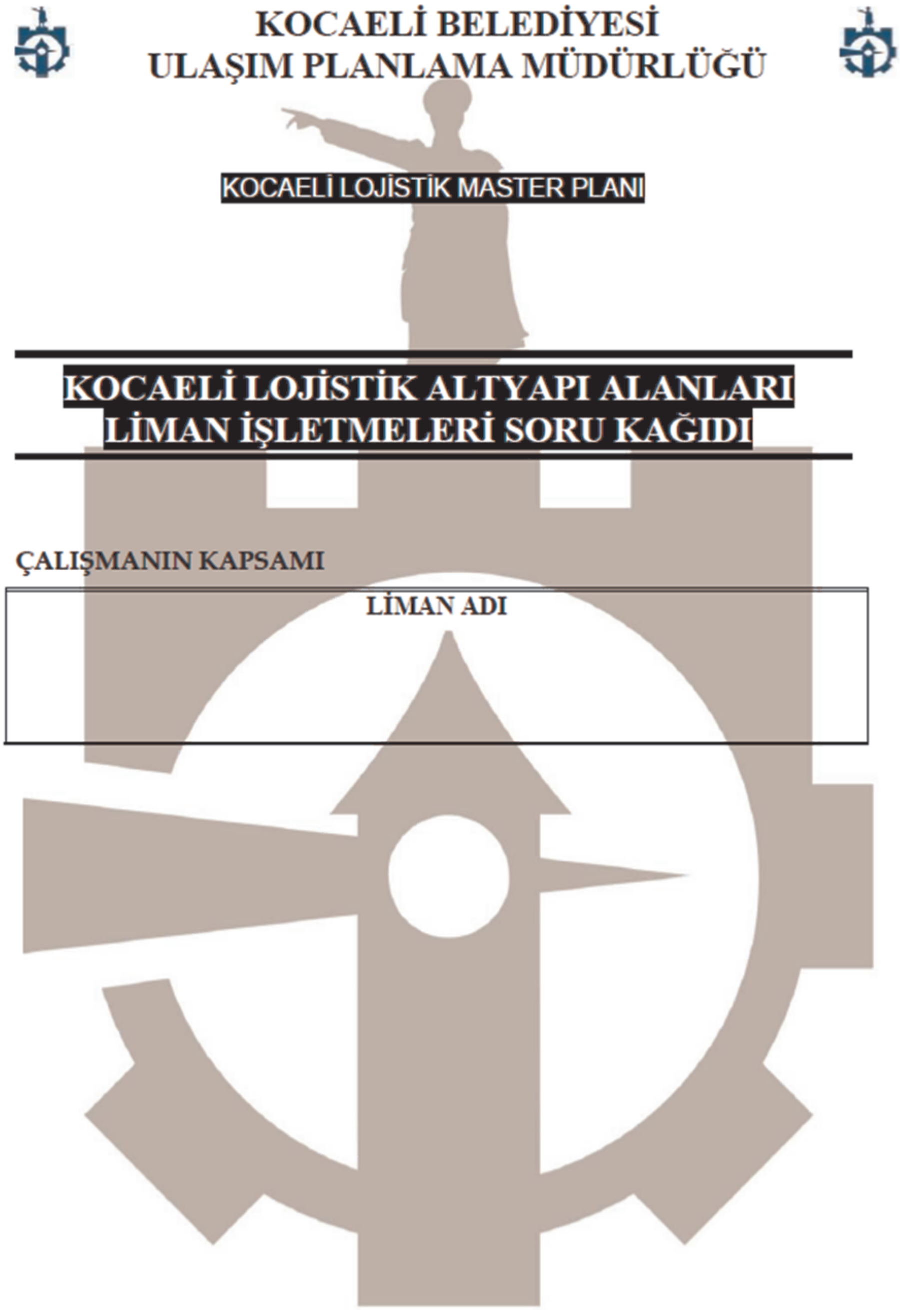
ARAÇ TÜRÜ	06:01-10:00	10:01-12:00	12:01-16:00	16:01-18:00	18:01-06:00
Tır					
Kamyon					
Kamyonet					

Aşağıdaki Tablodaki Araç Sayılarını Firmanıza Çıkış 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
Tır					
Kamyon					
Kamyonet					

Figure A.11. Industrial Firm Survey, Page 11.

APPENDIX B: PORT SURVEY



KOCAELİ BELEDİYESİ
ULAŞIM PLANLAMA MÜDÜRLÜĞÜ

KOCAELİ LOJİSTİK MASTER PLANI

KOCAELİ LOJİSTİK ALTYAPI ALANLARI
LİMAN İŞLETMELERİ SORU KAĞIDI

ÇALIŞMANIN KAPSAMI

LİMAN ADI

Figure B.1. Port Survey, Page 1.

GENEL BİLGİLER

1. Görüşülen kişin kimliği	Adı/Unvanı	
	Telefon Numarası	
	E-mail Adresi	
	Faks	

2. Şu sayacağım faaliyetlerden hangileri liman içerisinde gerçekleştirilmektedir?		Evet	Hayır
Üretim		1	2
Toptan/Perakende Satış		1	2
İthalat - İhracat		1	2
Kalite Kontrol, Gözetim İşleri		1	2
Depoculu		1	2
Taşımacılık	Kara	1	2
	Deniz	1	2
	Hava	1	2
	Raylı	1	2
	Boru Hattı	1	2
	Kombine	1	2
Komisyonculuk		1	2
Gümrük İşlemleri		1	2
Dağıtım		1	
Finansman ve Sigortalama İşlemleri		1	2
Gemi acentesi		1	2
Diğer (Belirtiniz...)			

3. Limanın çalışma günleri nelerdir?

GÜNLER	Odağın Çalışma Günleri (Mesai Günleri)		Yük Aracı Giriş Çıkışının Olduğu (Odağın Faaliyette Olduğu)	
	Evet	Hayır	Evet	Hayır
Pazartesİ	1	2	1	2
Salı	1	2	1	2
Çarşamba	1	2	1	2
Perşembe	1	2	1	2
Cuma	1	2	1	2
Cumartesi	1	2	1	2
Pazar	1	2	1	2
Dini Bayramlar	1	2	1	2
Resmi Bayramlar	1	2	1	2
Farklı Bir Cevap Veriyorsa Açıklayınız				

Figure B.2. Port Survey, Page 2.

4. Yük araçlarının limana giriş ve çıkış yaptığı kapı sayıları nedir?

EĞER LİMAN BELİRLİ KAPALI SINIRLAR İÇERİSİNDE DEĞİLSE VE KENDİNE ÖZEL KAPISI BULUNMUYORSA ODAĞA ULAŞIMI SAĞLAYAN GİRİŞ ÇIKIŞ NOKTALARINI BELİRTİNİZ.

SADECE GÖRÜŞMENİN YAPILDIĞI ALANIN (YERLEŞKENİN) KAPI SAYILARINI ALINIZ

KAPINI KULLANIM TÜRÜ	SAYISI
Sadece Girişe Ayrılan Kapı Sayısı	
Sadece Çıkışa Ayrılan Kapı Sayısı	
Hem Giriş Hem Çıkış Yapılan Kapı Sayısı	

5. Liman giriş ve çıkışlarında yük aracı sürücüleri ile görüşme yapılacaktır. Söz konusu sürücüler ile yapılacak görüşmenin sizce en uygun zaman aralığı nedir?
(24 SAAT ESASINA GÖRE YAZINIZ)

Şoför Anketin Yapılabileceği Uygun Zaman Aralığı

6. Yük araçlarının liman içerisinde kalma sürelerini kısıtlayan bir kural var mı? Varsa sebebi nedir?

Hayır Yok	Evet Var	2	Sebebi
1	En fazla .... saat liman çerisinde kalabilirler	1	
	En geç saat ……….'da limanı terk etmek zorundalar	2	

7. Limanda elleçlenen veya elleçlenebilecek yük türleri

Türü	Kodu
Konteyner	1
Dökme Yük	2
Sıvı Yük	3
Diğer	4

Figure B.3. Port Survey, Page 3.

Genişlem ve Gelecek Planları
8. Teorik Maksimum Kapasitesi (Ton, Teu Konteyner vs)

9. Geleceğe yönelik yatırım planları

10. Yatırım sonucu elde edilecek maksimum kapasite

Figure B.4. Port Survey, Page 4.

MEKANSAL BİLGİLER

11. Lojistik odak kapsamındaki alanların kapasiteleri ve kullanım oranları nedir?

Toplam Alan	Mevcut (M^{2})	Potansiyel (M^{2})	Planlanan (M^{2})
Toplam Yapı Alanı (Donatı Hariç)			
Konteyner Platformu			
Konteyner Depolama Alanı			
Dökme Yük Alanı			
Likit İskeleler			
Normal İskeleler			
Binek Araç Otopark Alanı			
Yük Aracı (TIR) Park Alanı			
Likit Tank Alanı			
Sosyal Donatı ve Ortak Kullanım Alanları (yeşil alan, cami, sağlık tesisi, vb.)			
Demiryolu Alanı (M^{2})			
Demiryolu Uzunluğu (mt)			
TOPLAM			

12. EKİPMAN

EKİPMAN ADI	SAYISI
Vinç (Hidrolik)	
Vinç (Halatlı)	
RTC	
Stacker	
MAFI	
Forklift	

Figure B.5. Port Survey, Page 5.

13. çalışanlarınızın pozisyonlarına sayılarını belirtiniz.

Personel Türü	Personel Sayısı (KADROLU)	Personel Sayısı (TAŞERON)
İdari Personel		
Teknik Personel		
Vasıflı İşçi		
Vasıfsız İşçi		
Diğer		
Toplam		

YÜK AKIŞI

14. Liman genelinde araç türlerine göre günlük ortalama yük getiren ve yük götüren araç sayısı nedir?

(BÜTÜN BİR YILI DÜŞÜNEREK GÜNLÜK ORTALAMAYI VERİNİZ)

Türü	Yükü Getiren Araç Sayısı	Yükü Götüren Araç Sayısı
TIR		
Kamyon		
Kamyonet		
Diğer (Belirtiniz)		
TOPLAM		

15. Günlük ortalama işlem gören yük miktarı nedir? Bu miktar son 1 yıl içinde sabit mi kalmıştır ya da artış/düşüş göstermekte midir?

GÜNLÜK RAKAMLAR VERİLEMİYORSA HAFTALIK VEYA AYLIK ALINIZ.

...... İLE BELİRTİLEN YERE ALINAN ZAMAN ARALIĞININ NE OLDUĞUNU YAZINIZ. (HAFTALIK, AYLIK, YILLIK)

Ortalama Yük Miktarı : **ton / ....**

Ortalama Yük Miktarı : **20'lik konteyner / ....**

Ortalama Yük Miktarı : **40'lık konteyner / ....**

	Evet	Hayır
Sabit	1	2
Giderek artmaktadır.	1	2
Giderek azalmaktadır.	1	2

Figure B.6. Port Survey, Page 6.

16. **Son 10 yılda yüklerin/gemilerin geliş ve gidişlerini bölge bazda yıllık olarak belirtebilir misiniz?**

GİDEN MALLAR

Bölge/Kıta/Ülke	**Mal Grubu (yük türü)**	**Ton, M^3, TEU**

GELEN MALLAR

Bölge/Kıta/Ülke	**Mal Grubu (yük türü)**	**Ton, M^3, TEU**

Figure B.7. Port Survey, Page 7.

17. **Limanın Demir yolu bağlantısı var mıdır?**

Var ise, Yıllık olarak demir yolundan ne kadar yük gelmektedir ya da gitmektedir.

Demiryolu bağlantısı var	1
Demiryolu bağlantısı yok	2

Gelen Yük

Ortalama Yük Miktarı : ☐☐☐☐ ton / ....

Ortalama Yük Miktarı : ☐☐☐☐ 20'lik konteyner / ....

Ortalama Yük Miktarı : ☐☐☐☐ 40'lık konteyner / ....

Giden Yük

Ortalama Yük Miktarı : ☐☐☐☐ ton / ....

Ortalama Yük Miktarı : ☐☐☐☐ 20'lik konteyner / ....

Ortalama Yük Miktarı : ☐☐☐☐ 40'lık konteyner / ....

EKONOMİK

18. **Liman gelirlerini oluşturan başlıca kalemler şu sayacaklarımdan hangileridir? Ve Her bir kalemin ortalama tutarı ne kadardır.**

	Yok	Var	TUTAR
Pilotaj gelir	0	1→	
Römorkör geliri	0	1→	
İşgaliye Geliri	0	1→	
Gemi içi hizmetler	0	1→	
ISPS	0	1→	
Yükleme bedeli	0	1→	
İndirme bedeli	0	1→	
Lashing	0	1→	
Terminal geliri	0	1→	
Depolama geliri	0	1→	
Diğer	0	1→	

19. **Liman İşletmesinin 2010 yılı cirosu nedir?**

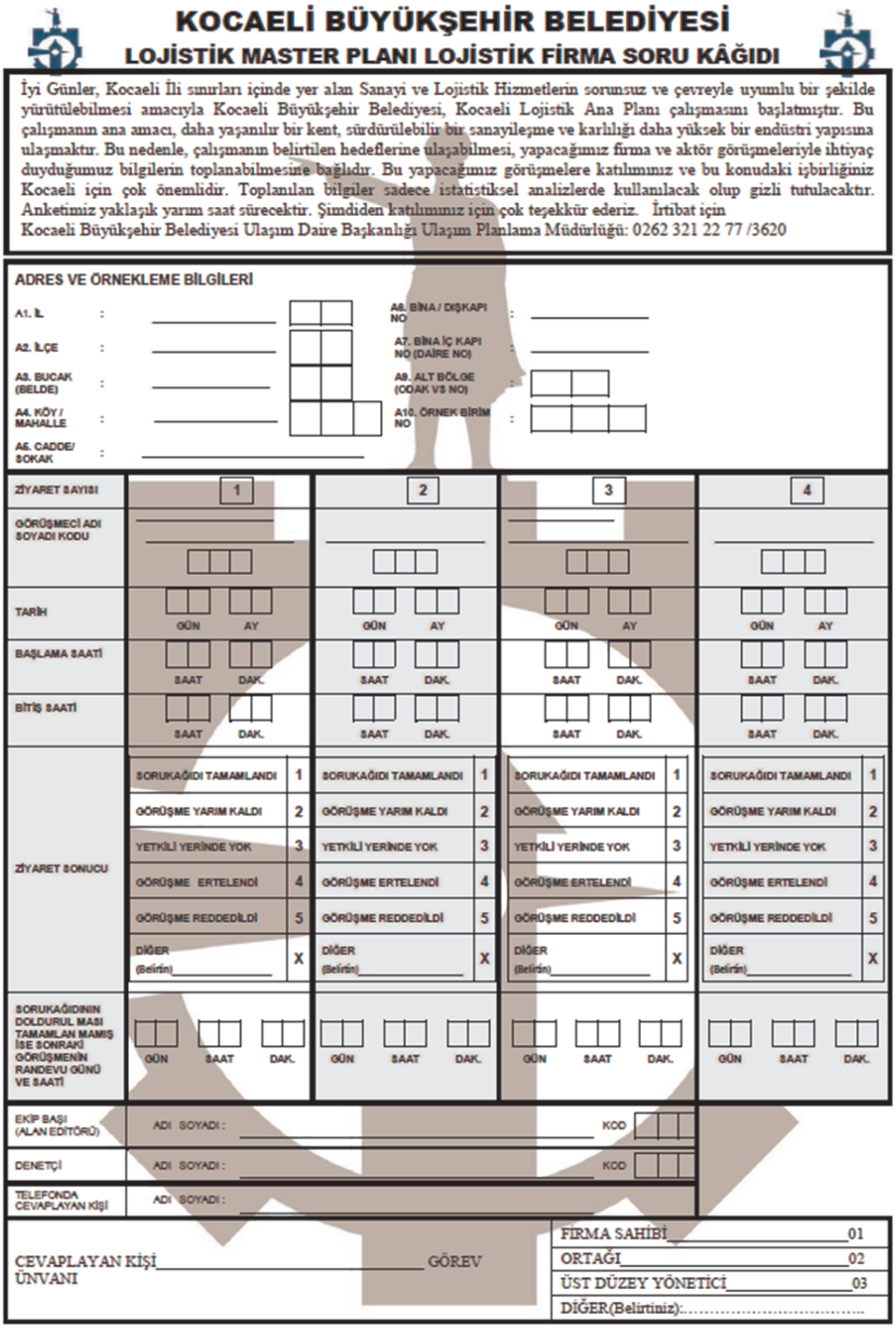
☐☐☐☐☐☐☐☐☐☐ TL

20. **Liman İşletmesinin 2010 yılı net kar/zararı (bütçe açığı/fazlası) nedir?**

Kar	1	☐☐☐☐☐☐☐☐☐	TL
Zarar	2	☐☐☐☐☐☐☐☐☐	TL

Figure B.8. Port Survey, Page 8.

APPENDIX C: LOGISTICS COMPANY SURVEY



KOCAELİ BÜYÜKŞEHİR BELEDİYESİ
LOJİSTİK MASTER PLANI LOJİSTİK FİRMA SORU KÂĞIDI

İyi Günler, Kocaeli İli sınırları içinde yer alan Sanayi ve Lojistik Hizmetlerin sorunsuz ve çevreyle uyumlu bir şekilde yürütülebilmesi amacıyla Kocaeli Büyükşehir Belediyesi, Kocaeli Lojistik Ana Planı çalışmasını başlatmıştır. Bu çalışmanın ana amacı, daha yaşanılır bir kent, sürdürülebilir bir sanayileşme ve karlılığı daha yüksek bir endüstri yapısına ulaşmaktır. Bu nedenle, çalışmanın belirtilen hedeflerine ulaşabilmesi, yapacağımız firma ve aktör görüşmeleriyle ihtiyaç duyduğumuz bilgilerin toplanabilmesine bağlıdır. Bu yapacağımız görüşmelere katılımınız ve bu konudaki işbirliğiniz Kocaeli için çok önemlidir. Toplanılan bilgiler sadece istatistiksel analizlerde kullanılacak olup gizli tutulacaktır. Anketimiz yaklaşık yarım saat sürecektir. Şimdiden katılımınız için çok teşekkür ederiz. İrtibat için
Kocaeli Büyükşehir Belediyesi Ulaşım Daire Başkanlığı Ulaşım Planlama Müdürlüğü: 0262 321 22 77 /3620

ADRES VE ÖRNEKLEME BİLGİLERİ

A1. İL :	A6. BİNA / DIŞKAPI NO :
A2. İLÇE :	A7. BİNA İÇ KAPI NO (DAİRE NO) :
A3. BUCAK (BELDE) :	A9. ALT BÖLGE (ODAK VS NO) :
A4. KÖY / MAHALLE :	A10. ÖRNEK BİRİM NO :
A5. CADDE/ SOKAK :	

ZİYARET SAYISI	1	2	3	4
GÖRÜŞMECİ ADI SOYADI KODU				
TARİH	GÜN AY	GÜN AY	GÜN AY	GÜN AY
BAŞLAMA SAATİ	SAAT DAK.	SAAT DAK.	SAAT DAK.	SAAT DAK.
BİTİŞ SAATİ	SAAT DAK.	SAAT DAK.	SAAT DAK.	SAAT DAK.
ZİYARET SONUCU	SORUKAĞIDI TAMAMLANDI 1 GÖRÜŞME YARIM KALDI 2 YETKİLİ YERİNDE YOK 3 GÖRÜŞME ERTELENDİ 4 GÖRÜŞME REDDEDİLDİ 5 DİĞER (Belirtin)____ X	SORUKAĞIDI TAMAMLANDI 1 GÖRÜŞME YARIM KALDI 2 YETKİLİ YERİNDE YOK 3 GÖRÜŞME ERTELENDİ 4 GÖRÜŞME REDDEDİLDİ 5 DİĞER (Belirtin)____ X	SORUKAĞIDI TAMAMLANDI 1 GÖRÜŞME YARIM KALDI 2 YETKİLİ YERİNDE YOK 3 GÖRÜŞME ERTELENDİ 4 GÖRÜŞME REDDEDİLDİ 5 DİĞER (Belirtin)____ X	SORUKAĞIDI TAMAMLANDI 1 GÖRÜŞME YARIM KALDI 2 YETKİLİ YERİNDE YOK 3 GÖRÜŞME ERTELENDİ 4 GÖRÜŞME REDDEDİLDİ 5 DİĞER (Belirtin)____ X
SORUKAĞIDININ DOLDURUL MASI TAMAMLAN MAMIŞ İSE SONRAKİ GÖRÜŞMENİN RANDEVU GÜNÜ VE SAATİ	GÜN SAAT DAK.	GÜN SAAT DAK.	GÜN SAAT DAK.	GÜN SAAT DAK.

EKİP BAŞI (ALAN EDİTÖRÜ)	ADI SOYADI : ____ KOD
DENETÇİ	ADI SOYADI : ____ KOD
TELEFONDA CEVAPLAYAN KİŞİ	ADI SOYADI :

CEVAPLAYAN KİŞİ____ GÖREV ÜNVANI	FİRMA SAHİBİ____01
	ORTAĞI____02
	ÜST DÜZEY YÖNETİCİ____03
	DİĞER(Belirtiniz):…………………………

Figure C.1. Logistics Company Survey, Page 1.

GENEL BİLGİLER

1. Firmanızın kimliği	Adı / Unvanı	
	Telefon Numarası	
	E-mail Adresi	
	Faks	

2. Yapılan işi detaylı olarak ayrıntılı bir şekilde tanımlayınız.	

3. Bulunduğumuz mahalde ana faaliyet alanınız nedir?

(SADECE BİR SEÇENEK İŞARETLENECEKTİR)

Liman İşletmeciliği	1
Gümrük Müşavirliği	2
Genel Antrepo İşletmeciliği	3
Milli Depo İşletmeciliği	4
Kargo Aktarma Merkezi	5
Büyük Üretici Ana Deposu İşletmeciliği	6
Konteyner Stoklama Alanı	7
Büyük Zincir Market Ana Deposu	8
Perakende Dağıtıcı Ana Deposu	9
Açık Dökme Malzeme Deposu	10
Binek araç PDI ve Stok merkezi	11
Akaryakıt Dolum Tesisi	12
Diğer Likit Malzeme Depolama Alanı	13
Uluslararası/Ulusal/Bölgesel Lojistik Firması	14
50 Araç Üzeri Tır Parkı	15
Uluslar arası Kara Taşıması	16
Yurt içi kara taşıması	17
Demiryolu terminali işletmesi	18
Kara Nakliye Ambarı	19
Diğer (Belirtiniz)	20

Figure C.2. Logistics Company Survey, Page 2.

4. Ana faaliyet dışında hangi faaliyetlerde bulunuyorsunuz ? (BİRDEN FAZLA SEÇENEK İŞARETLENECEKTİR)	

Liman İşletmeciliği	1
Gümrük Müşavirliği	2
Genel Antrepo İşletmeciliği	3
Milli Depo İşletmeciliği	4
Kargo Aktarma Merkezi	5
Büyük Üretici Ana Deposu İşletmeciliği	6
Konteyner Stoklama Alanı	7
Büyük Zincir Market Ana Deposu	8
Perakende Dağıtıcı Ana Deposu	9
Açık Dökme Malzeme Deposu	10
Binek araç PDI ve Stok merkezi	11
Akaryakıt Dolum Tesisi	12
Diğer Likit Malzeme Depolama Alanı	13
Uluslararası/Ulusal/Bölgesel Lojistik Firması	14
50 Araç Üzeri Tır Parkı	15
Uluslar arası Kara Taşıması	16
Yurt içi kara taşıması	17
Demiryolu terminali işletmesi	18
Kara Nakliye Ambarı	19
Diğer (Belirtiniz)	20

5. Firmanızda (bu noktada) şu an kaç kişi çalışmaktadır?	*Kişi*
6. Firmanızda (bu noktada) son mali yıl içerisinde (2010 yılı) aylık ortalama kaç kişi çalışmaktadır?	*Kişi*
7. Firmanın tam kapasitede çalışırken ulaşabileceği en yüksek istihdam sayısı nedir?	*Kişi*
8. Firma (şube) parsel büyüklüğü	*M²*
9. Elleçlenen yıllık yük miktarı.	*Ton*
10. Şirketinizin sahip olduğu yetki belgeleri hangileridir?	

C_1	01	H_2	10	N_1	19
C_2	02	K_1	11	N_2	20
C_3	03	K_2	12	P_1	21
E_2	04	K_3	13	P_2	22
G_1	05	L_1	14	R_1	23
G_2	06	L_2	15	R_2	24
G_3	07	M_1	16	T_1	25
G_4	08	M_2	17	T_2	26
H_1	09	M_3	18	T_3	27

Figure C.3. Logistics Company Survey, Page 3.

11. **Bu şirket/şube aşağıdaki araçlardan ve gayri-menkullerden hangilerine ve kaç tanesine sahiptir ya da uzun dönem kiralıktır?**

TÜRÜ	Adedi
TIR	..............................Adet
Kamyon	..............................Adet
Kamyonet	..............................Adet
Treyler	..............................Adet
Vagon	..............................Adet
Gemi	..............................Adet Tipi .... Kapasitesi ....dwt
Açık Depolama Alanı	..............................m²
Kapalı Depo Alanı	..............................m²
Açık Antrepo Alanı	..............................m²
Kapalı Antrepo Alanı	..............................m²
Soğuk Hava Deposu	..............................m²
Araç/Tır Parkı	..............................m²

12. **Aşağıda sayılan hizmetlerden hangileri şirketiniz tarafından verilmektedir?**

Karayolu taşımacılığı	01	Kargo Hizmetleri	15
Demiryolu taşımacılığı	02	Barkod/Etiketleme	16
Denizyolu taşımacılığı	03	Konteynır taşımacılığı	17
Havayolu taşımacılığı	04	Kalite Kontrol	18
Uluslararası Taşıma	05	Envanter/Stok yönetimi	19
Depo işletmeciliği	06	Cross-D king	20
Antrepo işletmeciliği	07	Satın alma	21
Liman Elleçleme	08	İthalat/İhracat	22
Dağıtım Merkezi	09	Gümrükleme	23
Çok noktalı toplama/dağıtım	10	Yük Konsolidasyonu	24
Tersine Lojistik	11	Sigorta	25
Sipariş işleme	12	Diğer (açıklayınız) ____________________ ____________________	26
Ambalajlama/Paketleme	13		
Proje Taşımacılığı	14		

13. **Kaç yıldır bu tesiste çalışmaktasınız?**

[ ][ ] *Yıl*

14. **Tesisiniz kendinize mi ait yoksa kiralıkmı?**

Kendisine Ait	1
Kiralık	2
Diğer______________________	3

15. **Kaç sene daha bu tesis size yetecektir?**

[ ][ ] *Yıl*

Figure C.4. Logistics Company Survey, Page 4.

LOJİSTİK SEKTÖRÜ SORUNLARI

16. Firmanızın Lojistik Operasyonlarını olumsuz etkileyen, kentsel altyapı ve üstyapı kaynaklı eksiklik ve sorunlar nelerdir?

17. Bu sorunları/eksiklikleri giderebilmek için Kocaeli Yerel Yönetim Birimlerinin Ne yapmasını önermektesiniz? (örneğin ışık konması ilave kamyon/tır parkları yapılması gibi)

18. Firmanızın lojistik operasyonlarını kolaylaştırma ve/veya kapasitesini arttırmak üzere önümüzdeki orta ve uzun vadeli planlamış olduğunuz yatırımlar nelerdir?

Figure C.5. Logistics Company Survey, Page 5.

GÖRÜŞMECİNİN DİKKATİNE AŞAĞIDAKİ PARAGRAFI MUTLAKA OKUYUNUZ !!!

19. **Aşağıda belirtilen Kocaeli Lojistik Sektörüne yönelik potansiyel sorunlara yönelik ifadeleri sizi etkileme derecesine göre (1 kesinlikle katılmıyorum, 2 katılmıyorum, 3 bir şey söyleyemem, 4 katılıyorum 5 kesinlikle katılıyorum) 1 ile 5 arasında değerlendiriniz.**

Karayolu altyapısına yönelik sorunlar	Kesinlikle Katılmıyorum	Katılmıyorum	Bir Şey Söyleyemem	Katılıyorum	Kesinlikle Katılıyorum
Kocaeli kent içi yolları ve otoyol bağlantılanndaki trafik sıkışıklığı yük taşımasını engelleyecek düzeyde çok fazladır.	1	2	3	4	5
Kocaeli'ndeki karayolları kamyon operasyonlarını kısıtlayacak şekilde kötüdür.	1	2	3	4	5
Kocaeli'nde yeterli kamyon ve araç parkı bulunmamaktadır.	1	2	3	4	5
Diğer sorunlar (açıklayınız) ______ ______ ______	1	2	3	4	5

Demiryolu Taşımacılığında Yaşanan Sorunlar	Kesinlikle Katılmıyorum	Katılmıyorum	Bir Şey Söyleyemem	Katılıyorum	Kesinlikle Katılıyorum
Demiryolu ağı ve modernizasyonu yetersizdir.	1	2	3	4	5
Demiryolu taşımacılığında vagon temini zor olmaktadır.	1	2	3	4	5
Demiryolu taşımacılığında Kocaeli'nde ciddi yönetim sorunları bulunmaktadır.	1	2	3	4	5
Diğer sorunlar (açıklayınız) ______	1	2	3	4	5

Kocaeli Limanlarında Yaşanan Sorunlar	Kesinlikle Katılmıyorum	Katılmıyorum	Bir Şey Söyleyemem	Katılıyorum	Kesinlikle Katılıyorum
Depolama sahaları yetersizdir.	1	2	3	4	5
Boşaltma yükleme ekipmanları yetersizdir.	1	2	3	4	5
Yanaşma ücretleri yüksektir.	1	2	3	4	5
Gümrükleme hizmetleri yetersizdir.	1	2	3	4	5
Yükleme ve boşalma ücretleri yüksektir.	1	2	3	4	5
Tır-Kamyon araç park sahaları yetersizdir.	1	2	3	4	5
Gemiler yanaşabilmek için uzun süre bekletilmektedir.	1	2	3	4	5
Kombine taşımacılık olanakları açısından yetersizdir.	1	2	3	4	5
Diğer sorunlar (açıklayınız). ______ ______	1	2	3	4	5

Figure C.6. Logistics Company Survey, Page 6.

Havayolu Taşımacılığı ile ilgili Sorunlar	Kesinlikle Katılmıyorum	Katılmıyorum	Bir Şey Söyleyemem	Katılıyorum	Kesinlikle Katılıyorum
Havayolu taşımacılığına erişim sorunludur.	1	2	3	4	5
Hava meydanları kargo taşımacılığı için yeterli filo kapasitesine ve donanıma sahip değildir.	1	2	3	4	5
Havayolu taşımacılığında gümrükleme sorunları yaşanmaktadır.	1	2	3	4	5
Kocaeli çevresindeki havayolu taşımacılığında gereksiz bürokrasi zaman ve kaynak kaybına neden olmaktadır.	1	2	3	4	5
Diğer sorunlar (açıklayınız). ____________	1	2	3	4	5

Gümrüklerde Yaşanılan Sorunlar	Kesinlikle Katılmıyorum	Katılmıyorum	Bir Şey Söyleyemem	Katılıyorum	Kesinlikle Katılıyorum
Gümrüklerindeki elemanların ciddi bir eğitim eksikliği bulunmaktadır.	1	2	3	4	5
Gümrüklerindeki bürokrasi olması gerekenden fazladır	1	2	3	4	5
Kocaeli gümrüklerdeki teknik altyapı olanakları oldukça düşüktür.	1	2	3	4	5
Kocaeli gümrüklerindeki personel sayısı yetersizdir.	1	2	3	4	5
Kocaeli gümrüklerinde haksız taleplerde bulunulmaktadır.	1	2	3	4	5
Diğer sorunlar (açıklayınız). ____________	1	2	3	4	5

Depolarda karşılaşılan sorunlar	Kesinlikle Katılmıyorum	Katılmıyorum	Bir Şey Söyleyemem	Katılıyorum	Kesinlikle Katılıyorum
Soğutmalı depo temininde güçlük çekilmektedir.	1	2	3	4	5
Kapalı depo bulmakta zorluklar yaşanmaktadır.	1	2	3	4	5
Depolardaki elleçleme araçları ve altyapısı yetersizdir.	1	2	3	4	5
Depo lokasyonları erişimi, trafik nedeniyle zor yerlerde kalmaktadır.	1	2	3	4	5
Depo yanaşma alanları lokasyonları kamyon manevralarına uygun değildir.	1	2	3	4	5
Depolarda yönetim ve organizasyon sorunları yaşanmaktadır.	1	2	3	4	5
Depolardaki emtia kötü koruma koşullarından ötürü zarar görebilmektedir.	1	2	3	4	5

Figure C.7. Logistics Company Survey, Page 7.

Diğer Sorunlar	Kesinlikle Katılmıyorum	Katılmıyorum	Bir Şey Söyleyeme m	Katılıyorum	Kesinlikle Katılıyoru m
Kocaeli'de lojistik sektöründe kalifiye eleman bulma sıkıntısı yaşanmaktadır.	1	2	3	4	5
Kocaeli'de kalifiye eleman maaşları olması gerekenden yüksektir.	1	2	3	4	5
Kocaeli'de bir lojistik sürekli eğitim merkezi kurulmalıdır.	1	2	3	4	5
Sizin işaret etmek istediğiniz başka sorunlar var mıdır?____________________	1	2	3	4	5

Figure C.8. Logistics Company Survey, Page 8.

EK-TRAFİK ÜRETİM TESPİT FORMU

Görüşmenin yapıldığı tarih: ________/____/________

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

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

Aşağıdaki Tablodaki Araç Sayılarını 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
Tır					
Kamyon					
Kamyonet					

Aşağıdaki Tablodaki Araç Sayılarını Firmanıza Çıkış 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
Tır					
Kamyon					
Kamyonet					

Figure C.9. Logistics Company Survey, Page 9.

APPENDIX D: SITE ADMINISTRATION SURVEY

KOCAELİ BÜYÜKŞEHİR BELEDİYESİ

LOJİSTİK MASTER PLANI ODAK YÖNETİMİ SORU KÂĞIDI

İyi Günler, Kocaeli İli sınırları içinde yer alan Sanayi ve Lojistik Hizmetlerin sorunsuz ve çevreyle uyumlu bir şekilde yürütülebilmesi amacıyla Kocaeli Büyükşehir Belediyesi, Kocaeli Lojistik Ana Planı çalışmasını başlatmıştır. Bu çalışmanın ana amacı, daha yaşanılır bir kent, sürdürülebilir bir sanayileşme ve karlılığı daha yüksek bir endüstri yapısına ulaşmaktır. Bu nedenle, çalışmanın belirtilen hedeflerine ulaşabilmesi, yapacağımız firma ve aktör görüşmeleriyle ihtiyaç duyduğumuz bilgilerin toplanabilmesine bağlıdır. Bu yapacağımız görüşmelere katılımınız ve bu konudaki işbirliğiniz Kocaeli için çok önemlidir. Toplanılan bilgiler sadece istatistiksel analizlerde kullanılacak olup gizli tutulacaktır. Görüşmemiz yaklaşık yarım saat sürecektir. Şimdiden katılımınız için çok teşekkür ederiz. İrtibat için
Kocaeli Büyükşehir Belediyesi Ulaşım Daire Başkanlığı Ulaşım Planlama Müdürlüğü: 0262 321 22 77 /3620

ADRES VE ÖRNEKLEME BİLGİLERİ

A1. İL : ________		A6. BİNA / DIŞKAPI NO : ________	
A2. İLÇE : ________		A7. BİNA İÇ KAPI NO (DAİRE NO) : ________	
A3. BUCAK (BELDE) : ________		A9. ALT BÖLGE (ODAK VS NO) :	
A4. KÖY / MAHALLE : ________		A10. ÖRNEK BİRİM NO :	
A5. CADDE/ SOKAK : ________			

ZİYARET SAYISI	1	2	3	4
GÖRÜŞMECİNİN ADI SOYADI KODU	________	________	________	________
TARİH	GÜN AY	GÜN AY	GÜN AY	GÜN AY
BAŞLAMA SAATİ	SAAT DAK.	SAAT DAK.	SAAT DAK.	SAAT DAK.
BİTİŞ SAATİ	SAAT DAK.	SAAT DAK.	SAAT DAK.	SAAT DAK.
ZİYARET SONUCU	SORUKAĞIDI TAMAMLANDI 1	SORUKAĞIDI TAMAMLANDI 1	SORUKAĞIDI TAMAMLANDI 1	SORUKAĞIDI TAMAMLANDI 1
	GÖRÜŞME YARIM KALDI 2	GÖRÜŞME YARIM KALDI 2	GÖRÜŞME YARIM KALDI 2	GÖRÜŞME YARIM KALDI 2
	YETKİLİ YERİNDE YOK 3	YETKİLİ YERİNDE YOK 3	YETKİLİ YERİNDE YOK 3	YETKİLİ YERİNDE YOK 3
	GÖRÜŞME ERTELENDİ 4	GÖRÜŞME ERTELENDİ 4	GÖRÜŞME ERTELENDİ 4	GÖRÜŞME ERTELENDİ 4
	GÖRÜŞME REDDEDİLDİ 5	GÖRÜŞME REDDEDİLDİ 5	GÖRÜŞME REDDEDİLDİ 5	GÖRÜŞME REDDEDİLDİ 5
	DİĞER (Belirtin)________ X	DİĞER (Belirtin)________ X	DİĞER (Belirtin)________ X	DİĞER (Belirtin)________ X
SORUKAĞIDININ DOLDURUL MASI TAMAMLAN MAMIŞ İSE SONRAKİ GÖRÜŞMENİN RANDEVU GÜNÜ VE SAATİ	GÜN SAAT DAK.	GÜN SAAT DAK.	GÜN SAAT DAK.	GÜN SAAT DAK.

EKİP BAŞI (ALAN EDİTÖRÜ)	A I SOYADI : ________	KOD
DENETÇİ	ADI SOYADI : ________	KOD
TELEFONDA CEVAPLAYAN KİŞİ	ADI SOYADI : ________	

CEVAPLAYAN KİŞİ________ GÖREV ÜNVANI	GENEL MÜDÜR/BAŞKAN________01
	ORTAĞI________02
	ÜST DÜZEY YÖNETİCİ________03
	DİĞER(Belirtiniz):................................

Figure D.1. Site Administration Survey, Page 1.

1. Lojistik odağın kimliği

Adı/Unvanı	
Telefon Numarası	
E-mail Adresi	
Faks	

2. Odağınızın ana faaliyet alanı nedir?

(TEK CEVAP VERİNİZ.)

		Evet
Üretim		01
Toptan/Perakende Satış		02
İthalat - İhracat		03
Kalite Kontrol, Gözetim İşleri		04
Depoculuk		05
Taşımacılık	Kara	06
	Deniz	07
	Hava	08
	Raylı	09
	Boru Hattı	10
	Kombine	11
Komisyonculuk		12
Gümrük İşlemleri		13
Dağıtı		14
Finansman ve Sigortalama İşlemleri		15
Diğer (Belirtiniz...)		16

3. Şu sayacağım faaliyetlerden hangileri odak içerisinde gerçekleştirilmektedir?

		Evet	Hayır
Üretim		1	2
Toptan/Perakende Satış		1	2
İthalat - İhracat		1	2
Kalite Kontrol, Gözetim İşleri		1	2
Depoculuk		1	2
Taşımacılık	Kara	1	2
	Deniz	1	2
	Hava	1	2
	Raylı	1	2
	Boru Hattı	1	2
	Kombine	1	2
Komisyonculuk		1	2
Gümrük İşlemleri		1	2
Dağıtım		1	2
Finansman ve Sigortalama İşlemleri		1	2
Eğitim-Danışmanlık		1	2
Diğer (Belirtiniz...			

Figure D.2. Site Administration Survey, Page 2.

4. Odağın çalışma günleri nelerdir?

GÜNLER	Odağın Çalışma Günleri (Mesai Günleri)		Yük Aracı Giriş Çıkışının Olduğu (Odağın Faaliyette Olduğu)	
	Evet	Hayır	Evet	Hayır
Pazartesi	1	2	1	2
Salı	1	2	1	2
Çarşamba	1	2	1	2
Perşembe	1	2	1	2
Cuma	1	2	1	2
Cumartesi	1	2	1	2
Pazar	1	2	1	2
Dini Bayramlar	1	2	1	2
Resmi Bayramlar	1	2	1	2
Farklı Bir Cevap Veriyorsa Açıklayınız.				

5. Odak yönetiminin çalışma saatleri nedir? (Faaliyette bulunduğu zaman dilimleri)

	Saat		Çalışan
	Başlangıç	Bitiş	Sayısı
1. Zaman Dilimi			
2. Zaman Dilimi			
3. Zaman Dilimi			
4. Zaman Dilimi			
TOPLAM ÇALIŞAN SAYISI			
Farklı Bir Cevap Veriyorsa Açıklayınız			

6. Yük araçlarının odağa giriş ve çıkış yaptığı kapı sayıları nedir?

EĞER ODAK BELİRLİ KAPALI SINIRLAR İÇERİSİNDE DEĞİLSE VE KENDİNE ÖZEL KAPISI BULUNMUYORSA ODAĞA ULAŞIMI SAĞLAYAN GİRİŞ ÇIKIŞ NOKTALARINI BELİRTİNİZ.

SADECE GÖRÜŞMENİN YAPILDIĞI ALANIN (YERLEŞKENİN) KAPI SAYILARINI ALINIZ

KAPININ KULLANIM TÜRÜ	SAYISI
Sadece Girişe Ayrılan Kapı Sayısı	
Sadece Çıkışa Ayrılan Kapı Sayısı	
Hem Giriş Hem Çıkış Yapılan Kapı Sayısı	

Figure D.3. Site Administration Survey, Page 3.

MEKANSAL BİLGİLER

7. (BKZ SORU 1. OSB veya KSS İSE SORUNUZ. DEĞİL İSE GEÇİNİZ SORU 13.) **Lojistik odak bünyesinde bulunan firmaların sektörlere göre dağılımı nedir?**

(TÜM SAYILAR SAĞA BİTİŞİK YAZILACAKTIR)

SEKTÖR	SAYISI	ÇALIŞAN SAYISI	ALANI (m²)
Gıda, içki ve tütün sanayi	_____	_____	_____
Dokuma, giyim eşyası ve deri sanayii	_____	_____	_____
Orman ürünleri ve mobilya	_____	_____	_____
Kağıt, kağıt ürünleri ve basın sanayii	_____	_____	_____
Kimya, petrol, kömür, kauçuk ve plastik mamulleri sanayii	_____	_____	_____
Taş ve toprağa dayalı sanayi	_____	_____	_____
Metal ana sanayi	_____	_____	_____
Metal eşya, makine ve teçhizat, ulaştırma aracı, ilmi ve meslek ölçme aletleri sanayii	_____	_____	_____
Diğer imalat sanayi	_____	_____	_____
TOPLAM	_____	_____	_____

8. Lojistik odak bünyesinde bulunan toplam işletme (firma) kapasitesi ve faaliyette olan işletme sayısı nedir?

(TÜM SAYILAR SAĞA BİTİŞİK YAZILACAKTIR)

Toplam İşletme (Firma) Kapasitesi	☐☐☐☐
Faaliyette Olan İşletme Sayısı	☐☐☐☐

9. Lojistik odak bünyesinde yeni işyeri açılabilecek açık-kapalı toplam alan büyüklüğü nedir?

(İŞYERİ BÜYÜKLÜĞÜ) [AÇIK ALANLARI İLE BİRLİKTE]

☐☐☐☐☐☐☐ m²

Kayıtlara Bakılarak Cevaplandırıldı	01
Tahmini Olarak Cevaplandırıldı	02

Figure D.4. Site Administration Survey, Page 4.

10. Lojistik odak kapsamındaki alanların kapasiteleri ve kullanım oranları nedir?

Toplam Alan	M^2	Kapasite Kullanım Oranı (%)
Toplam Yapı Alanı (Donatı Hariç)		
Binek Araç Otopark Alanı		
Yük Aracı Otopark Alanı		
Sosyal Donatı ve Ortak Kullanım Alanları (yeşil alan, cami, sağlık tesisi, vb.)		
Diğer		
TOPLAM		

Kayıtlara Bakılarak Cevaplandırıldı	01
Tahmini Olarak Cevaplandırıldı	02

Figure D.5. Site Administration Survey, Page 5.

YÜK AKIŞI

11. **Odak genelinde araç türlerine göre günlük ortalama yük getiren ve yük götüren araç sayısı nedir?**

(BÜTÜN BİR YILI DÜŞÜNEREK GÜNLÜK ORTALAMAYI VERİNİZ)

Türü	Yükü Getiren Araç Sayısı	Yükü Götüren Araç Sayısı
TIR		
Kamyon		
Kamyonet		
Diğer (Belirtiniz)		
TOPLAM		

Kayıtlara Bakılarak Cevaplandırıldı	01
Tahmini Olarak Cevaplandırıldı	02

12. **Odağa giriş çıkış yapan yük aracı sayılarının aylara göre yoğunluk sıralamasını yapınız.**

(İÇİNDE BULUNDUĞUMUZ AYI 100 OLARAK BELİRLEYİN DİĞER AYLARI BU AYA GÖRE ORANLAYIN)

Aylar	ENDEKS	Aylar	ENDEKS
Ocak		Temmuz	
Şubat		Ağustos	
Mart		Eylül	
Nisan		Ekim	
Mayıs		Kasım	
Haziran		Aralık	

13. **Yük araçlarının giriş çıkışlarının olduğu saatler nelerdir?**

(24 SAAT ESASINA GÖRE YAZINIZ)

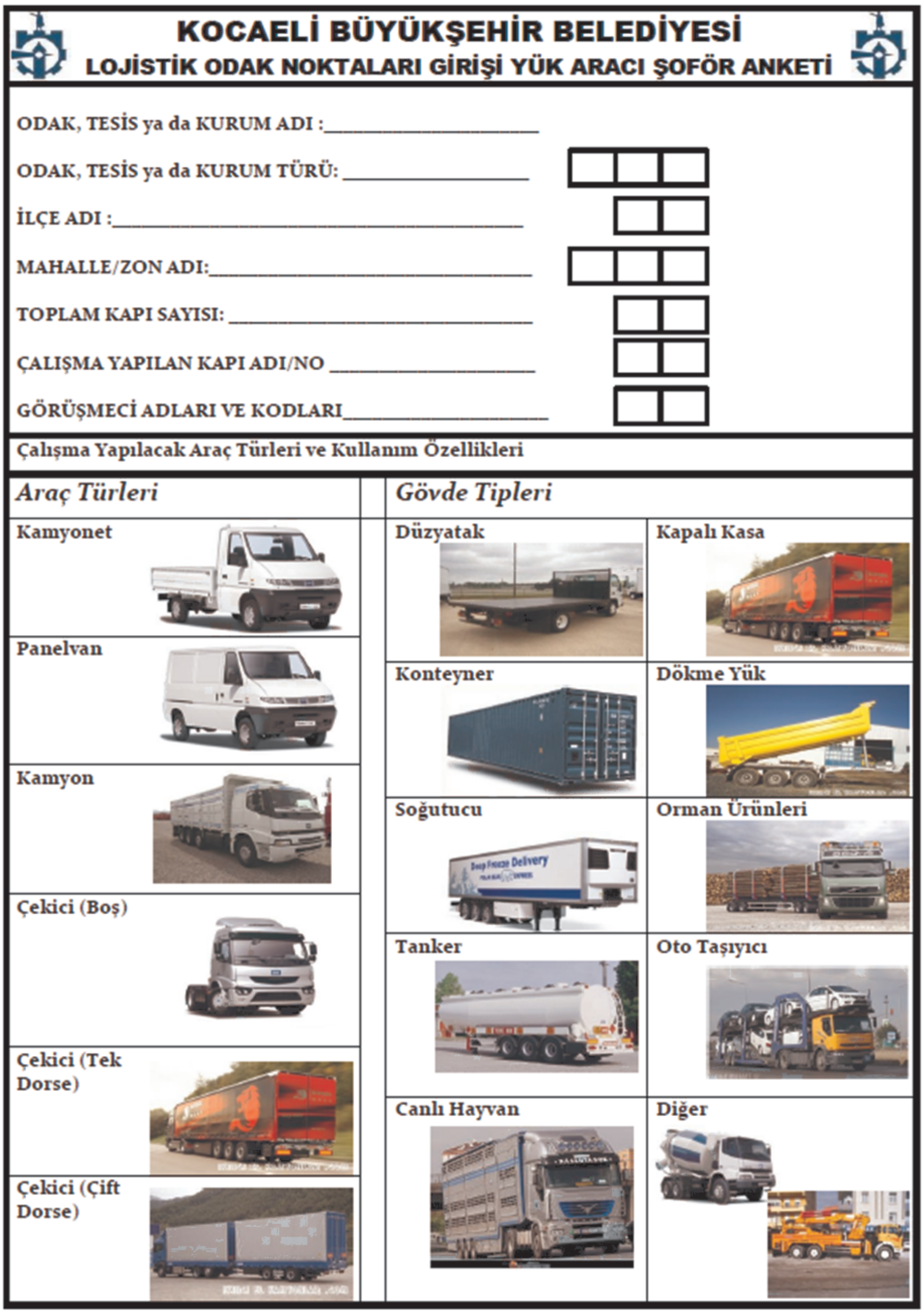
Araç Giriş Çıkış Saatleri

14. **Yük araçlarının odak içerisinde kalma sürelerini kısıtlayan bir kural var mı? Varsa sebebi nedir?**

Hayır Yok	Evet Var	2	Sebebi
1	En fazla .... saat odak içerisinde kalabilirler	1	
	En geç saat ……….'da odağı terk etmek zorundalar	2	

Figure D.6. Site Administration Survey, Page 6.

APPENDIX E: INCOMING DRIVER SURVEY



KOCAELİ BÜYÜKŞEHİR BELEDİYESİ
LOJİSTİK ODAK NOKTALARI GİRİŞİ YÜK ARACI ŞOFÖR ANKETİ

ODAK, TESİS ya da KURUM ADI :____________________

ODAK, TESİS ya da KURUM TÜRÜ: ________________

İLÇE ADI :____________________________________

MAHALLE/ZON ADI:____________________________

TOPLAM KAPI SAYISI: ___________________________

ÇALIŞMA YAPILAN KAPI ADI/NO __________________

GÖRÜŞMECİ ADLARI VE KODLARI___________________

Çalışma Yapılacak Araç Türleri ve Kullanım Özellikleri

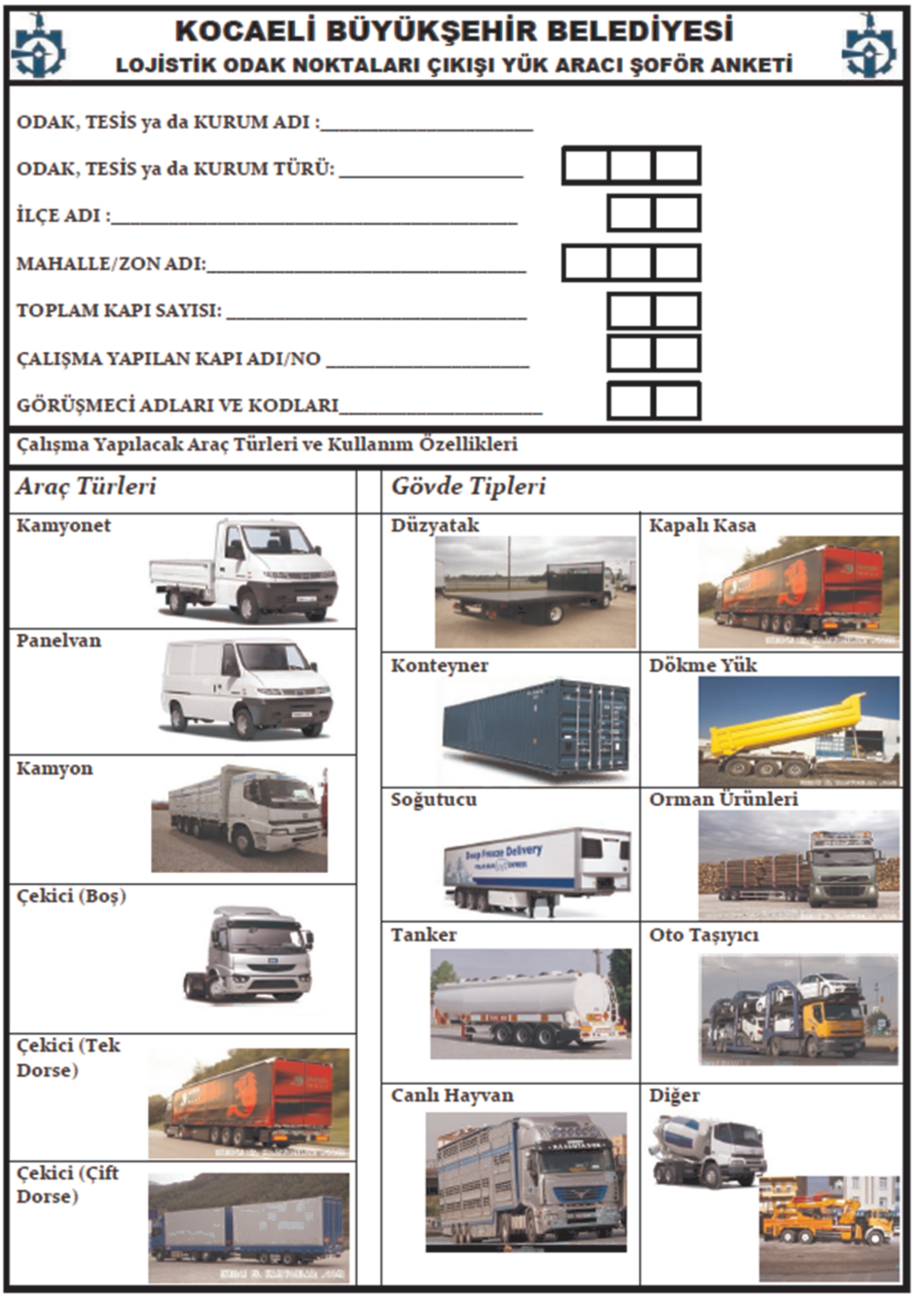
Araç Türleri	*Gövde Tipleri*	
Kamyonet	Düzyatak	Kapalı Kasa
Panelvan	Konteyner	Dökme Yük
Kamyon	Soğutucu	Orman Ürünleri
Çekici (Boş)	Tanker	Oto Taşıyıcı
Çekici (Tek Dorse)	Canlı Hayvan	Diğer
Çekici (Çift Dorse)		

Figure E.1. Incoming Driver Survey, Page 1.

S1. Araç No	S2. Aracın plakası	S3. Araç Türü: Kamyonet ..1 Panelvan....2 Kamyon......3 Çekici (Boş)..........4 Çekici (Tek Dorse) ....5 Çekici (Çift Dorse) 6	S4. Gövde Tipi: Düzyatak..........1 Kapalı Kasa .....2 Konteyner.........3 Dökme Yük ......4 Soğutucu ....5 Orman Ürünleri ....6 Tanker ....7 Oto Taşıyıcı .....8 Canlı Hayvan............9 Diğer............10	S5. Aracın Taşıma Belgesi Tipi	S6. Aracın Sahipliği Kendisine Ait....1 İmalatçı Firmaya Ait .....2 Taşıma Lojistik Firmasına Ait ..3 Diğer..............4	S7. Aracın Taşıma Belgesinin Kayıtlı Olduğu ve Bölge	S8. Araç Taşıma Kapasitesi: (Ton ve Hacim olarak)	S9. Araç dolu mu boş mu ? (Araç boş ise, soru 10 cevaplanıp anket bitirilecek, dolu ise soru 11'a geçilecek) BOŞ.................... 1 DOLU 2	S.10 Bu yolcuğa nerden ve hangi saate başladı?		S.11 Araçtaki yük parsiyel mi? EVET....... 1 HAYIR...... 2	S12. Araçtaki Yük Cinsi (Detaylı Yazınız)	S13. Araçtaki Yükün Ağırlığı ve Hacmi	S14. Araçtaki Yükü(leri)n. Bu Araca Yüklendiği Son Yer ve tarih/saat		S15. Aracın yüklendiği yerin kullanım tipi (OSB, Liman, istasyon,, havaalanı, Depo, Antrepo, Ev, Tarla, Dükkan, fabrika)	S16. Araç Kocaeli dışından geliyorsa Kocaeli'ne Girdiği Nokta	S17. Yükün. yüklendiği yerden bu noktaya kadar bu araçla taşındığı mesafe	S18. Araçtaki Yük, son olarak teslim edileceği yer burası değil ise en son teslim yer neresidir
									Yer	Saat				Yer	Saat				
1	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				
2	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				
3	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				
4	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				
5	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				
6	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				
7	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				
8	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				
9	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				
10	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				
11	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				
12	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				
13	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				
14	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				
15	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				
16	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				
17	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				
18	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				
19	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				
20	__/__/__	☐	☐	☐	☐	____	____	1 2 ↳ S10	____	__:__	1 2			____	__:__				

Figure E.2. Incoming Driver Survey, Page 2.

APPENDIX F: OUTGOING DRIVER SURVEY



KOCAELİ BÜYÜKŞEHİR BELEDİYESİ
LOJİSTİK ODAK NOKTALARI ÇIKIŞI YÜK ARACI ŞOFÖR ANKETİ

ODAK, TESİS ya da KURUM ADI :____________________

ODAK, TESİS ya da KURUM TÜRÜ: ________________

İLÇE ADI :______________________________________

MAHALLE/ZON ADI:______________________________

TOPLAM KAPI SAYISI: ____________________________

ÇALIŞMA YAPILAN KAPI ADI/NO __________________

GÖRÜŞMECİ ADLARI VE KODLARI___________________

Çalışma Yapılacak Araç Türleri ve Kullanım Özellikleri

Araç Türleri	*Gövde Tipleri*	
Kamyonet	Düzyatak	Kapalı Kasa
Panelvan	Konteyner	Dökme Yük
Kamyon	Soğutucu	Orman Ürünleri
Çekici (Boş)	Tanker	Oto Taşıyıcı
Çekici (Tek Dorse)	Canlı Hayvan	Diğer
Çekici (Çift Dorse)		

Figure F.1. Outgoing Driver Survey, Page 1.

S1. Araç No	S2. Aracın plakası	S3. Araç Türü: Kamyonet...1 Panelvan....2 Kamyon.....3 Çekici (Baş).........4 Çekici (Tek Dorse) ....5 Çekici (Çift Dorse) 6	S4. Gövde Tipi: Düzyatak........1 Kapalı Kasa .....2 Konteyner.........3 Dökme Yük.......4 Soğutucu..........5 Orman Ürünleri..........6 Tanker ....7 Oto Taşıyıcı .....8 Canlı Hayvan..........9 Diğer 10	S4. Aracın Taşıma Belgesi Tipi	S5. Aracın Sahipliği Kendisine Ait...1 İmalatçı Firmaya Ait.....2 Taşıma Lojistik Firmasına Ait...3 Diğer..............4	S6. Aracın Taşıma Belgesinin Kayıtlı Olduğu ve Bölge	S7. Araç Taşıma Kapasitesi: (Ton ve Hacim olarak)	S8. Araç dolu mu boş mu ? (Araç boş ise, soru 10 cevaplanıp anket bitirilecek, dolu ise soru 10'a geçilecek) BOŞ..................1 DOLU 2	S.9 Bu yolcuğu nerede ve hangi saate bitireceksiniz		S.10 Araçtaki yük parsiyel mi? EVET.......1 HAYIR.....2	S11. Araçtaki Yük Cinsi (Detaylı olarak yazınız)	S12. Araçtaki Yükün Ağırlığı ve Hacmi	S14. Araçtaki Yükü(leri)n. bu araçtan İndirileceği Yer ve tarih/saat		S15. Aracın yüklendiği yerin kullanım tipi (OSB, Liman, istasyon,, havaalanı, Depo, Antrepo, Ev, Tarla, Dükkan, fabrika)	S16. Araç Kocaeli dışına gidiyorsa Kocaeli'nd en çıkacağı Nokta?	S17. Yükün, bu noktadan indirileceği yere kadar olan bu araçla taşınacağı mesafe	S18. Araçtaki Yükün, son teslim edileceği yer
									Yer	Saat				Yer	Saat				
1	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				
2	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				
3	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				
4	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				
5	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				
6	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				
7	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				
8	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				
9	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				
10	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				
11	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				
12	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				
13	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				
14	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				
15	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				
16	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				
17	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				
18	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				
19	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				
20	__/__/__	☐	☐	☐	☐	____	____	1 2 → S10	____	__:__	1 2			____	__:__				

Figure F.2. Outgoing Driver Survey, Page 2.

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