INVESTIGATION OF THE EFFECTS OF TRANSPORTATION INVESTMENTS ON REAL ESTATE PRICES: CASE STUDY BEYLIKDUZU & ESENYURT

by

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ABSTRACT

INVESTIGATION OF THE EFFECTS OF TRANSPORTATION INVESTMENTS ON REAL ESTATE PRICES: CASE STUDY BEYLIKDUZU & ESENYURT

Transportation investments provide many benefits such as economic growth and less commuter costs. The goal of this study is to determine and measure the effect of transportation systems on real estate prices. The parameters affecting the property prices are determined through a comprehensive literature review. These parameters are evaluated by analyzing the outcomes of the survey administered to 81 real estate experts. The data (3,498 real estates) is gathered using a convenience sampling technique. The parameters with higher frequency in the literature and suitability of the case study of Beylikduzu and Esenyurt are proximity to transportation systems, the closest high school, shopping mall, hospital, the seaside, Central Business District, existence of facilities, floor level, age, size, number of rooms and credit viability of the real estate. In order to investigate combined effects of two transportation systems, a new hedonic price model (HPM), "overlapping zone model" (OZM) is proposed. The dataset is analyzed by ordinary least squares (OLS), spatial auto regression (SAR), geographically weighted regression (GWR) for the residential properties in the primary (PCA) and the secondary catchment areas (SCA). Multiscale geographically weighted regression (MGWR) is used for the first time in the literature. The proximity to the BRT line and metro line provides a premium to the medium and small real estates in PCA, and to almost all types of real estate prices in all neighborhoods within both catchment areas, respectively. The proposed model performed better than HPM for all methods in the defined overlapping zone. The OZM can be transferred to the other study areas. Also, the findings of this dissertation can be used as a guide for policy makers.

ÖZET

ULAŞIM YATIRIMLARININ KONUT FİYATLARI ÜZERİNE ETKİSİNİN İNCELENMESİ: BEYLİKDÜZÜ VE ESENYURT VAKA ÇALIŞMASI

Ulaşım yatırımlarının ekonomik kalkınma düşük ulaşım maliyeti gibi birçok faydası vardır. Bu çalışmanın amacı, ulaştırma sistemlerinin konut fiyatları üzerine etkisinin tespit edilmesi ve ölçülmesidir. Konut fiyatlarını etkileyen faktörler kapsamlı bir literatür taraması ile belirlenmiştir. Seçilen parametreler, 81 emlak uzmanı ile yapılan anket ile değerlendirilmiştir. Kolay ulaşılabilir örnekleme metodu ile 3498 adet konuta ait bilgiler toplanmıştır. Literatür taramasında yüksek frekansa sahip olan ve Esenyurt ile Beylikdüzü ilçelerinde yapılan bu çalışmaya uygun olan parametreler; ulaştırma sistemlerine, okullara, hastanelere, alışveriş merkezlerine, deniz kenarına ve merkezi iş alanına erişim mesafeleri ile konutun yüksekliği, büyüklüğü, yaşı, oda sayısı, krediye uygunluk durumu, otopark, yüzme havuzu ve spor salonu gibi olanaklarının bulunması olarak sıralanabilir. İki ulaştırma sisteminin aynı anda etkisini incelemek için, girişim bölgesi modeli adı verilen yeni bir model önerilmiştir. Veri sıradan en küçük kareler yöntemi, konumsal oto regresyon ve coğrafi ağırlıklı regresyon teknikleri kullanılarak birincil ve ikincil yakalama bölgeleri için analiz edilmiştir. Çok ölçekli coğrafi ağırlıklı regresyon analizi literatürde ilk defa kullanılmıştır. Metrobüse yakınlık ilk yakalama bölgesinde küçük ve orta ölçekteki konut fiyatlarına, metro hattı için ise hemen hemen her konutun fiyatını arttırmıştır. Girişim bölgesi için önerilen model, analiz sonuçlarına göre faydacı fiyat modeline oranla daha iyi sonuç vermektedir. Girişim bölgesi modeli diğer çalışma bölgelerine transfer edilebilir. Ayrıca bu tezden elde edilen sonuçlar kanun koyucular tarafından rehber olarak kullanılabilir.

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LIST OF SYMBOLS

a_{ik}	The weight term in kernel function
d_{ik}	The distance term
r	Radius of the weight circles
W	Spatial Lag Term
W_i	Diagonal weight matrix
α, β	Regression coefficient terms
ϵ	Error Term
$log(L(\theta\|y))$	Log likelihood term
ρ	Rho, Coefficient of Spatial Lag Term

LIST OF ACRONYMS/ABBREVIATIONS

AIC	Akaike Information Criterion
ANOVA	Analysis of Variances
BART	Bay Area Rapid Transit
BRT	Bus Rapid Transit
CBD	Central Business District
DID	Difference in Differences
GIS	Geographical Information System
GWR	Geographically Weighted Regression
HPM	Hedonic Price Model
LR	Likely Hood Ratio
LRT	Light Rail Transit
MGWR	Multiscale Geographically weighted regression
MLR	Multiple Linear Regression
OZM	Overlapping Zone Model
RSS	Residual Sum of Squares
SAC	Spatial Autocorrelation
SAR	Spatial Auto Regression
SEM	Spatial Error Model
SDM	Spatial Durbin Model
TBB	Turkey Bank Association
TOD	Transit Oriented Development

1. INTRODUCTION

1.1. Introduction and Background

Transportation investments are frequently regarded as an indicator of progress for developing countries. To drive economic growth, transportation infrastructure investments in particular are essential [1], [2], [3]. There are many different perspectives and approaches developed for determining the effects of the transportation investments. Due to its simplicity, ease of implementation and interpretation, hedonic price models have become very popular in investigating the relation between the transportation systems and property values [4], [5], [6], [7], [1], [8], [9], [2], [10], [11], [12], [13], [14], [15]. The price models are analyzed by various techniques such as ordinary least squares (OLS), spatial auto regression (SAR), spatial auto correlation (SAC), spatial durbin model (SDM), difference-in-differences (DID), geographically weighted regression (GWR) [16], [17], [18], [6], [7], [1], [19], [20], [2], [21], [11], [22], [23], [14], [15].

There is not a uniform and global outcome for the relation between the transportation facilities and property prices. The most important parameter in determining this relation is considered to be the location. Therefore, investigations of the effects of transportation systems on residential property prices within different study areas are necessary. There are many studies around the world investigate the parameters affecting the property prices and the effects of transportation systems such as Chiarazzo *et al.* (2014), Taranto, Italy; Eggermond *et al.* (2015), Singapore; Bohman & Nilsson (2016), Malmo, Sweden; Mulley and Tsai (2016) Sydney, Australia; Cao & Nelson (2016), St. Paul, Minnesota, USA; Xu *et al.* (2016), Wuhan, China; Zhong & Li (2016), Los Angeles, USA; Cohen & Brown (2017), Vancouver, Canada; Wagner *et al.* (2017), Hampton Roads, USA; Pilgram & West (2018), Minneapolis, USA; Dziauddin (2019), Greater Kuala Lumpur, Malaysia [24], [12], [25], [26], [22], [27], [28], [23], [14], [15]. The level of the effect might change nevertheless; there is still a significant effect of transportation facilities on residential property prices [29], [30], [8], [31]. However, this effect is not uniform in the vicinity of transportation systems. The effect diminishes as the distance from the transportation system increases. Therefore, in most of the studies a zone is defined and it is mostly called "catchment area" [19], [24], [11], [12], [23], [14]. This catchment area is generally decided by taking the 10 min average walking distances. They vary in radius between 500 m and 2,000 m depending upon the local and geographical characteristics of the study area. Moreover, the type of the prices used within the studies is not uniform. In some studies, transaction prices are used [7], [8], [2], [10], [12], [13], [14]. Having said that, the results based on the asking prices and transaction prices are not significantly different from each other. Therefore, asking prices are also utilized [6], [1], [2], [24], [11], [23].

The main purpose of this research is to investigate the effect of transportation systems on real estate prices and to determine the amount of its effect on prices. In this scope, a detailed literature review is performed and the factors affecting the real estate prices are selected. Then, the real estate experts who advice people professionally and have a high intuition about the price affecting factors are consulted through a questionnaire. The selected area for this study, Esenyurt and Beylikduzu, includes two transportation systems, the BRT line and the Metro line. The BRT line is currently providing service and the Metro line is on construction period and it is planned to provide service in August 2020. The data is gathered from the study area, Beylikduzu and Esenyurt Counties (in the vicinity of the BRT line and the Metro line) based upon parameters determined from the literature review. A hedonic price model is analyzed by four different techniques, ordinary least square (OLS), spatial auto regression (SAR), geographically weighted regression (GWR) and multiscale geographically weighted regression (MGWR). This research is expected to make a considerable contribution to the analysis of the effects of the transportation systems on real estate prices.

1.2. Problem Definition

Transportation financing has always been an important issue for transportation authorities. There are basically two main sources for financing the transportation investments, namely taxes (taxes such as vehicle tax and fuel tax) and the value paid by the users of transportation systems [32]. Yet, there is a value increase in the vicinity of newly introduced transportation systems. In Turkey, the government collects a tax based on the increase in the price of the property introduced to Turkish taxation system in 2007 [33]. The tax is collected from all types of properties if their prices are increased more than a limit value [33]. However, the prices of some properties increase mainly due to the introduction of a new transportation system which is financed by the government. The amount of the increase in property prices is not certain and there are several difficulties in evaluating the amount of increase in property prices. One of them is the challenge of deciding the impact zone of a newly introduced transportation system. In case of a second transportation system that operates within the same area, there might be combined effects of two transportation systems on the property prices at the same time. Isolation of these effects is a challenge and requires a further analysis. Similarly, deciding about whether there are other factors affecting the property prices significantly or not is a challenge too.

1.3. Goal and Objectives

The goal of this dissertation is to examine the effects of transportation systems on real estate prices. This goal is achieved by the following objectives:

- Determining the environmental and economic variables affecting the real estate prices by performing a comprehensive literature review,
- Evaluating the factors that affect the real estate prices by analyzing the outcomes of the survey administered to real estate experts,
- Defining a hedonic price model to determine the amount of the effect of transportation systems on the prices of real estates,
- Testing the model for a case study area:

  (i) Determination of the study area (namely Esenyurt and Beylikduzu Counties where the transportation investments may have an impact on the prices of the real estates),
  (ii) Collecting and adjusting data for the counties on each side of the BRT line, and an ongoing metro line project within the study area,

(iii) Applying different regression analysis methods such as OLS, SAR, GWR in order to see the statistical significance of the selected parameters which affect the prices of residential properties,

(iv) Applying MGWR, which is a new analysis method, the first time in the analysis of the effects of transportation systems on prices of residential properties,

(v) Proposing a new price model for the overlapping zones that are considered to be affected by two transportation systems.

1.4. Outline of the Dissertation

This dissertation consists of six chapters. The first chapter, which is the introduction of the dissertation, summarizes the importance of transportation investments especially for economic growth of a country. In the second chapter, previous studies related to the effects of transportation investments on property values and the analysis techniques used are presented. Afterwards, the analysis methods used within this dissertation are described in the third chapter. The fourth chapter includes the description of the data, information about the characteristics of the study area, the analysis process and the results of the analysis. In the fifth chapter, the proposed model for the overlapping zone is described and the performance of the proposed model is tested and compared with regular hedonic price model .Thereafter, in the last chapter, (Chapter 6); conclusions, contributions, limitations and future recommendations for further studies are presented.

2. LITERATURE REVIEW

2.1. Outline of Literature Review

The literature review is divided into 3 sections. The first one consists of the studies before millennium. In the second section, the studies between 2000 and 2019 are chronologically reviewed and summarized. The tables presented in the final section consist of the names of the researcher, type of the focused transportation system, the analysis methodology and the outcomes of the previous studies. The final section includes the brief summary of the all reviewed studies that are presented in those tables. The literature review is separated in this manner due to rapid increase and implementation of technological innovations after millennium. The use of improved technologies for analyses provides more accurate results compared to the old ones. This methodology provided an advantage of following the developments in outcomes in a more organized manner.

2.2. The studies regarding the effect of transportation systems on property prices before the year "2000"

Transportation systems undoubtedly affect many things in people's daily lives. Some of these effects may be noticed by simple observations. However, throughout the history the effects have become more noticeable and caused researchers to search for certain effects. Civilization increased rapidly over the last 40-50 years and growing cities increased the need for human and good transportation between cities. Regions providing better transportation options have become more popular and caused the prices of real estates to increase. E.H. Spengler (1930) examined the land values in the vicinity of transit lines in New York and concluded that the transit line was not the single factor affecting the land values. Also, the industrial growth causes an increase in land values [34]. A basic form of a hedonic price model is utilized in 60's, in order to see the effect of centrality on real estate prices [35], [36]. Then, the model is used in order to find the response of urban real estate values in anticipation of the Washington metro by again utilizing a hedonic approach [37]. The usage of hedonic price model and its efficiency is criticized when it is used with too small sample sizes [38]. Some of the researchers did not prefer isolating the effects on the real estate prices from overall effects, but instead attempted to reveal the effects of transportation investments on regional growth that includes the value increases of the real estates in the vicinity by using production functions [39].

On the other hand, hedonic price models have been very popular throughout history. Bajic (1982) used a hedonic price model in order to determine the direct benefits from the transportation improvements in Toronto. According to Bajic' study, the expenses of commuters dropped but savings; on the other hand, have been capitalized into housing costs [40].

Later on, Nelson (1992) investigated the effects of a railway system in Atlanta, Georgia. The main difference of this study from previously mentioned ones is that neighborhoods income levels show different reactions to the introduction of transportation systems. According to Nelson's regression analysis, closer railway stations cause a positive impact on real estate prices in low-income neighborhood whereas the impact is negative for high-income neighborhood [41].

Innovations in technology helped researchers to achieve better results and to extend the size and scope of their studies. An example of this is the introduction of geographical information system (GIS), as it helped many researchers find the exact distances between the target locations, which in particular are very useful in the transportation field. GIS can provide very detailed land use data separated in layers. With this, Lewis-Workman and Brod (1997) utilized GIS software in order to find the exact distances between houses and transit stations [42]. They studied several areas, namely San Francisco, Bay Area Rapid Transit (BART), New York City Queens and Portland Max study areas. A hedonic equation was used in the analysis and it was concluded that outside the negative effect zone; high quality heavy rail transit can provide benefits to the users; therefore, it indicates uplift in property values. In response to these studies, Ryan (1999) concentrated on the effects of transportation systems on real estate prices in order to understand the differences in the results [29]. It was revealed that the change in the sample size and the change in the study area (the distance from the transit stations) cause changes in the results. The level of the impact might change, nevertheless; there is still an effect on property prices.

2.3. The studies regarding the effect of transportation systems on property prices between the years "2000 and 2019"

These studies before the year 2000 were only a part of an increasing number of studies concerning the effect of transportation investments on real estate prices. Therefore, researchers attempted to extend the scope of their studies. As a result, new factors affecting the property prices were identified. These new factors aroused from the rapid increases in urban populations. One of these factors is the crime ratio. Crime ratio tends to increase especially in the vicinity of stations because these zones are highly crowded. In addition, the noise caused from the transportation systems especially heavy rail systems is considered as a factor with a negative effect. The enigma is that people desire to reach the transit stations quickly; on the other hand, people desire to live in quiet places. These negative and positive effects have to be considered together in order to reach more accurate results. In order to understand this, Bowes *et al.* (2001) and Efthymiou *et al.* (2013) searched for the effects of transportation systems on property values considering both positive and negative effects together [43], [2]. Bowes *et al.* (2001) revealed that there is a relationship between property values and rail stations, yet these effects are dependent on the distance from the city center and the income level.

Moreover, Haider and Miller (2000), applied spatial autoregressive techniques in order to reveal the effects of transportation infrastructure and its location on residential real estate values. They concluded that the use of spatial terms improved the models. According to the results of their study, improved accessibility has a certain impact on the prices of properties [44]. Meanwhile, Weinberger (2001) focused on the problem of how distance from light rail systems effects the property prices in Santa Clara. In the studied light rail system, substantial problems arised as habitants sued the authority of county as a consequence of the challenges caused by implementation of the light rail. Hence, Weinberger (2001) investigated the effects of the light rail in the vicinity of the system. By using a hedonic approach, Weinberger concluded that properties that are within 0.8 km (0.5 miles) of a light rail station are rented at a higher price. That 0.8 km (0.5 miles) zone is called catchment/service area. The rent gradient is constant up to 0.2 miles from stations, while, between 0.2 miles and 0.78 miles the gradient decreases constantly and almost linearly. For distances further than 0.78 miles, the gradient would stay constant (Figure 2.1) [16].

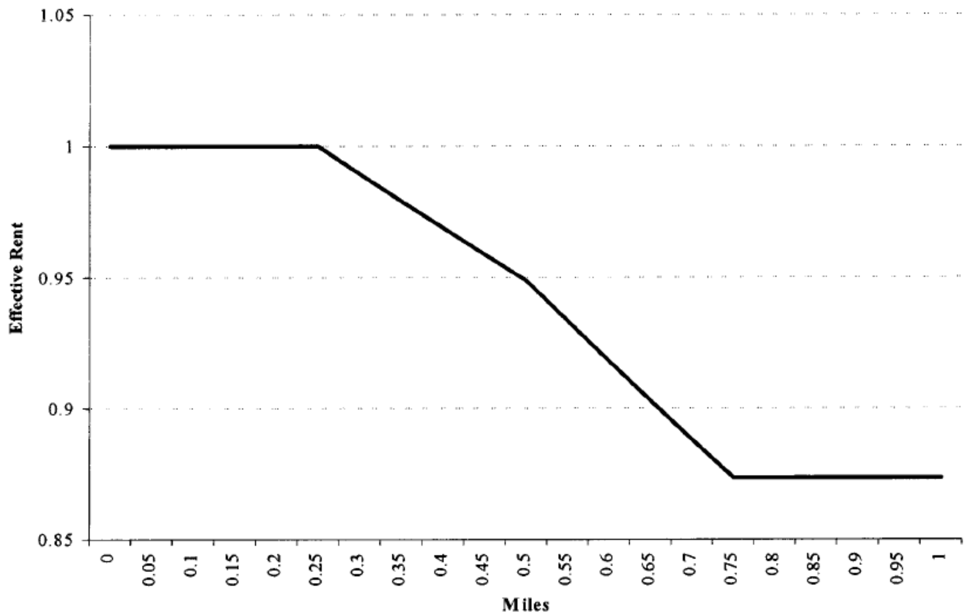

Figure 2.1. Rent gradient [16].

Contrary to Weinberger (2001) study, Cervero and Duncan (2002) investigated the positive effect of the railway system, this time, on the land values. Similarly, in order to predict the positive effect of the railway system, a hedonic price model was used. Subsequently, it was found out that within a 0.25 mile of the railway station, the values of the lands were 45% higher than the other comparable lands by keeping everything else constant [17]. Likewise, Duncan (2003) revealed the effects of both light rail systems and commuter rail systems on real estate prices in San Diego, again, by using hedonic price models [18]. The results showed that there is an increase in single-family housing prices in the vicinity of commuter railway stations, and an increase in multi-family real estates in the vicinity of light railway stations.

Another aspect to look into was changes in premiums due to the increase in accessibility. Rodriguez *et al.* (2003) investigated this aspect for the BRT system in Bogota. They used a hedonic approach although they were aware of the effects due to spatial heterogeneity. Therefore, they used spatial hedonic price functions for the analysis. According to their results, areas having a distance of 5 min to the BRT had their rental prices fall down between 6.8 and 9.3% [4].

Likewise, McMillen and McDonald (2004) examined the relation between real estate prices and the introduction of a BRT in Chicago. The time interval for their research ranges between 1983 and 1999. They investigated the price changes of approximately 17,034 houses that are within a radius of 1.5 miles centered by the transit line. Thus, using a hedonic approach they concluded that the total increase in the prices of properties is approximately $260,000,000 [5].

One thing that stands out among these studies is that the relationship have mainly covered residential properties only. As such, taking commercial properties into consideration, Debrezzion *et al.* (2007) performed a meta-analysis in order to find out the effects of rail stations on the values of both property types with the aim of attempting to find out whether there is uniformity among the result of the studies or not. According to their analysis, there is an impact zone at the station catchment area and when this station zone coincides with CBD, the price values reaches a peak as presented in Figure 2.2. Totally 73 previous studies are analyzed and according to their meta-analysis, the conclusions of the previous studies are not uniform. Another impressive outcome of their study is that existence of two transportation systems in the same zone reduces the impact of each transportation facility individually [30].

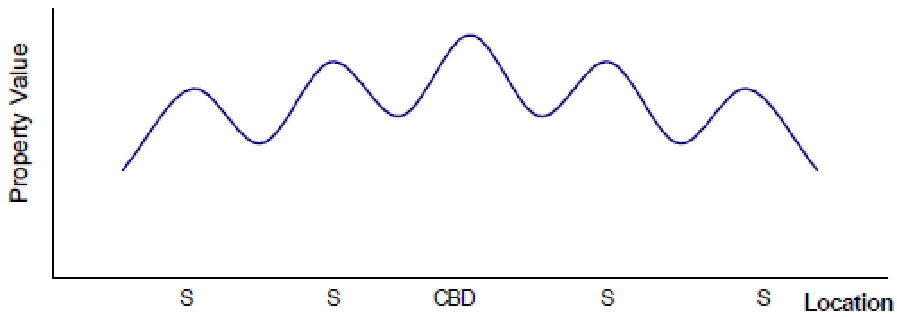

Figure 2.2. Property values along a transportation system [30].

Between 2006 and 2008, multiple studies kept on evaluating the relationship between real estate values and railway related infrastructure with differing approaches and across different regions. In Netherlands, Debrezion *et al.* (2011) attempted to reveal the effects of railway systems on property values by analyzing the Dutch real estate market empirically. According to their meta-analysis in 2011, hedonic pricing methodology is preferred due to its high performance in singling out the impact of one characteristic among others. Their study showed that the property values are 25% higher for regions up to 250 m from the stations, compared to the zone of 15km or more [45].

However, Hess *et al.* (2007) selected the affecting factors of light rail systems in Buffalo, New York, USA, depending upon the characteristics of Buffalo and then put these factors into a hedonic price function and analyzed them -assuming a catchment area of 0.8 km (0.5 miles). They revealed that a decrease in distance by 1 foot to the light railway stations caused, on the average, an increase in property values of $0.99 US Dollar when a network distance is used and an increase of $2.31 US Dollars when geographical distance (strait line) is used [6].

Yet in China, researchers attempted a different approach. Pan and Zhang (2008) attempted to provide the relation between land use and railway systems in Shanghai, China. They divided the impact zone into two buffer zones, one within a distance of 200 m from the station, and the other between 200 m 500 m from the station. However, for suburban areas, a distance of up to 1,000 m from stations is selected (Figure 2.3). The sample points with dark red have the highest price values and they are mostly in the cross section of different transit corridors. With a total number of observations reaching 503, the dataset is analyzed by hedonic price modeling. The results yielded that for every 100 m decrease in distance to the railway station, property prices increased by 152 yuan/m2. However, their analysis lacks the spatial interference effects [7].

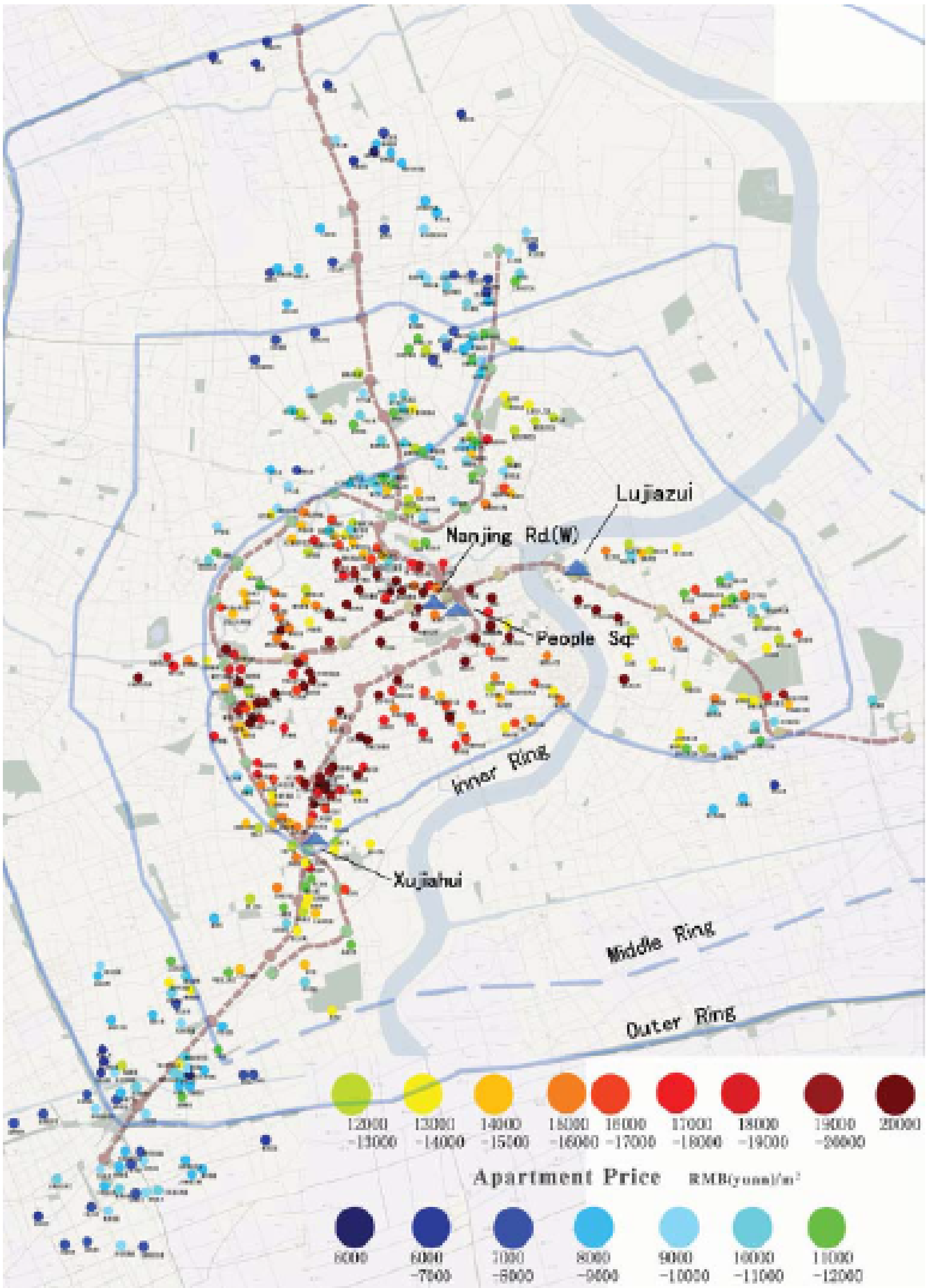

Figure 2.3. Map of the data points in Shanghai [7].

Throughout the past decade, more research focused on utilizing the hedonic price model in relation to transportation investments. Researchers such as Martinez and Vegas (2009) looked into the impacts caused by an increase in transportation accessibility on the price of houses in Lisbon, Portugal, using a hedonic price model. Approximate number of the data analyzed was 8,400. By considering the spatial interferences, it was revealed that there is a significant relation between prices of homes and distances to rail stations [1].

While others such as An *et al.* (2010) investigated the factors affecting the property values in Jilin, China. With a total number of observation reaching 2,001 accommodating both property characteristic variables and market variables in determining the values of the properties, the study concluded that location is found to be the most important parameter affecting the prices of the properties [8].

Munoz-Raskin (2010) focused on the BRT system in Bogota. In this study, the distance covered by 10 minutes of walking from the stations is considered as the catchment area (Figure 2.4). The catchment areas are the circles with a radius of 822 meters (average distance covered within 10 min walking). The black marks refer to the data points outside the catchment areas and the purple ones are in the catchment area. They utilized the GIS software in order to measure the distances between the stations and the residential properties and analyzed the data using a hedonic price model. According to their comprehensive analysis that considers also the spatial interference, the middle-income housing market is willing to pay more for closer properties to BRT system [19].

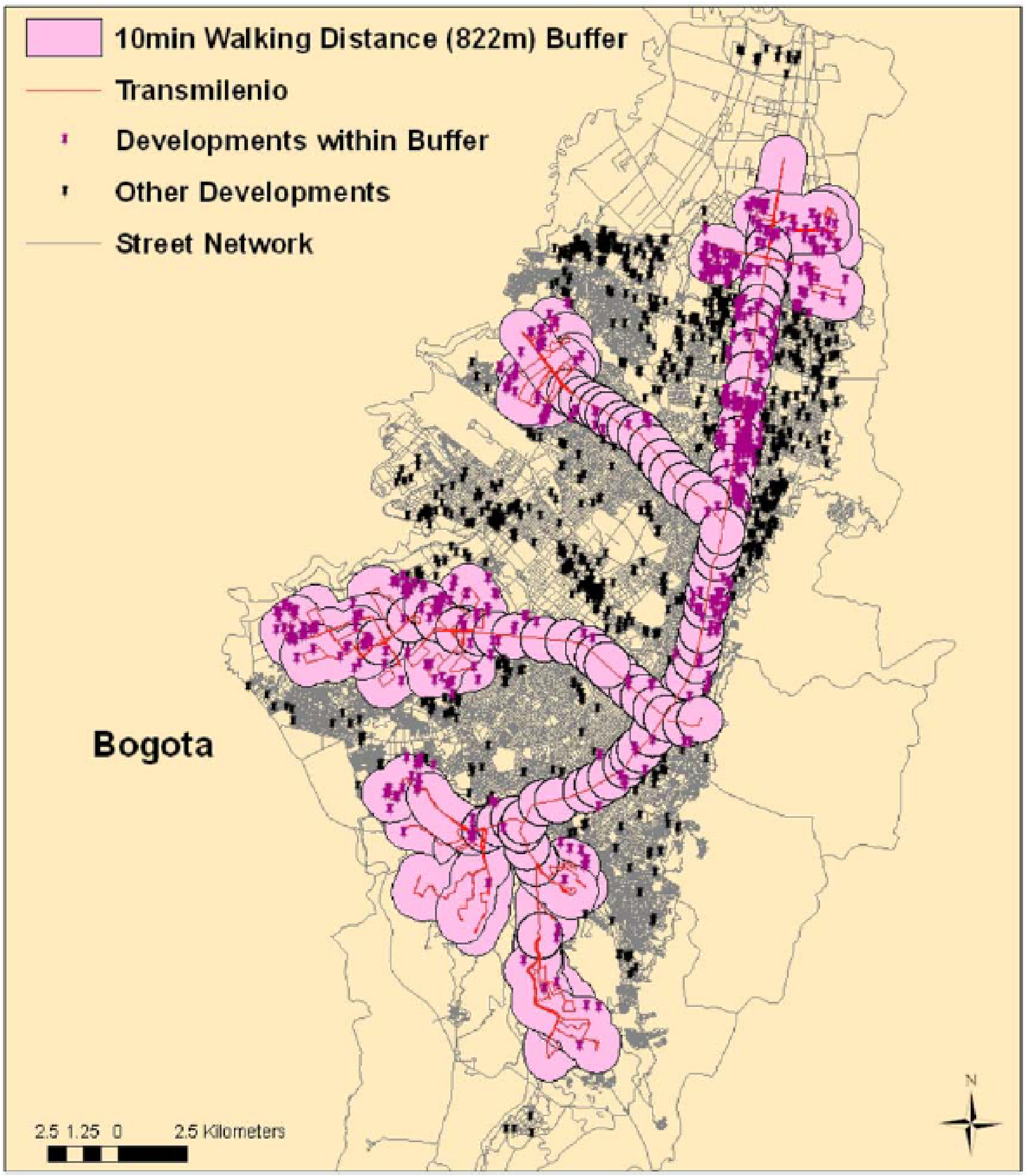

Figure 2.4. The buffer zones used for Transmilenio in Bogota [19].

Three studies conducted on the same year looked into different perspectives of the relationship between real estate and transportation investments. First, Duncan (2011) attempted to reveal the possible effects of Transit Oriented Development (TOD) on residential property values in San Diego. The results proved that station proximity has a significantly strong effect on real estate prices [46]. However, Pagliara and Papa (2011) conducted their study in Naples, Italy, and concluded that there is a negative effect on house prices within the station control areas. Yet, the prices are affected positively for station catchment areas. The catchment area is decided based on the average walking speed of 80 m/min and 10 min of average walking period within their study [24]. Thirdly, Vichiensan *et al.* (2011) studied the relation between the hedonic price models and the spatial dependence for price analyses. They analyzed the nonstationary effects on house prices in Bangkok utilizing hedonic models. They used various regression analysis techniques by considering the spatial interference and concluded that spatial dependence is significantly important [20].

A comprehensive research was conducted by Efthymiou *et al.* (2013) to find out the possible effects of transportation policies, property values and rents in Athens, Greece (Figure 2.5). Within their study, various analysis methods are used including spatial regression model (SAR), ordinary lest squares (OLS), spatial error model (SEM), spatial Durbin model (SDM), spatial autocorrelation model (SAC) and geographically weighted regression (GWR) which are increasingly used by econometricians to isolate the spatial effects. According to their comprehensive research, the apartment prices are directly affected by the transportation systems; nevertheless, this effect might be negative or positive depending upon the type of the transportation system. Although Light rail metro, BRT, bus stations, tram and suburban railways increase the property prices, other transportation modes such as national rail stations airports and ports decreases the price [2].

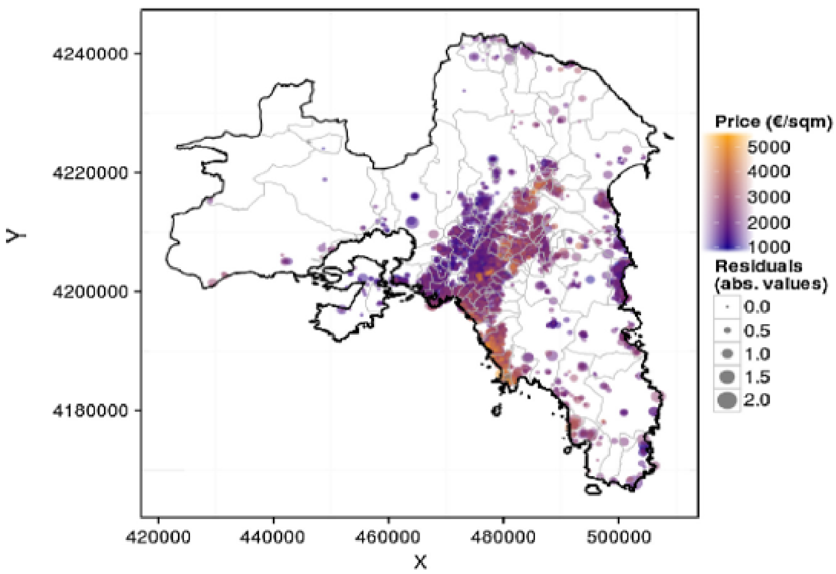

Figure 2.5. Real estate prices in Athens [2].

Also, in 2013 Dubée *et al.* investigated the relation between light rail accessibility and real estate prices in Montreal South Shore, Canada. They utilized a difference in differences (DID) estimator in the hedonic price model. Their results suggested that opening of a new commuter train service increases the values of the residential properties in the vicinity. The vicinity is defined as walking distance up to 1000 meters from stations [47]. The same year Mohammad *et al.* (2013) conducted a meta-analysis on 23 studies (102 observations) that analyzed the effects of railways on land and property price changes. According to their analysis, the change in purchase prices and rent values due to railway systems are not statistically different. Also, their study revealed that there are positive and negative results in the literature [37].

Later on, Efthymiou *et al.* (2014) attempted to evaluate the impact of transport infrastructure and land-use features on home prices and rents in Thessaloniki, Greece. Additionally, to search for possible effects of a metro line, which was in construction during the analysis. According to their study, there is a negative effect of proximity to the port and the railway station on property prices and rent values, and there is a positive effect of the proximity to airports. The metro line which is still under construction (5 more years to go), had a negative impact on property prices which indicates that the negative externalities generated by construction decreases the prices of properties [21].

Furthermore, the effects of both highways and railways on house prices in Phoenix, Arizona, were studied by Seo *et al.* (2014) using a spatial hedonic price model. They utilized the GIS software to obtain exact distances for analysis and they covered up to 3,200 m from exit point of highways instead of covering average walking distance. They revealed that when the distance to transportation facilities decreases; the house prices are affected positively [10].

With respect to land values, Hurst and West (2014) searched the relation between the railway systems and land use characteristics in Minneapolis, Minnesota, by utilizing a regression model including difference-in-differences estimator. According to their estimation, the construction period has no effect on land values, both vacant and in use. Yet, the opening of LRT and proximity to LRT increases values of the land, residential and industrial properties [48].

Adding to these findings, Chiarazzo *et al.* (2014) attempted to find out the impacts of increased accessibility on the prices of residential properties, especially in industrial cities focusing on Taranto, Italy. They used the asking prices and used hedonic Multiple Linear Regression (MLR) models to estimate the real estate price variations in metropolitan areas. According to their study, adverse environmental effects influence the property prices negatively and accessibility to train stations increase average asking prices [24].

Moreover, using the asking prices from a commercial property portal and transaction prices from governmental data sets, Eggermond *et al.* (2015) utilized a hedonic regression model in order to reveal the parameters that affect the house prices in Singapore. The models are estimated by standard OLS, Spatial Auto Regression (SAR) and Geographically Weighted Regression (GWR) for sub markets such as private sale and private rent, etc. According to the analysis, the floor area and distance to the CBD are the most important affecting factors, where higher floor levels and proximity to public transport have a positive effect. There is not a statistical difference between asking prices and transaction prices despite the large differences between both types of prices [11].

In 2016, Bohman and Nilsson investigated the effects of light rail systems on real estate prices considering price categories and income levels in Scania, Sweden. They utilized spatial auto regressive models and output of their analysis showed that the price effect of proximity to a commuter train station is the strongest in lower price segments in real estate market [12]. Mulley *et al.*, (2016) focused on the bus rapid transit (BRT) system in Sydney, Australia in order to evaluate the amount of effect on real estate prices due to new transport infrastructure. They used a hedonic regression model and did not include the spatial effect for their analysis. Totally 561 properties included in the dataset and the analysis revealed that the sales price of residential properties within 400 meters of BRT station are higher than those outside of the BRT service area [25].

The same year, Mulley *et al.* (2016) conducted a study in Brisbane, Australia concentrating on the impacts of proximity to transportation infrastructure on housing prices. Within their study, they utilized spatial modeling and geographically weighted regression (GWR). According to their study, there is a greater influence on prices in Brisbane compared to Sydney, which is likely due to larger BRT network coverage in Brisbane [49].

Cao and Porter-Nelson (2016), attempted to evaluate the effects of an upcoming project in St. Paul. By utilizing a difference in differences (DID) model, they concluded that preliminary design had no positive effect on prices whereas the official start of construction increased prices up to 80% [26]. Yang *et al.* (2016) analyzed 8 years of land transaction data by using a hedonic price model and revealed that the prices are higher in regions closer to metro line stations [50]. Xu *et al.* (2016) investigated the effects of urban railway transit by analyzing 676 observations in Wuhan, China. They utilized multiple linear regression (MLR) and Spatial Auto Regression (SAR) models and concluded that there is 16.7% increase in commercial type property prices for 0-100 m core area and 8.0% increase within 100-400 m radius [22]. Zhong and Li (2016) analyzed the real estate sale prices in Los Angeles, California by utilizing Spatial Durbin Model (SDM) and Geographically Weighted Regression (GWR) and revealed that there is a positive impact of proximity to railway stations [27].

In 2017, the negative effect of noise was investigated by Beimer and Maennig (2017). They utilized a semi log hedonic model in order to analyze the effect of noise caused by different transportation systems in Berlin. According to their research, noise caused by flights has the worst impact on property prices, which are followed by the noises caused by roads and trains [13].

Furthermore, between 2017 and 2018, multiple studies continued investigating the relationship between real estates and railway lines with different approaches. Cohen and Brown (2017) utilized OLS and GWR, and concluded that there might be a positive and negative effect on commercial property prices in Vancouver depending upon the locations and property use type [28]. However, Wagner *et al.* (2017) utilized difference in differences (DID) model for a new system in Hampton Roads, Virginia. According to their study, unlike the common results in literature, light rail has a negative impact on prices. The positive benefits due to accessibility do not outweigh the costs produced by pollution and other external effects due to light rail [23]. Lastly, Pilgram and West (2018) also used a difference in differences approach. According to their research, there is an increase in real estate prices due to light rail; however, the amount of the increase varies depending upon the location [14].

The models used in the literature are listed and presented in Figure 2.6. The models are separated based on the possession of the spatial lag. The non-spatial models are namely, hedonic price models (HPM), multiple linear regression (MLR), difference in differences (DID), ordinary least squares (OLS) and production functions. The spatial models are, spatial auto regression (SAR), spatial autocorrelation (SAC), spatial error model (SEM), spatial hedonic model (SHM), spatial durbin model (SDM), geographically weighted regression (GWR) and multiscale geographically weighted regression (MGWR).

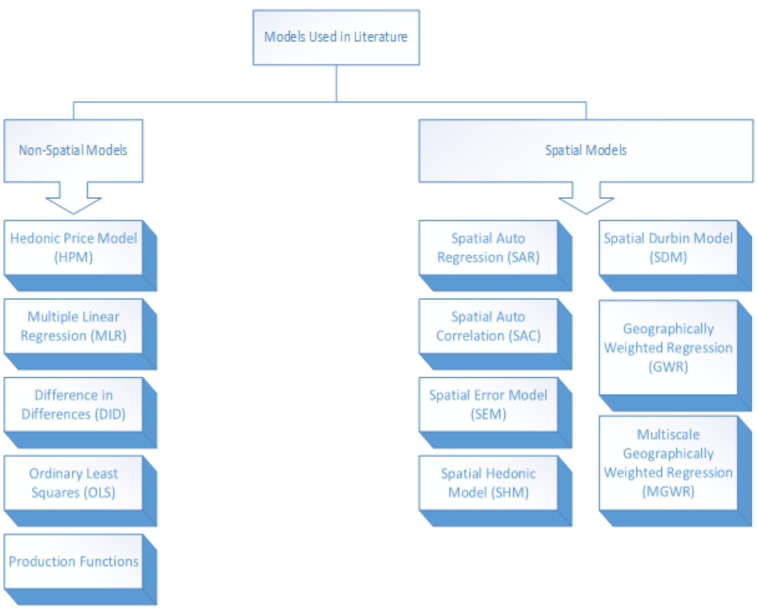

Figure 2.6. The predictive models used in the literature.

2.4. Summary of the Studies Regarding the Effect of Transportation Systems on Property Prices in Chronological Order

The literature review presented in the previous sections is summarized in Table 2.4. The table consists of the date of the research, name of the authors, focused transportation type and its location, the model and the summary of the outputs.

Table 2.1. A summary of the literature regarding the effects of transportation systems on property prices.

Researchers	**Years**	**Mode**	**Case Area (Country)**	**Analysis Model**	**Summary of Results**
Kawamura and Mahajan	1924	Highway	Chicago, USA	Spatial Price Model	Land uses and property values
Damm *et al.*	1980	Metro	Washington, USA	Regression Model	All types of property prices increase near the transit stations
Blum	1982	Highway	Washington, USA	Production Function	Transportation infrastructures increase the real estate prices
Bajic	1983	Subway	Toronto, Canada	Modal Choice model and Hedonic price model	The savings due to lower commuter costs are capitalized by real estates
Nelson	1992	Heavy-Rail Transit	Atlanta, USA	Regression Model	Negative effects due to noise, traffic and other nuisances positive effect due to proximity
Lewis-Workman & Brod	1997	Rail Transit	Oregon and New York	Hedonic Price Function	Within the walking distance, the proximity to rail stations increases the prices of residential properties
Ryan	1999	Multiple	Multiple Cities	Literature Review	There is a significant effect on property prices whether negative or positive depending upon the regional characteristics
Miller & Haider	2000	Highway	Toronto, Canada	Spatial Auto Regressive (SAR) Model	If there are other explanatory variables, location and transportation have insignificant influence on property prices
Bowes & Ihlanfeldt	2001	Railway	Atlanta, USA	Hedonic Price Model and Auxiliary Models	Stations may increase the prices of nearby real estates and the impact level depends upon downtown and income level
Weinberger	2001	Light Rail	Santa Clara, USA	Hedonic Price Model	Prices of real estate within 0.8 km distance to LRT are higher than the other ones.
Cervero & Duncan	2002	Light Rail	Los Angeles, USA	Hedonic Price Model	Proximity to light rail and commuter rail adds value to property prices
Cervero	2003	Railway	San Diego, USA	Hedonic Price Model	The effect is positive for single family houses and negative for commercial properties
Targa & Rodriguez	2003	BRT	Bogota, Colombia	Spatial Hedonic Price Functions	There is an increase in the property values to due to the BRT system
Debrezion *et al.*	2004	Multiple	Multiple Cities	Meta-analysis	The increase in accessibility of transportation systems significantly affects the real estate prices
McMillen & McDonald	2004	Rapid transit line	Chicago, USA	Hedonic Price Function	The prices of real estates highly increased due to new rapid transit
Debrezion *et al.*	2006	Railway	Netherlands	Hedonic Pricing Model	Increase in the frequency of railway services causes an increase in the values of residential properties

Table 2.1. A summary of the literature regarding the effects of transportation systems on property prices (Cont.).

Researchers	**Years**	**Mode**	**Case Area (Country)**	**Analysis Model**	**Summary of Results**
Hess & Almeida	2007	Light Rail Transit	Buffalo New York, USA	Hedonic Models	The effect of LRT on real estate prices is less than the impacts of the size of the property, number of bathrooms and the location of the property
Pan & Zhang	2008	Rail Transit	Shanghai, China	Hedonic Price Modeling	Increased accessibility causes increase in the prices of lands and real estates
Martinez and Viegas	2009	Metro	Lisbon, Portugal	Spatial Hedonic Model & Spatial Lag Model	The accessibility to public transportation has a significant effect on real estate prices
Munoz-Raskin	2010	Bus Rapid Transit	Bogota, Colombia	Spatial Hedonic Model	The real estates in the walking distance to BRT have higher prices
An *et al.*	2010	All	Jilin, China	Hedonic Price Model	The most significant effect on real estate prices is the location of the property
Pagliara & Papa	2011	Railway	Naples, Italy	Hedonic Price Model	The prices of residential properties are higher in catchment areas, yet the prices are lower in control areas
Duncan	2011	Rail Transit	San Diego, USA	Hedonic Price Model	The effect on the real estate prices is higher when pedestrian orientation is improved
Vichiensan *et al.*	2011	Railway	Bangkok	Hedonic Price Model & Spatial Auto Regressive Model & Geographically Weighted Regression	The proximity to stations causes higher prices for real estates
Efthymiou & Antoniou	2013	Railway	Athens, Greece	Hedonic Price Model based on OLS, SAR, SEM, SDM, SAC & GWR	The prices of real estates are positively affected by railways and highways, yet there is a negative impact due to airports and ports
Dubée *et al.*	2013	Railway	Montreal, Canada	DID estimator & Hedonic Price model	There is an increase in the real estate prices in the vicinity of commuter rail stations
Mohammad *et al.*	2013	Multiple	Multiple Cities	Meta-analysis	There are both positive and negative effect on property prices and these effects are significantly important
Hurst & West	2014	Railway (Metro Line)	Minneapolis, USA	Difference-in-differences model (DID)	The proximity to LRT significantly affects the land use and property prices
Seo *et al.*	2014	Highway & Railway	Phoenix, USA	Spatial Hedonic Price Model	Highway exits and LRT stations have positive effect on real estate prices
Efthymiou & Antoniou	2014	Multiple	Thessaloniki, Greece	Hedonic Price models & Spatial Lagged models (SAR,SEM,SDM)	There is a negative effect on the residential property prices due to rail stations and ports, yet there is a positive effect due to airports

Table 2.1. A summary of the literature regarding the effects of transportation systems on property prices (Cont.).

Researchers	**Years**	**Mode**	**Case Area (Country)**	**Analysis Model**	**Summary of Results**
Chiarazzo *et al.*	2014	Railway	Taranto, Italy	Hedonic Multiple Linear Regression Model	The increase in accessibility indicates higher prices for residential properties
Eggermond *et al.*	2015	All	Singapore	Hedonic Pricing Model & SAR,SDM,GWR	The most significant effect on real estate prices is the floor level
Cao & Porter-Nelson	2016	Railway	St. Paul, Minnesota	Difference-in-difference model (DID)	Preliminary design of the railway has no effect; however, the introduction of railway has a positive impact on real estate prices
Mulley *et al.*	2016	BRT and Railway	Sydney, Australia	Hedonic Regression model and Multilevel Hedonic Model	The prices of residential properties are higher up to 400 m distance from BRT
Mulley & Tsai	2016	Bus Rapid Transit	Brisbane, Australia	Spatial Modelling and Geographical Weighted Regression	Longer BRT corridor has a stronger positive effect on real estate prices
Bohman & Nilsson	2016	Railway	Malmo, Sweden	Hedonic Price Model and OLS	In lowest price group, the effect of proximity to the railway stations is higher
Yang *et al.*	2016	Railway	Beijing, China	Hedonic Price Model	Higher population density around the rail transit station causes higher market prices
Xu *et al.*	2016	Railway	Wuhan, China	Spatial Autoregressive Model (SAR) and Spatial Economic Model (SEM) and Multiple Linear Regression Model (MLR)	There is an increase in the values of commercial properties within 400 m radius
Zhong & Lei	2016	Railway	Los Angeles, USA	Spatial Regression Model, OLS model, Spatial Durbin Model GWR model	There is a negative effect on the single-family household due to heavy rail transit lines
Cohen & Brown	2017	Railway	Vancouver, Canada	OLS Model & GWR Model	The effects of proximity transportation could be either negative or positive depending on the property type
Beimer & Maennig	2017	All Types	Berlin, Germany	Semi Log Hedonic Model	There is an increase in the real estate prices in the vicinity of transportation systems due to noise effect
Wagner *et al.*	2017	Railway	Virginia, USA	Hedonic Model & DID Model	There is a negative effect on residential property priced due to construction period of railways.
Pilgram & West	2018	Railway	Minnesota. USA	DID Model	There is a premium in property prices due to proximity to Light Rail Stations

3. THEORY

In this chapter, the econometric models and theoretical information about the analysis methods are briefly explained. Then, data analysis methods are defined. At the end of the chapter, the survey analysis method is described.

3.1. Data Analysis Methods

In the literature, there are many different models and analysis methods, nonetheless; hedonic price models and regression-based analysis are the most frequently used ones [29], [30], [31]. Therefore, hedonic price models are used within this study. These hedonic price models are analyzed using ordinary least squares (OLS), spatial auto regression (SAR), geographically weighted regression (GWR) and multiscale geographically weighted regression (MGWR) for predicting the estimates of the models.

3.1.1. Hedonic Price Models

Hedonic regression is firstly introduced to statistics by Court in 1939 in order to define a hedonic price index for automobiles [51]. Thereafter, many other researchers helped the hedonic price model to be improved [52], [53], [36], [54]. The hedonic price model (HPM) technique is extensively used within many disciplines [55]. HPM is also widely preferred for property investigations in different real estate markets in order to find out the price affecting factors around the world [11], [49], [27], [28]. HPM, also known as hedonic regression [56], provides the possibility of evaluating the effect of each explanatory variable in the model which affects the prices of properties [57]. Since, the market price can be considered as a function of structural characteristics and other influencing factors for each specific study area, the parameters can be defined and HPM can be adapted. This availability makes hedonic price models very popular among developers, corporate real estate groups, owners, and operators for investigating the affecting parameters in different study areas [58]. Monson defined the market price as dependent variable and provided the Equation 3.1:

$$\begin{aligned}&Market\ Price = \ f\ (tangible\ \&\ building\ characteristics,\\&other\ influencing\ factors)\end{aligned} \tag{3.1}$$

The hedonic price function consists of various parameters depending upon the study area. A more general form of a hedonic price model consists of parameters, which have impacts on real estate prices, are presented in the equation:

$$P = \ f\ (J,\ A,\ E,\ S,\ H,\ B), \tag{3.2}$$

where P indicates the price, J indicates the distance from nearest CBD, A indicates the total area of the property, E indicates environmental condition of the property, S indicates the school quality, H indicates the proximity to an highway, B indicates the distance to the nearest public transportation system.

The hedonic price function consists of various parameters depending upon the study area. Therefore, a more general type and a derived sample hedonic price model are provided above.

Advantages and disadvantages of the hedonic price models could be listed as follows [59]:

Advantages are:

- Researchers can create a model based on available features without constraint.
- HPMs are widely feasible, in other words, when the model is established it can be utilized to evaluate many properties.
- HPMs can be adapted to different study areas and they can be updated in analysis process.
- HPMs are very easy to implement and understand.

Disadvantages are;

- HPM analyses require substantial amount of data.
- It is not possible to include external factors such as interest rate or political situation to the HPMs.
- HPM analysis process requires possessing the knowledge within the field of mathematical statistics in order to build the model and interpret the results.
- The HPM analysis results only reflect the impacts due to the individuals that are aware of them.

Hedonic models need various assumptions [60]; which are:

- The equilibrium is provided in the market.
- There is no other market in the study area.
- The parameters that affect the prices are known and the data can be gathered from the study area.
- There is continuity in the production differentiation,
- There are no external costs and any arbitrage.

3.1.1.1. Ordinary Least Squares (OLS). In order to model the relationship between one or more dependent or responding variables and a set of independent variables, regression analysis is used. A general form of regression is presented in Equation 3.3.

$$Y_i = \alpha + \beta X + \varepsilon_i, \tag{3.3}$$

where Y_i is the value of dependent variable, α is the intercept, X is the explanatory variable and β is the coefficient of the explanatory variable. The parameter of the model α is called the constant of intercept and it indicated the value where the regression line crosses the y-axis. β is called coefficient ant it indicates the slope of the regression line. The OLS technique makes it possible to analyze the models that consist of a single or multiple explanatory variables as well as the categorical explanatory variables [61].

The purpose of OLS is describing the relationship between variables Y and X by using the equation of the line best fit with model parameters. There are confidence intervals for β indicating how well the model fits the data. An example of the best fitting line and observed scattered data around the line is presented in Figure 3.1.

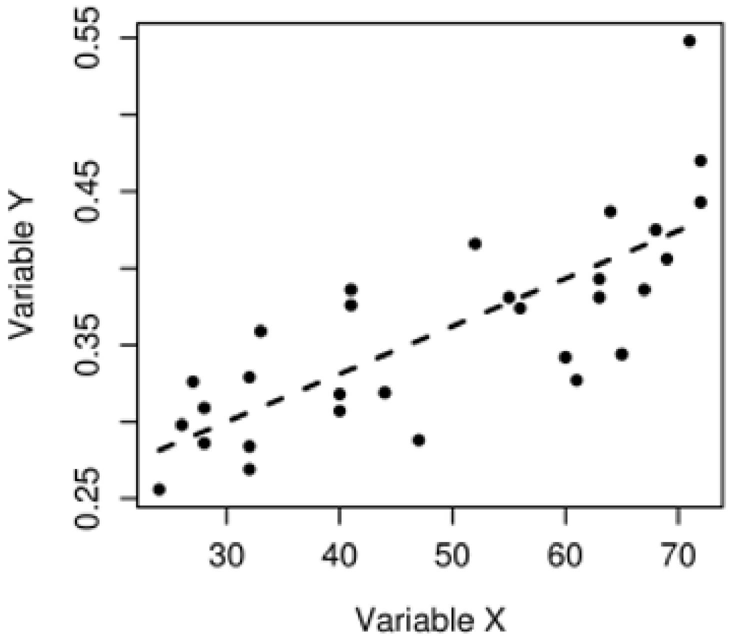

Figure 3.1. The Line of Least Squares Regression [61].

The OLS technique also can be utilized for the models with multiple explanatory variables. There might be more β values depending on the numbers of explanatory variables; in other words, as the number of the explanatory variables increases the number of the coefficients increases. The general form of multiple OLS regression is presented in the Equation 3.4:

$$Y_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4, \tag{3.4}$$

where Y_i is the value of dependent variable α and β are coefficients of the model, X_1, X_2, X_3 and X_4 are the explanatory variables of the model. In general, the OLS technique is preferred by researchers mostly due to its ease of use and comprehension.

3.1.1.2. Spatial Auto Regression (SAR). The hedonic models without a spatial lag term can be easily analyzed by OLS method, yet if the data set is bounded by locational effects. If there is a possible effect of the spatial dependence, then the spatial lag term should be included into the hedonic regression model [62]. The general form of Spatial Auto Regression (SAR) is presented in Equation 3.5.

$$y_i = \rho W y_j + X\beta + \varepsilon, \tag{3.5}$$

where y_i is the dependent variable for observation point, ρ is the coefficient for spatial auto regression, W is the spatial weight matrix, y_j is the neighbor point, X is the explanatory variable, β is the coefficient and ε is the error term [63]. Spatial interactions can be included into the analysis by the help of a spatial lag term. The spatial auto regression model (SAR) is a more generalized regression form including spatial inferences [64]. The term $\rho W y$ in Equation 3.5 is called the spatial autocorrelation term. The term W indicates a spatial weight matrix. It is created by considering the effect of the neighbor points on the observation point. A sample neighborhood structure is presented in Figure 3.2. The pink arrows indicate that only 2 neighbor points have an effect on the observation point whereas green arrows indicate 4 neighbor points, yellow square indicates 8 neighbor points, blue square indicate 16 neighbor points and red square indicate 24 neighbor points are considered as the points affecting the dependent variable at the observation point. These are the option for deciding the number of the neighbor points based upon the intuition of the researcher using the SAR technique for a study area.

However, selection of these parameters are not systematic. Therefore, the outputs cannot be generalized. Instead these outputs can be used as a guiding tool for further analyses.

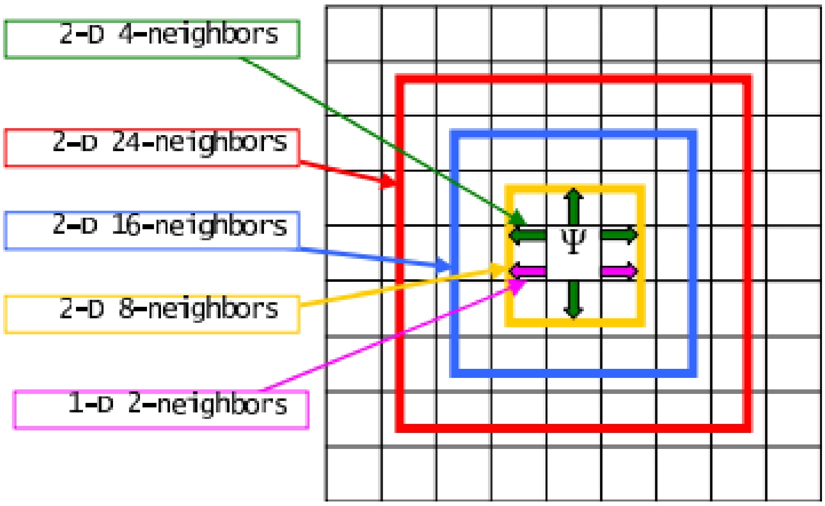

Figure 3.2. Sample neighborhood structure [64].

3.1.1.3. Geographically Weighted Regression (GWR). Real estate price analysis requires application of spatial statistics because real estate prices are subject to the spatial heterogeneity. Introduction of new analysis techniques provided researchers to use more software and computing in the studies. Hereby, better results are obtained in shorter time periods. The introduction of spatial terms in to analysis models provided the benefit of including the spatial dependencies. The first law of geography, remarked by Waldo Tobler (1970), is "everything is related to everything else, but near things are more related than distant things" [65]. Without spatial dependence, the models assume that there is no change across the space. The general regression model is improved by techniques which allow measuring the effects of spatial terms. Geographically weighted regression is one of these techniques. The analysis is based on computer programming and it helps researchers to evaluate for spatial interferences. Nearby data is used in order to see location based factor estimations in models. A single bandwidth parameter is used in order to provide the possible effect of a geographic scale. In other words, the GWR is a regression model considering the localities. Cassetti (1972) proposed a regression model including explicit functions taking into account the spatial locations [66]:

$$y_i = \sum\nolimits_j X_{ij}\beta_j\left(p_i\right) + \epsilon_i, \tag{3.6}$$

where y_i is the dependent variable, β_j is the coefficient of the j th explanatory variable (j = 1, 2, 3... j) to be estimated, ϵ_i is the error term and (p_i) is the geographical location of i th case (i = 1, 2, 3...i). Casetti's model is improved in the following years [67], [68]. However, the main problem of equation 3.6 is providing estimates for β_j (p_j); in other words, defining the borders of the nearby data that have influence on the target point (real estate). This is made possible by drawing circles with constant radius r around the target point [69]. There will still be a problem due to the selection of radius r. For instance, if it is very small, it would not be enough to explain the model. On the other hand, if the r value is very large, it might take entire data into the analysis of the target point. This problem is addressed by introducing Kernel-Weighted Regression. Each p_j is considered as the center of a weighted ordinary least squares. So, these weights are notated as:

$$a_{ik} = \begin{cases} 1 \ \ if \ \ d_{ik} < r \\ 0 \ \ otherwise \end{cases} \tag{3.7}$$

where a_{ik} is the weight, $d_(ik)$ is the distance from an observation point i (i = 1, 2, 3...i) to an observation point k (k = 1, 2, 3...k). Equation 3.7 is a stepwise function and for a better application of the kernel-weighted regression, the function is proposed in a continuous form as follows:

$$a_{ik} = \begin{cases} \left\{1 - \left(-\frac{d_{ik}^2}{h^2}\right)\right\}^2 \ \ if \ \ d_{ik} \ \ < r \\ \qquad\qquad 0 \ otherwise \end{cases} \tag{3.8}$$

This is called kernel function [70] denoted by $K(d_{ik})$ indicating that $a_{ik} = K(d_{ik})$. The constant h is the control range for the influence zone. By the use of Kernel functions, the effect of weighting decreases with distance instead of suddenly falling to zero for the outside of the circle. According to the theory of likelihood estimation, the likelihood estimate of β in Equation 3.6 provides:

$$\beta = (X^T X)^{(-1)} X^T y \tag{3.9}$$

If this representation is calibrated according to a selected weighting function, the β becomes:

$$\beta_i = \left(X^T W_i X\right)^{-1} X^T W_i y, \tag{3.10}$$

where

$$W_i = \begin{pmatrix} a_{i1} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & a_{iN} \end{pmatrix} \tag{3.11}$$

W_i is a diagonal matrix. The diagonal components are the weights for a weighted regression around point p_i and N is the total number of observations.

The main assumption of GWR model is that the local parameters in the model change at the same spatial scale [71]. This limitation is attempted to be addressed by introduction of semiparametric GWR (SGWR), which allows the subset data to have a different bandwidth, yet the limitation is continued since in the subset data the local parameters still change at the same spatial scale [72].

3.1.1.4. Multiscale Geographically Weighted Regression (MGWR). The geographical datasets are directly related to a fundamental concept, namely "scale". The importance of the scale in geographical analysis is investigated in previous studies [73-78], [71]. The most widely used analysis method concerning the spatial interference in the models is "GWR" [79]. However, the limitation of GWR due to the constant scale for all explanatory variables pushed the researchers to develop a model which allows all variables to have their optimal scales. The new proposed model, which relaxes the constant bandwidth assumption of GWR is called multiscale geographically weighted regression MGWR [71]. By the help of MGWR, it is possible to produce a spatial model that shows higher performance for predicting the coefficients of the explanatory variables. The general form of the geographically linear regression is provided in Equation 3.6. The general form of the multiscale geographically weighted regression is obtained by adding the bandwidth calibration term to the equation 3.6. The obtained equation is:

$$y_i = \sum_{j=0}^{m} \beta_{bwj}\left(u_i, v_i\right) x_{ij} + \varepsilon_i, \tag{3.12}$$

where the term β_{bwj} is the added term representing the bandwidth value for model calibration of the j th experimental condition. The calibration process starts with taking the bandwidth value of GWR analysis then these bandwidth values are adjusted and compared with the previous values with respect to RSS and AIC values. By relaxing the main assumption allowing the coefficients to be optimized at different scales, the MGWR is superior to the GWR. However, some parameters that seem to be affected at larger scales should be limited in order to understand their effect on a target zone. Additionally, MGWR requires an optimization process throughout a back-fitting algorithm, which is a process using the output of an analysis as a comparative indicator for the next analysis in order to reach the optimum value. Hence, it requires much iteration; therefore, it takes longer times for predictions [71]. Compared to GWR technique, which uses a single bandwidth value for each explanatory variable in the model, MGWR provided a solution for bandwidth optimization by removing the limitation of GWR analysis assuming all parameters have been affected at similar distances [71]. In other words, each variable in the MGWR model uses its own level spatial interference [72]. Due to the complexity of the MGWR technique and its computational process, comparison of MGWR techniques with other techniques in terms of R2 value does not provide a good comparison. Therefore, the MGWR technique and its performance in prediction of the estimates of the models should be compared to other techniques in terms of RSS and AIC values [71].

Fotheringham *et al.* (2017), proposed the MGWR technique and by various simulations compared the statistical results of MGWR and GWR. In Figure 3.3, the RSS values of OLS, GWR and MGWR are presented. According to Figure 3.3 the performances of GWR and MGWR are very high compared to OLS method [71].

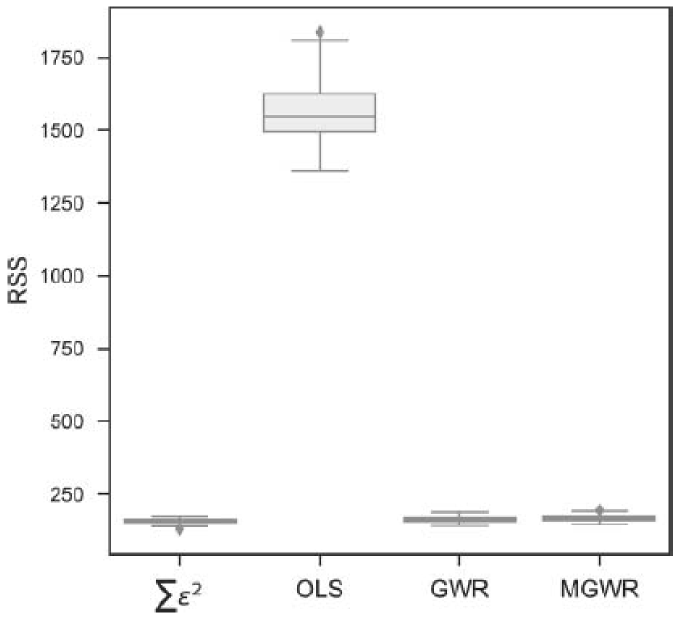

Figure 3.3. RSS values for OLS, GWR and MGWR analysis of a simulation model [71].

The GWR and MGWR results are zoomed and the difference in RSS values is observed in detail in Figure 3.4.

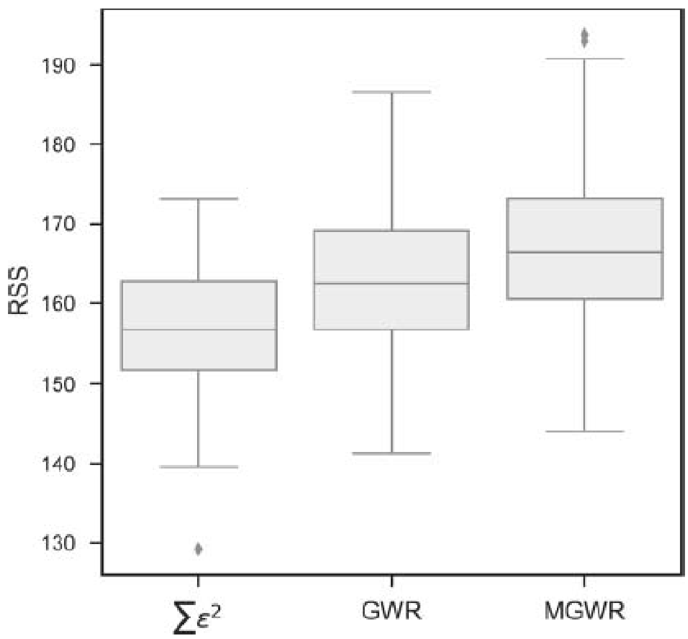

Figure 3.4. RSS values for GWR and MGWR analysis of a simulation model [71].

According to Figure 3.4, RSS value is lower for GWR [71]. The average time spent for 100 runs is presented in Figure 3.5.

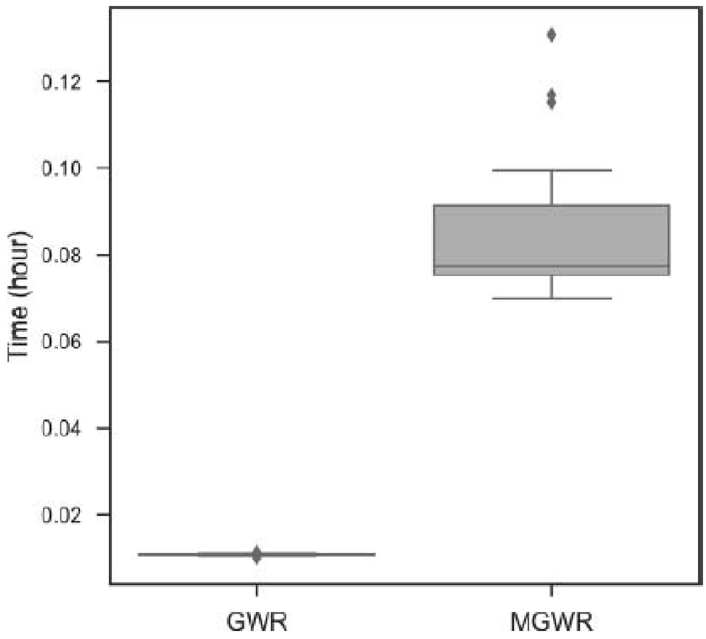

Figure 3.5. Times for 100 runs of GWR and MGWR analysis of a simulation model [71].

According to representation in Figure 3.5, the GWR analysis process is almost 8 times faster than MGWR analysis [71].

3.1.1.5. Model Comparison Techniques. F tests are used to in order to measure performance of the models for prediction of the estimates. Comparison of the residual sum of squares (RSS) for the analysis methods provide an intuition for analysis techniques. Thereafter in order to compare the models and analysis results Akaike Information Criterion (AIC) is used [80]. Akaike (1973) showed the selection of the best model is determined by AIC score, which is calculated as follows:

$$AIC = 2K - 2\log\left(L\left(\theta|y\right)\right) \tag{3.13}$$

where K denotes for the number of parameters; that is, the degree of freedom and the term log $(L(\theta|y))$ is the log likelihood of the estimated model [81]. The maximum likelihood method is used in order to obtain information and an intuitive approach about unknown quantities. The log likelihood function is used in most cases due to its computational convenience [82]. Since the log likelihood value is negative, it should be minimized in order to decrease the AIC value provided in equation [3.13].

Another technique is the likelihood ratio test, which tests the number variables in the model. In other words, it measures whether the increase or decrease in the number of variables is better or not for estimation of the model. Also, there is a spatial statistic term called Moran's' I index, which measures spatial autocorrelation. When the samples in a dataset are geographically close, there might be a spillover effect of each sample on others. Hence, spatial autocorrelation is necessary to perform better investigations. Moran's I index helps to find out whether the spatial autocorrelation varies over the space of the study area or not. It measures the relationship between the values estimated for each parameter and the mean value of the dataset. Based on this approach, Moran's I index provides the spatial pattern, the distribution, of the estimated values [63]. The values of Moran's I index and indication of each value is presented in the Table A.1.

Table 3.1. Moran's I index.

Moran's I score	**Spatial Pattern - Distribution**
Score > 0	Clustered
Score $= 0$	Random
Score < 0	Dispersed

3.1.2. Statistical Analysis of the Survey Data

The survey data is collected by consulting the real estate experts. The expert group is divided into subgroups based on their experience levels. By this methodology, it is aimed to understand if there is a significant difference regarding their observations and comments on the factors affecting the real estate prices in Beylikduzu and Esenyurt counties. The statistical way of controlling the differences of subgroups is application of Analysis of Variances (ANOVA).

3.1.2.1. Analysis of Variances (ANOVA). The ANOVA is first implemented by Iversen and Norpoth in 1976 [83]. They attempted to analyze the data from independent groups. ANOVA is a statistical method and it identifies the variations of groups. Many study areas utilized ANOVA technique due to its high performance in assessing the mean effect of different experimental factors on different groups [84].

The assumptions of ANOVA are listed in the following.

- Sample size should be more than “30”, which increase the robustness to violations of assumptions.
- Normality assumption; the distribution of data for each group should be normal.
- The observations should be independent.
- The variances should be homogenous, in order to provide homogeneity assumption.

ANOVA mainly searches for an answer to the question whether the scores of dependent variable obtained through a study under experimental conditions are significantly different or not [85]. The linear model for one-way ANOVA is as follows:

$$y_{ij} = \mu + \tau_i + \varepsilon_{ij}, \tag{3.14}$$

where y is the observation j (j = 1, 2, 3, 4,...n) for experimental condition i (i = 1, 2, 3, 4,...n) and μ is the constant, τ_i is the impact of experimental condition i (i = 1, 2, 3, 4,...n) and ε_{ij} is the error term of the observation j (j = 1, 2, 3, 4, ...) for experimental condition i (i = 1, 2, 3, 4,...n) [86].

The general form of the analysis of variance (ANOVA) model is:

$$\widehat{X(k)} = \widehat{\mu_k} + \widehat{a_k} + \widehat{\beta_k} + \epsilon(k), \tag{3.15}$$

where $\widehat{X(k)}$ is the estimate of sample "k", (μ_k) is the general mean and (a_k), (β_k) are the sample parameters. The term at the end of the equation $\epsilon(k)$ refers to the unknown effects.

As most statistical analysis methods, there are some assumptions behind the ANOVA. In the literature, many studies revealed that ANOVA is robust to assumption violations [86]. Therefore, ANOVA is still a powerful tool in order to reject the null hypothesis H0 that:

$$H_0 = \mu_0 = \mu_1 = \mu_1 = ... \quad ... \quad ... = \mu_n..., \tag{3.16}$$

where $\mu_i, i = 1, 2, 3, ...n$ are the mean values of the n different data groups.

Depending on the Levene statistics and ANOVA results, if the mean values are significantly different from each other post hoc tests are implemented. The selection of the post hoc statistic tests is decided based on their assumptions and requirements [87]. The selection of proper post hoc test is important because the main purpose of these tests is to avoid the type I and type II errors. In general, the post hoc tests are divided in two main groups based on whether the variances are equal or not [88].

There are several tests in case of having equal variances such as least significant test (LSD), Tukey, Scheffe and so on. In this study the Scheffe test is used because compared to LSD test, it tends to show type I error when the analysis consists of more than 3 groups [89]. Tukey test is very robust to show type I error yet the main requirement of Tukey test is having equal number of observations in each group [90]. Scheffe test is in general most flexible method and it is very robust to showing type I error in case of having many groups to be analyzed. The number of observations in each group is not necessarily to be equal [91, 92].

The post hoc tests are different in case of having unequal variances based on the Levene statistics. The tests, Games-Howell, Tamhane's T2 and T3, Dunnet's C and T3 are the tests used in order to analyze the mean differences between groups. These tests use “student t” or “expanded t modulus” in order to define the differences. While Tamhane’s T2 and T3 tests use only “student t” concept [93] and Dunnet’s C and T3 tests use only “expanded t modulus” concept [94], Games-Howell test uses both of these concepts for comparison and because of that it is called liberal multiple comparison test [95].

4. METHODOLOGY

There are many parameters in the literature which affect the real estate prices whereas the cultural differences might change the impact level of parameters. As an example the interior furniture is not a very common property feature in Turkey because mostly the houses are sold without any furniture. Therefore, the literature is reviewed comprehensively and the parameters that might affect the property prices in Turkey are determined. Afterwards, in order to have an intuition about the effect of the selected parameters, 81 real estate experts, who are focused on the transaction within the study area of this dissertation, are surveyed a questionnaire. Based on the literature review and the survey results the possible affecting parameters are defined and the data is gathered from the study area by using convenient sampling technique. Then, the data is analyzed by using various techniques such as ordinary least squares (OLS), spatial auto regression (SAR), geographically weighted regression (GWR) and multiscale geographically regression (MGWR). The analysis results of different techniques are compared based on the statistical performance criteria for prediction of the estimates.

4.1. Study Area

According to selected parameters, data is collected from the case study area. The case study zone consists of two regions of the city, one of which is Esenyurt, the most crowded region of Istanbul, and the other one is Beylikduzu, one of the youngest counties of Istanbul. Istanbul is the most crowded city of Turkey. The current population of Istanbul is 15,067,724 [96]. Modern age made big cities more and more popular. People migrate from rural areas to city centers due to its accessibility to almost every facility such as, better schools, better hospitals, more options for shopping malls, etc. Therefore, every year similar to other cities Istanbul population keeps rising as presented in Figure 4.1.

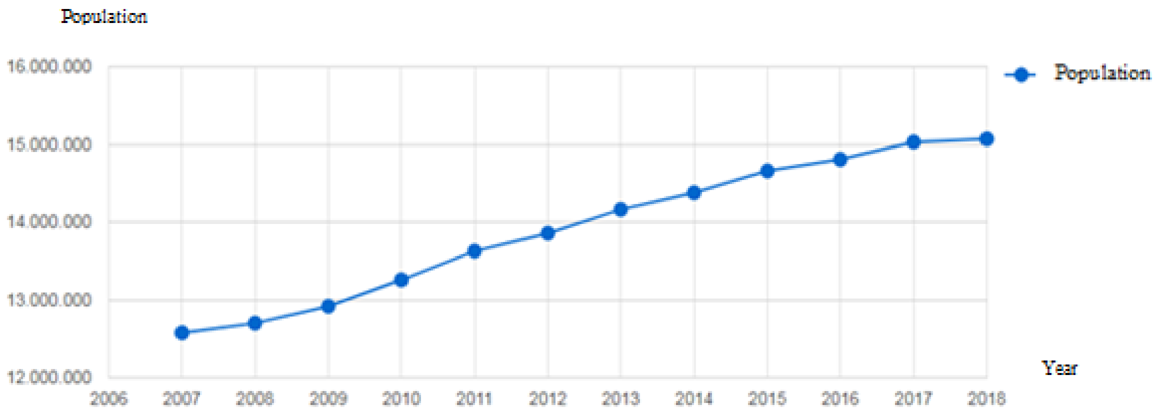

Figure 4.1. Population of Istanbul between 2006 and 2018 [96].

Istanbul covers an area of 5,313 km^2 and current population density is 2,836 per/km^2. It is a very high density relatively to other metropolitans in the world compared to other crowded cities in the world. Currently, Istanbul is the 14th city in the world in terms of its population [97]. Since Istanbul is a very crowded city, in order to manage the city effectively, it is divided into many counties. Currently the total number of counties in Istanbul city is 39. The population of the Istanbul is not equally distributed to the counties some of them have higher populations than the others. Esenyurt and Beylıkduzu counties are the target study area of this dissertation and according to the Table 4.2 Esenyurt has the highest number of population among the 39 counties of Istanbul. The population is 891,20 for Esenyurt County and this number represents 5.91 percent of whole Istanbul population. On the other hand, Beylikduzu County is in the 22nd order among the 39 counties. Its population is 331,525 and it hosts 2.20% of the population of Istanbul. Hence, the study area, consisting of Beylikduzu and Esenyurt Counties, hosts 8.11 percent of city population [96]. There are some regions within the city where the population density is very high. Those regions are mostly in the city center, yet there are some exceptions. Esenyurt is the most prominent example of these exceptions. Although it is far away from the city center, it has the highest population among all counties.

Esenyurt is established as a county in 22.03.2008 by the government. It consists of 43 quarters currently. It is relatively far away from the city center. It is placed between the two main roads of the city, namely D100 Highway and TEM Highway. The borders of the Esenyurt County and the locations of D100 Highway are presented in the Figure 4.2.

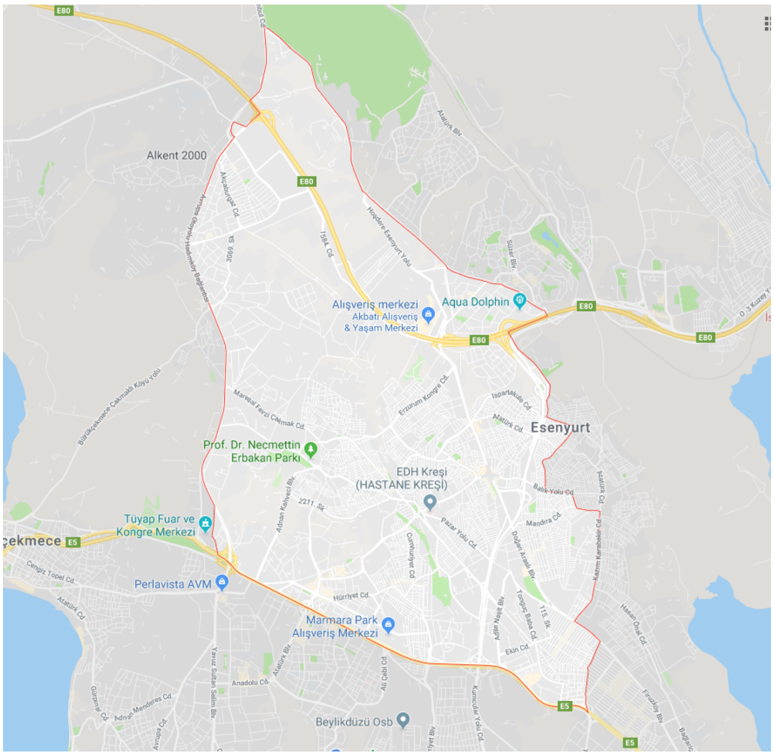

Figure 4.2. Borders of Esenyurt Map view [98].

Currently, there is only a few public express bus services through TEM Highway and express lines in Istanbul costing twice of the regular fare [99]. Therefore, the population density is higher in regions closer to D100 Highway on which BRT line operates. The implementation of the BRT line made the county more attractive for people to live. The property prices are relatively lower than the properties at city center. The county might be away from the city center yet, implementation of the BRT line increased the appealing of the county for especially young people. As a popular trend, the populations of cities are increasing in spite of that the capacity of city centers are almost out of limits. This popular trend is reflected by the increase in the population of Esenyurt. The current population of Esenyurt is 891,120 [96]. The population of the Esenyurt County increased continuously thought ten years as presented in Figure 4.3.

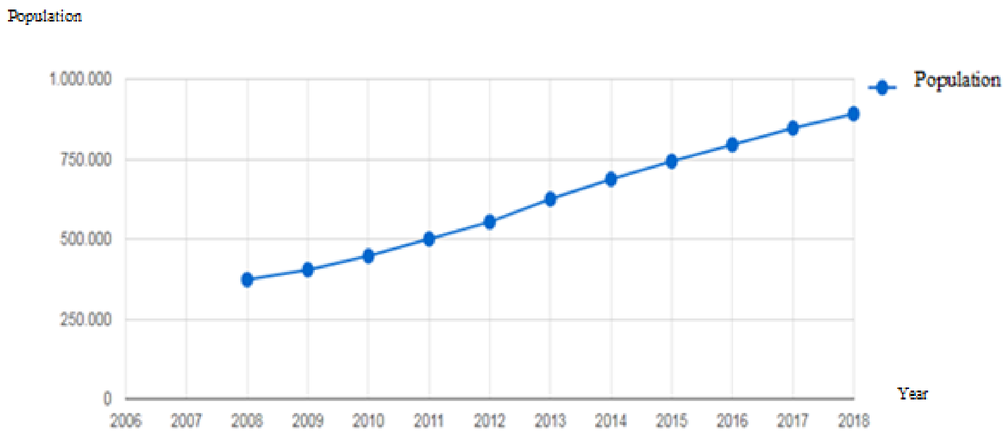

Figure 4.3. Population of Esenyurt between 2008 and 2018 [96].

The population of Esenyurt County mostly consists of young people. The distribution of population according to ages of the people indicates that the number of the commuters is high. In addition, the average walking time of 10 min [19] is suitable for the age average of the County. The age distribution of Esenyurt County is presented in Figure 4.4.

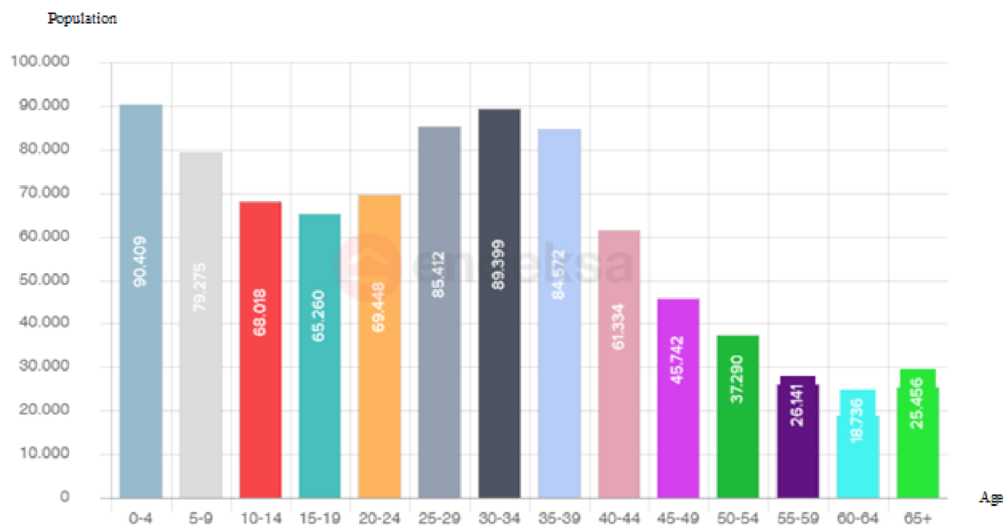

Figure 4.4. Age intervals of the inhabitant of Esenyurt County, 2019 [96].

Education level of the county is not very high as people with primary and secondary school degree constitutes more than half of the county's population. The number of the people with a PhD degree is below 1,000 [96]. Esenyurt County is mostly preferred by young people who are just married and bought a new house due to its relatively lower property prices. Therefore, the majority of the county population is married. The socioeconomic level of Esenyurt is not very high and the average income level is below the city average [96].

The satellite view of the Esenyurt County is presented in Figure 4.5. According to the satellite image, there is rare green area in the county; therefore, people often visit shopping malls and the lakes around the county. This is the reason for selecting the distance to seaside and the distance to shopping malls as possible affecting parameters for the analysis models used within this study. Current number of quarters of Esenyurt County is 43 [96].

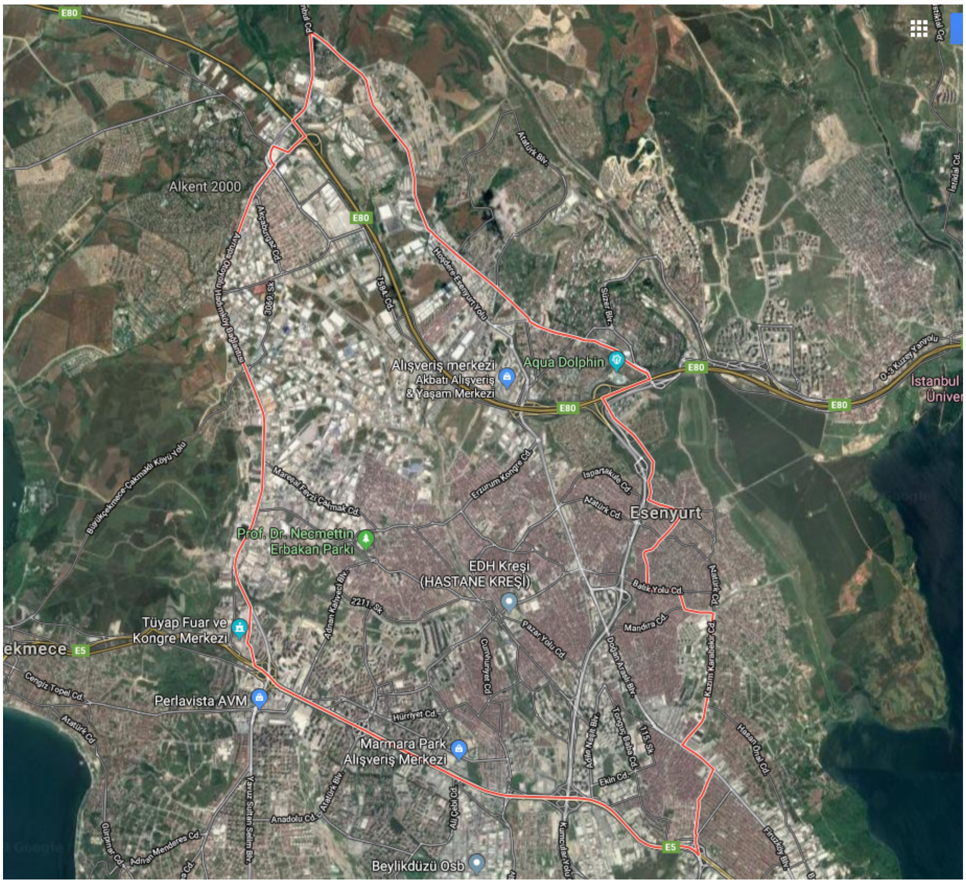

Figure 4.5. Satellite view of Esenyurt County [98].

Beylikduzu is established as a county in 22.03.2008 by the government due to the fact that it is a young county and its population has been increasing since its establishment. The county is connected to the city center by D100 Highway. Before the implementation of the BRT line the county was considered as a very far district of the city; however, the BRT line decreased the average travel times to the city center. Due to this development, the county made its popularity increased day by day. Beylikduzu County consists of 11 quarters currently. As presented in the map of the county in Figure 4.6, the county is placed between the D100 Highway and the Marmara Sea.

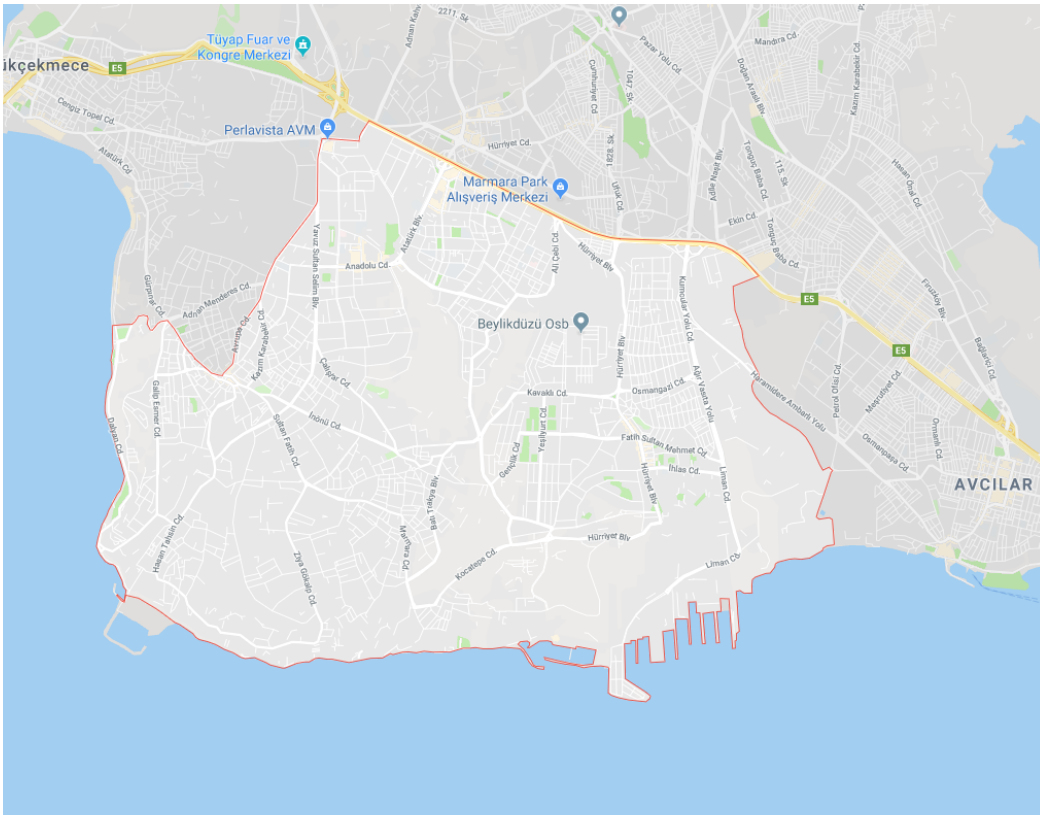

Figure 4.6. Borders of Beylikduzu, Map view [98].

D100 Highway is the main connection way of county to the city. Therefore, the population is higher in close quarters to D100 Highway. Also, the main attraction points such as shopping malls, big hospitals etc. are placed on each side of D100 Highway. BRT made the county more attractive for people to live. The property prices are relatively lower than the properties at city center. The county might be away from the city center whereas the BRT connection made the county an opportunity for especially for commuters.

Beylikduzu is still developing and it is a very organized county because the Istanbul Municipality used all the experience gained from the city center in order to organize Beylikduzu. Design of the main roads, architectural condition of the county reflects that experience. Therefore, Beylikduzu is one of the most popular counties of the city resulting as a rapid increase in population. This popular trend is reflected as a continuous increase in population of the Beylikduzu County. The current population of Beylikduzu is 331,525 [96]. The population of the region increased continuously thought ten years as presented in Figure 4.7.

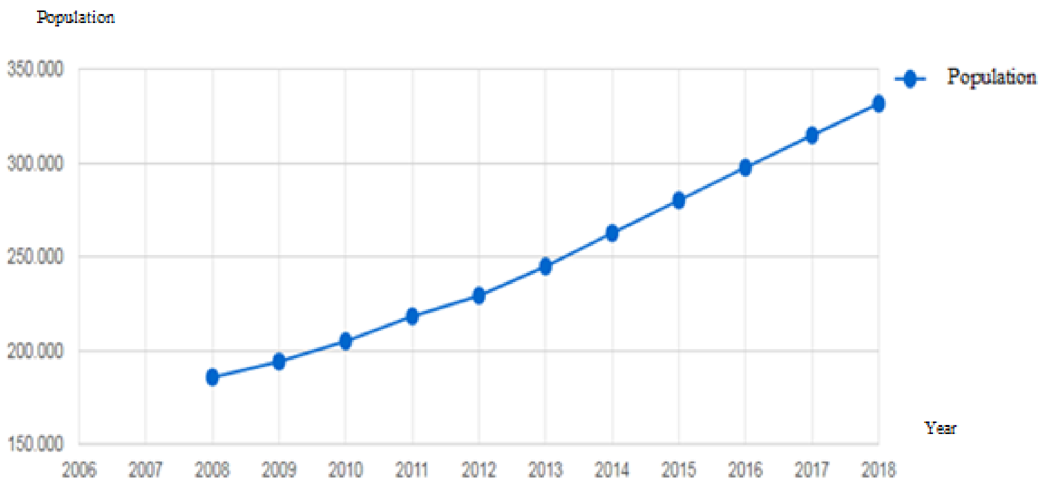

Figure 4.7. Population of Beylikduzu between 2008 and 2018 [96].

The population of Beylikduzu is relatively young as presented in Figure 4.8. The ratio of people over 65 is also high (96) because old people prefer to live in Beylikduzu County especially in the vicinity of sea side due to the higher environmental quality and less noise. Similar to Esenyurt County, this young population refers to a high commuter ratio. Therefore, CBD distance and proximity to main public transportation option BRT line are considered as possible variables affecting the prices of residential properties.

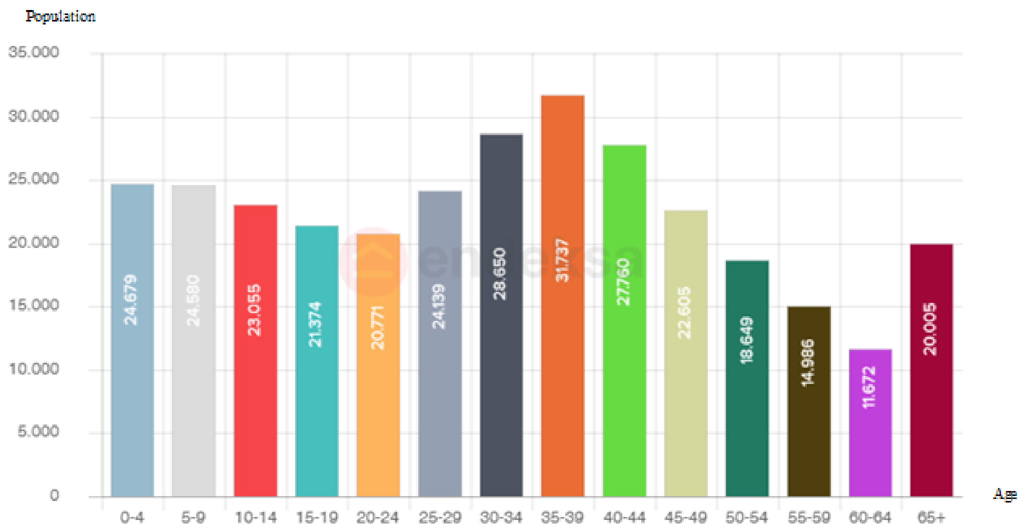

Figure 4.8. Age intervals of the inhabitant of Beylikduzu County, 2019 [96].

Education level of the county is relatively high as people with university and high school degree constitutes more than half of the county population. The majority of the county population is married in Beylikduzu [96]. The socioeconomic level of Beylikduzu is relatively high. Especially, the quarter named Adnan Kahveci consists of habitants with high-income level [96]. There is green area in the southwest side of the county as presented in the satellite view in Figure 4.9. Therefore, people often visit those areas for social activities and the Marmara Sea around the county that is one of the reasons for selecting the distance to seaside as a model parameter within this study. The Beylikduzu County consists of 11 quarters currently.

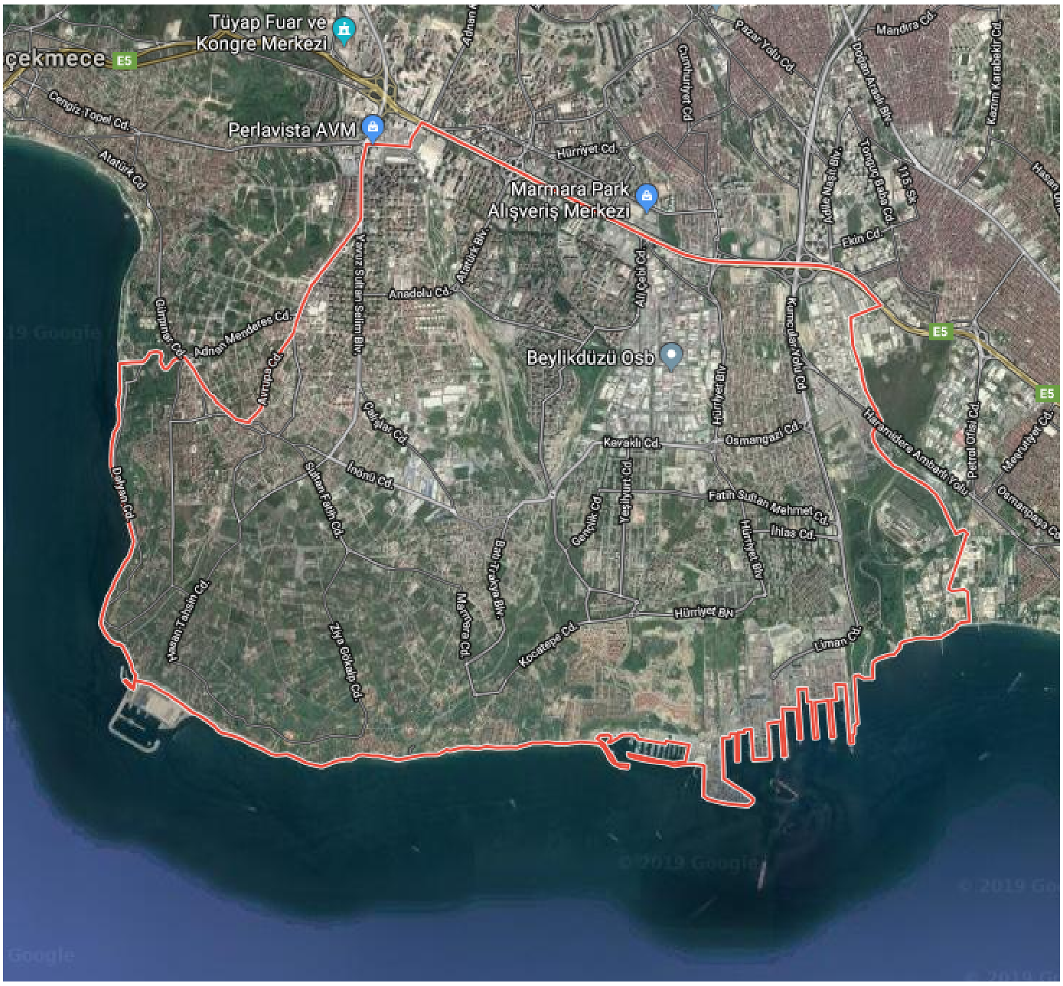

Figure 4.9. Borders of Beylikduzu, Satellite view [98].

Esenyurt and Beylikduzu county borders are separated by D100 Highway. D100 Highway is relatively an old highway of the city, which provides service almost all of the time with full capacity. Therefore, traffic congestion caused the habitants of Esenyurt and Beylikduzu to stay away from city centers. The view of D100 Highway before BRT implementation is presented in Figure 4.10.

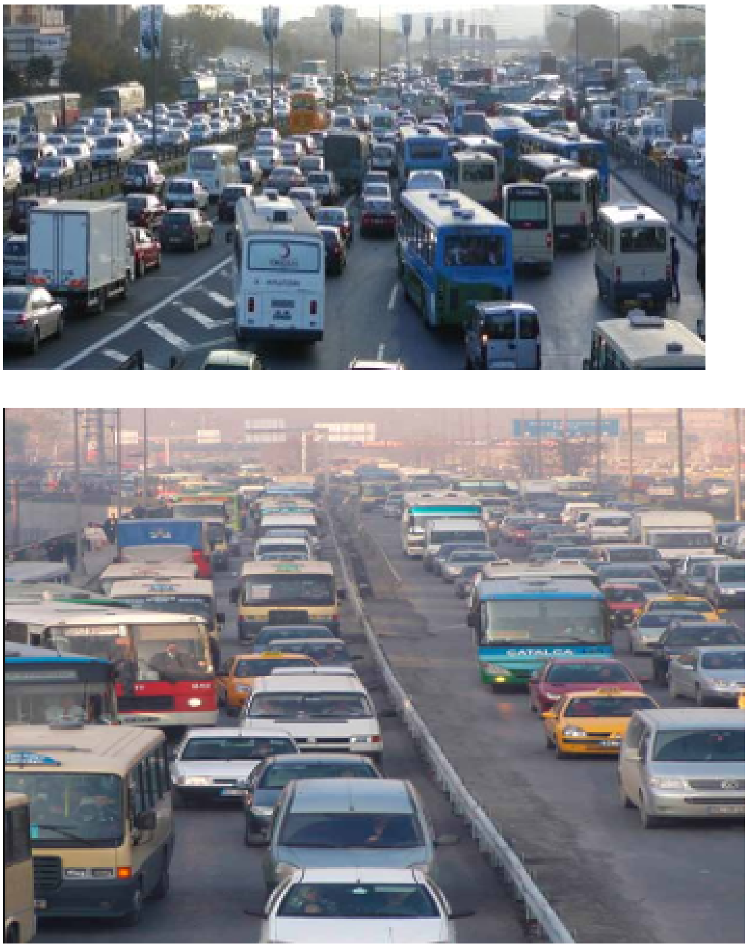

Figure 4.10. D100 Highway and Topkapı intersection before the implementation of the BRT line [100].

Especially in peak hours, the traffic congestion is very high in Istanbul. According to the research by the navigation company TomTom, Istanbul has the highest ratio in the world based on the traffic congestion in peak hours. The traffic congestion index of Istanbul is 109% at peak hours [101].

The government and the municipality of Istanbul attempted to address the problem and hereby, the first BRT system of the Turkey is implemented on D100 Highway. It used to take almost 90 minutes to travel from Beylikduzu to Mecidiyekoy (considered as city center) before the BRT implementation. The BRT system decreased that travel time to 30 minutes. Due to this rapid connection, the interaction of the Beylikduzu and Esenyurt increased and those regions become more popular living areas for people.

People started to buy real estates and increased the market prices. For that matter, the amount of the increase on these real estate prices due to implementation of the BRT line is needed to be measured. The implementation of BRT has improved the flow in D100 Highway traffic. The view of the D100 with BRT line is presented in Figure 4.11.

Figure 4.11. D100 Highway after the implementation of the BRT line [100].

4.1.1. BRT System

Bus Rapid Transit (BRT) is relatively a younger transportation system then traditional transportation systems. It has its own right of way similar to railways but instead of rail trains, the vehicles are running on rubber wheels similar to the highways. Hence, it might be considered as a transition between highway and railway systems. Considering the components of a BRT system, it can be defined as a rapid transit system, which combines road and intelligent transportation systems with a strong and positive identity [102]. The BRT system is cost effective compared to traditional railways [103].

The BRT line in Istanbul, the first BRT project in the country, is planned and implemented very quickly. The construction period started in 2007. The first phase between Topkapi and Avcilar, which is 18.7 km, consists of 15 stations. It is competed and started to operate within 8 months only. The second phase is constructed in 77 days and the BRT line is extended from Topkapi to Zincirlikuyu. The total number of the stations have reached to 25 when the second phase was completed [100]. The third phase was very important because it passes through the Bosporus Bridge connecting Europe to Asia. It is also the first and only BRT line connecting two continents in the world. The third phase which is from Zincirlikuyu to Sogutlucesme, opened in 3 March 2009. Then, the final phase between Avcilar and Beylikduzu is completed in 19 July 2012. Currently, the BRT line in Istanbul is totally 52 km. The average travel time from one terminal (Beylikduzu) to other terminal (Sogutlucesme) is 83 minutes. The BRT line carries approximately 950,000 passengers every day. There are currently 535 vehicles operating on the BRT line [100]. The four phases of the BRT line is represented below in Figure 4.12.

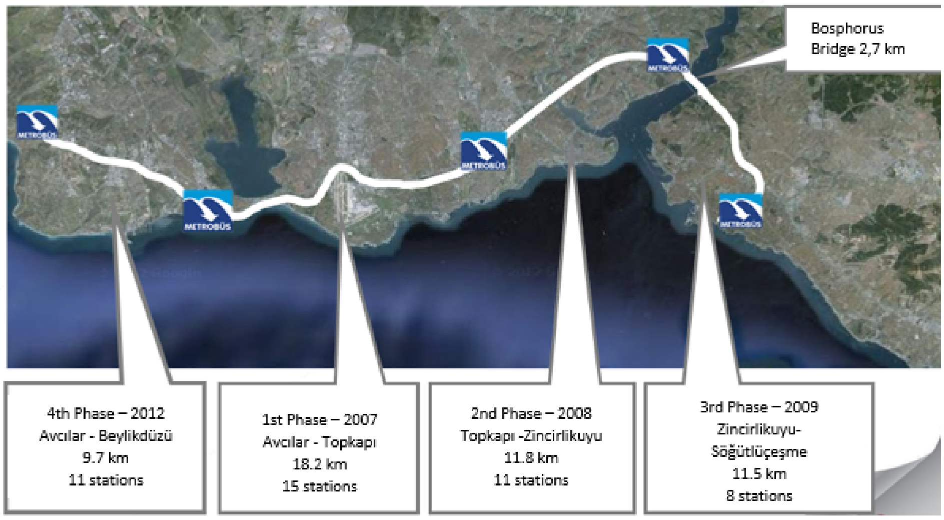

Figure 4.12. Four Phases of BRT line in Istanbul [100].

There are 44 stations totally between Beylikduzu and Sogutlucesme (Figure 4.13). In the Figure 4.13 also the average travel times between some stations are provided. The fourth phase of the BRT line is in the focus of this dissertation and it consists of 11 stations from Avcilar station to Gurpınar (Tuyap) station. The average travel time on the fourth phase of the BRT line is 20-25 minutes [100].

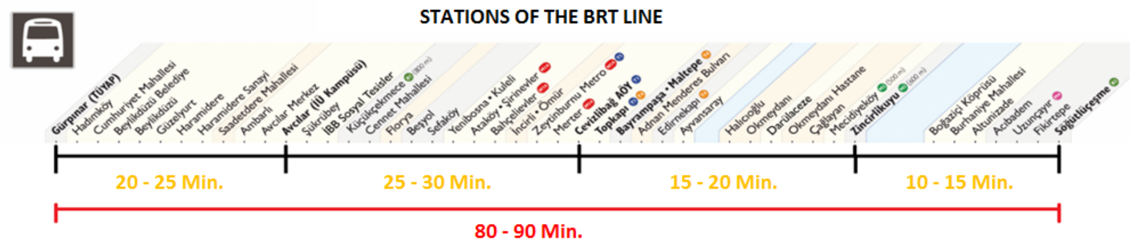

Figure 4.13. Average travel times between the BRT stations [100].

Currently, the BRT system operates between Sogutlucesme and Tuyap and it has totally 44 stations. The vehicles have different codes according to their route. A detailed map of the Current BRT system is provided in Figure 4.14. The map includes the stations and the routes of the busses that provide service on different sections of the BRT line [100].

Figure 4.14. Map of the BRT line in Istanbul [100].

4.1.2. Esenyurt Metro Project

There is an ongoing metro project between Mahmutbey and Esenyurt. This metro line aims to connect Esenyurt County to Mahmutbey and via another metro line to the city center. Therefore, it will serve as an alternative transportation mode to the BRT line, which is considered as main public transportation system that connects Esenyurt County to the city center. The metro line is presented in Figure 4.15.

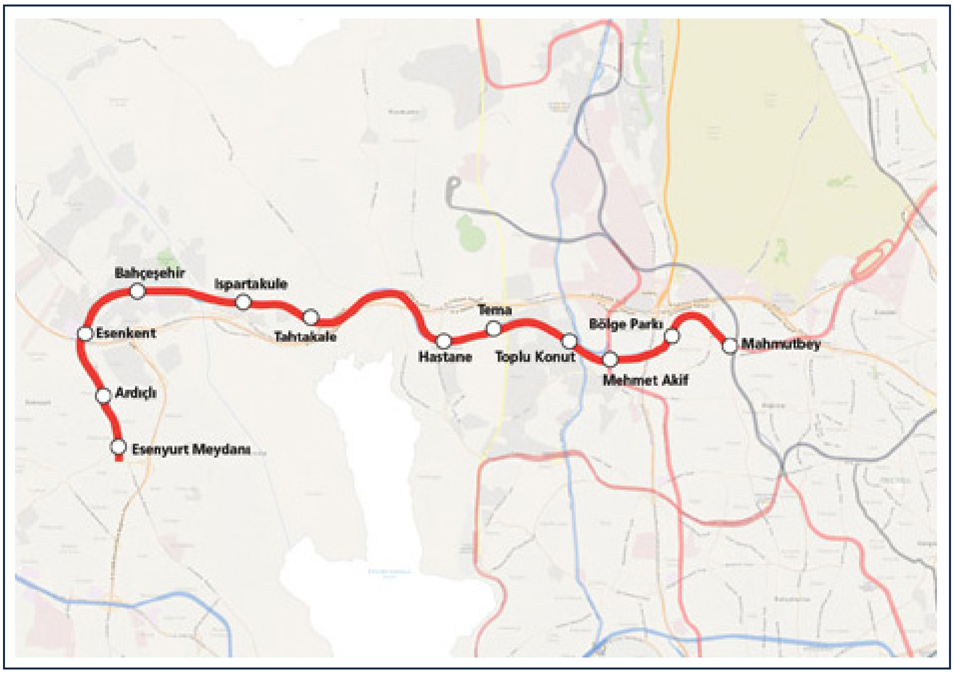

Figure 4.15. Mahmutbey Esenyurt Metro line [104].

As presented in Figure 4.20, there will be 12 stations on the Metro line. The total length will be 18.6 km and the predicted passenger capacity of the Metro line is 70,000 passengers per day. The total travel time on the Metro line is estimated as 25 minutes. The project started in 2017 and it will start to provide service in August, 2020 [104]. Last 3 stations namely, Esenkent, Ardıclı and Esenyurt Meydan stations are on the focus of this dissertation.

4.1.3. Residential Properties of Esenyurt and Beylikduzu Counties

The average square meter price of a residential property in Beylikduzu is $399 whereas this value is $642 for the city of Istanbul and $344 for Esenyurt County [105]. The price of a 100m2 residential property varies between $29,940 and $49,896 for Beylikduzu and it varies between $48,137 and $80,223 for Istanbul and the prices are between $25,772 and $42,946 for Esenyurt County [105] ($ at second quarter of

2019). The change of average price asked for per square meter for the city of Istanbul, Beylikduzu and Esenyurt Counties are presented in Figure 4.16.

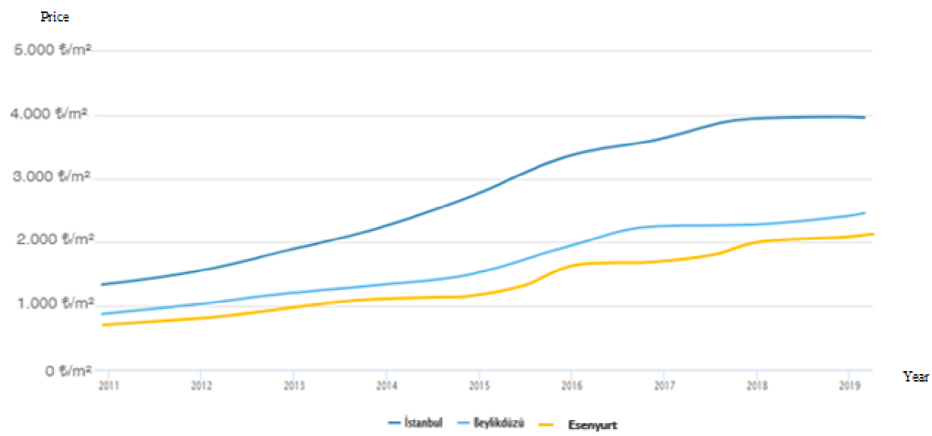

Figure 4.16. Price per square meter between 2011 and 2019 Istanbul vs Beylikduzu and Esenyurt Counties [105].

The Figure 4.16 shows that the trend of increase in the price per square meter is similar for Istanbul and Beylikduzu and Esenyurt Counties. The trend of the price value shows an increase and the marginal increase is decreased in recent years due to the economic recession in the country, which slowed down the speed of sales transaction [106], [107]. The average price per square meter in Esenyurt County is lower than Beylikduzu County due to that the environmental quality and architectural design in Beylikduzu County is better compared to Esenyurt County. Therefore, the average asking prices are lower than Istanbul and Beylikduzu County.

The real estate market in Turkey mostly depends on the ratio of the property credit rates [108]. The lower rates cause an increase in the number of sales and vice versa. As presented in Figure 4.17, according to the Turkey Bank Association (TBB) credit report [108], the real estate credit transactions constitutes 22% of all credit transactions and based on the amount of the balance, real estate credits constitute 48% of the all credit balances.

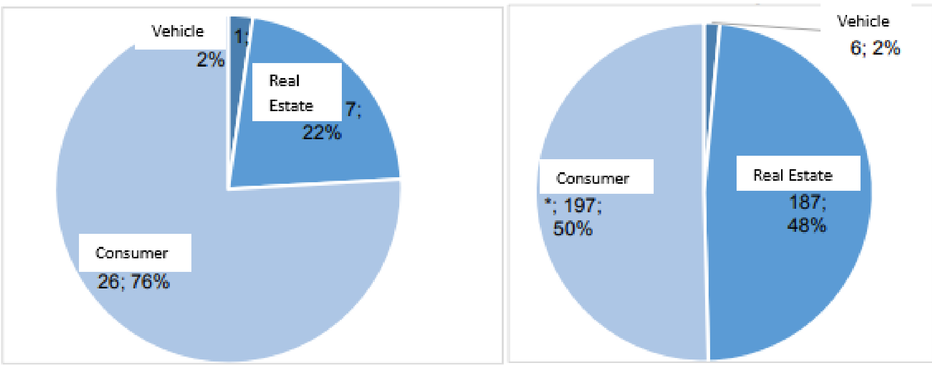

Figure 4.17. Ratio of property credits [108].

4.2. Data Collection

The data is collected by utilizing the convenience sampling technique. The convenient sampling is a non-probability sampling in other words since the population is very large in most cases, each member of the population cannot be included the samples only the ones that are convenient included. Convenience sampling technique is commonly used in cases where there is a criterion to be met by aimed population [109]. The convenient sampling is easy to imply, affordable and time efficient [110]. The basic disadvantage of the convenient sampling is the bias problem [111]. In order to mitigate this problem and decrease the bias, the samples from outside the convenient population should also be included [112].

The real estate agencies are visited and asked for the details of the residential properties at every quarter. Also a part of the data set is collected from on-line real estate platforms as [24]. The most popular real estate websites of Turkey are observed and the data is gathered. The type of the data used within this dissertation is cross sectional data. The studies including datasets for longer time periods, in other words, before and after studies, have the disadvantage of considering economic conditions, endogenous factors, interest rates and other external factors [49]. Therefore, isolation of the effect of transportation investments is not very effective by performing before and after studies.

The availability of the coordinates for each data providing the exact location of each property is marked on the map and their coordinates are coded in GIS. The error margin is at most 10 meters. The data is gathered based on the parameters that are determined previously from literature review [114] of the previous studies and the survey of the real estate experts.

The data is collected from 3,498 residential properties. The data includes the total price in Turkish Liras (TL), the size of the property (m^2), the credit viability of the property, the age of the property, the level of floor, existence of parking and other facilities, the number of rooms, the distances of each property from the closest BRT station, the distance of each property to the closest Metro station, the distance of each property to the closest shopping mall, the distance of each property to the closest hospital, the distance of each property to the seaside, the distance of each property to the closest high school, the distance of each property to the Central Business District (CBD) and the coordinates of each residential property (latitude and longitude).

There are cultural and local differences for every location in the world. Therefore, some parameters found in the literature review are not included in the model set for the case area Beylikduzu in this study. For example, the houses with the interior furniture is very common in the U.S.A. Therefore, the condition of the interior furniture is a factor that affects the price of real estates. However, in Turkey the houses are rarely put on sale with interior furniture. In other words, it is not very common in Turkey. Therefore, this parameter is not considered as an affecting factor and excluded from the regression models. Since the aim is to evaluate the impact of the proximity to BRT line, the distance values are very important within this study. The distance values used within this study are the direct distances (air distances); the difference between exact walking distance and the direct (air) distance is ignored [19], [1]. The price values of the residential properties are the asking prices whereas the previous studies revealed that the results obtained by using transaction prices and asking prices are not significantly different [24], [11]. The sale prices of the residential properties used within this study instead of the rent values of the residential properties in spite of that the effects of the selected parameters on the sale prices and rent values are not significantly different

[31].

By the help of Geographical Information System (GIS), the exact distances between the coordinates are obtained and exported to an excel file. The prices of the residential properties within the collected data are presented in Figure 4.18. The average prices of the real estate within Beylikduzu County are higher compared to Esenyurt County (Figure 4.16). According to the price map, the collected data is in accordance with the current price trend.

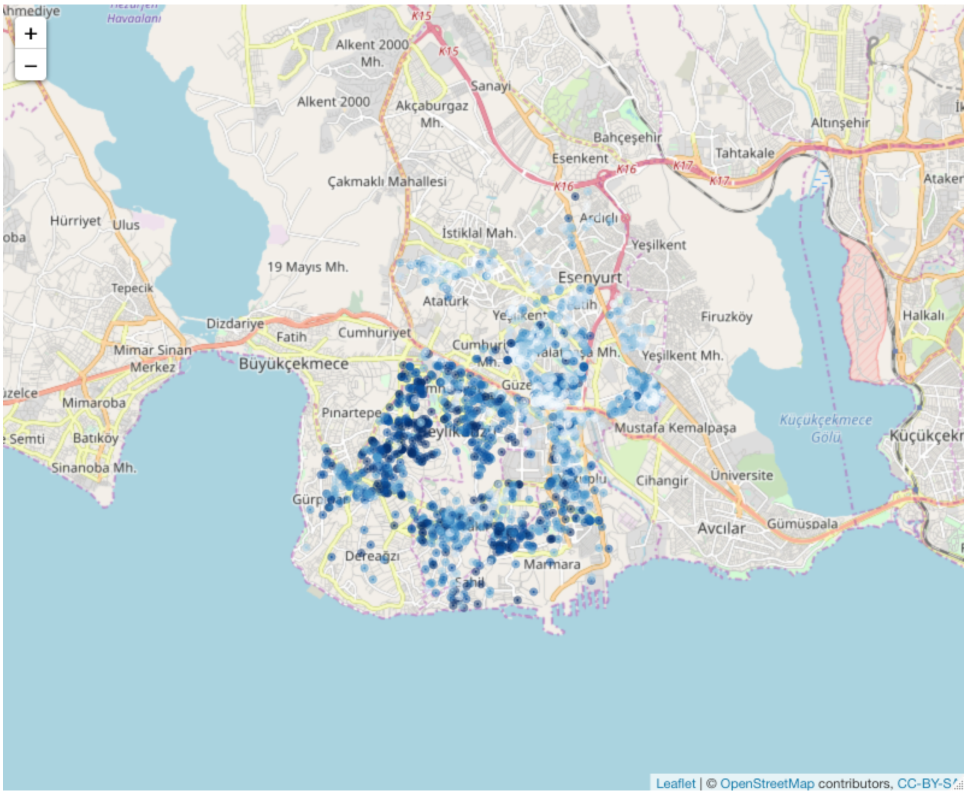

Figure 4.18. Prices of the residential properties in the data for the study area.

The distances between the residential properties in the collected dataset and the BRT line are calculated using GIS, presented in the Figure 4.19. The darker colors are used for the properties closer to the BRT line.

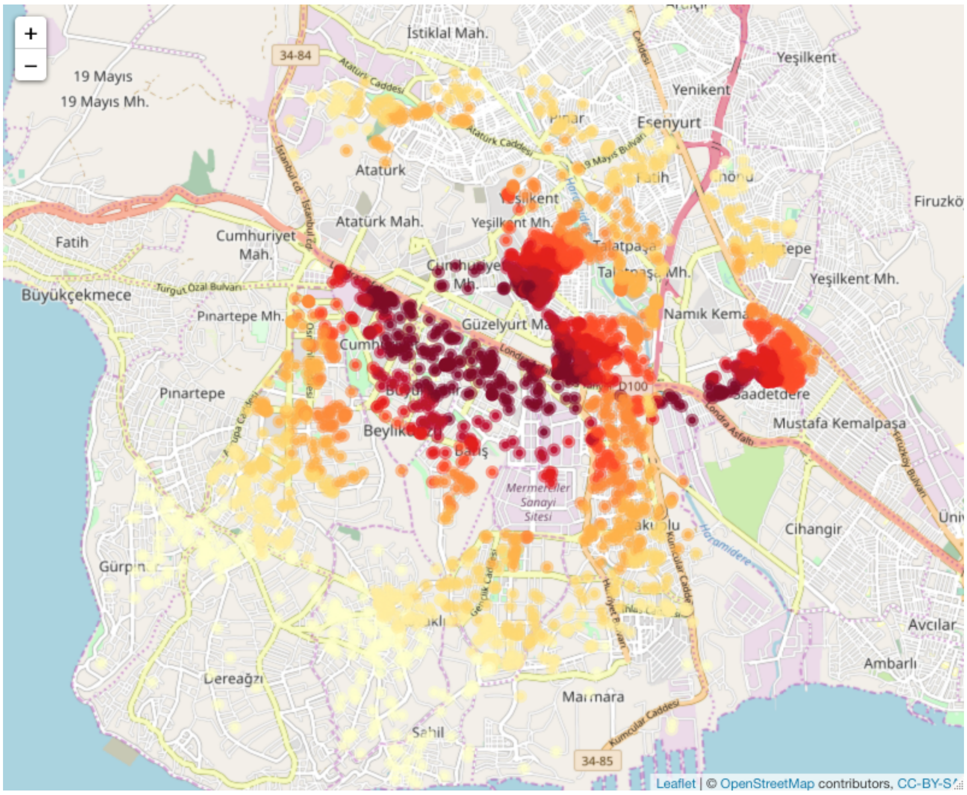

Figure 4.19. Distances of the residential properties for the study area.

The location of the residential properties, the hospitals, shopping malls, schools, the BRT stations are presented in Figure 4.20. The proximity to seaside is considered as the minimum direct distance from the seaside.

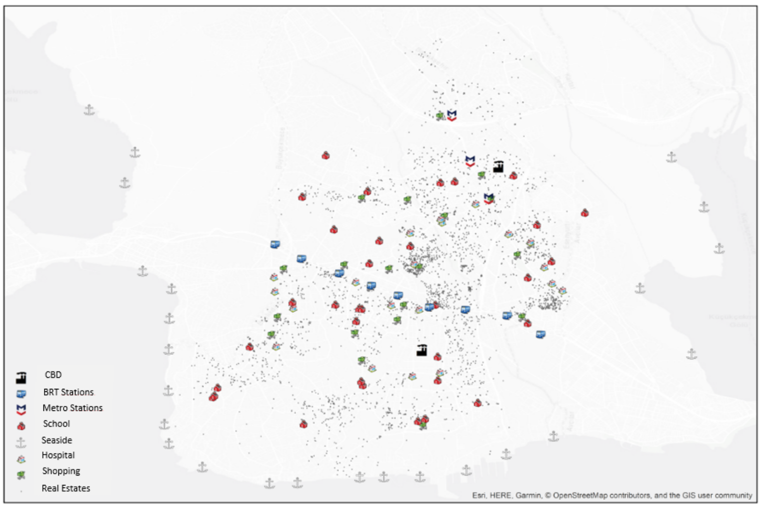

Figure 4.20. Study area in GIS program.

4.3. Preparation of the Survey

Collecting the data from the site alone might not reflect the actual condition, therefore; the parameters are selected at first from the literature review and then according to these selected parameters a questionnaire is prepared. The aim of the questionnaire is to utilize the experiences of real experts in order to see the effects of selected parameters. The survey questions and the possible impact levels (the intervals as %) in the answers part are decided with two head director of the real estate experts depending upon their experiences. The real estate experts are surveyed in person and asked to concentrate on the Beylikduzu BRT zone while answering the survey questions based on their job experiences and observations on buyers. In the first part of the survey, demographical profile of the real estate experts is gathered. Then in the second part of the survey, the aim is to measure the experience levels of the real estate experts. Two questions were directed to the experts in this part, first one is the number of years in the real estate sector and second one is the number of the clients that each expert interacted with. The aim of the second question to determine the experience levels based on the number of clients that the real estate experts interviewed.

The third part of the survey aims to reveal the opinion of experts about the amount of impact of residential property characteristics on the prices. The selected parameters are the age of the property, the floor level of the property and the existence of parking and other facilities. Current number of vehicles in Istanbul is 3,571,000 [115]. These vehicles cover more area than 6 counties, (Gungoren, Beyoglu, Bayrampasa, Zeytinburnu, Gaziosmanpasa and Fatih), which is approximately 64.5 million square meters [115]. Therefore, the importance of a parking facility is increasing day by day. People are going to pay more money to have a private parking place in the future.

In the fourth part of the survey, the effect of the surrounding area on real estate prices is measured based on their experiences about the Beylikduzu and Esenyurt Counties. Since in rural areas it is very hard to reach a hospital in case of emergency, people sometimes migrate to the cities only for that specific reason [116]. Esenyurt is holding responsibility for providing accommodation for recent migrations from rural areas to the Istanbul therefore the effect of hospital accessibility is considered as an affecting factor [96]. Nowadays people spend too much time in shopping malls due to the fact that shopping malls include all facilities and social activities such as stores, theatres, cinemas, restaurants, fitness clubs and so on [117]. Therefore, the accessibility of a shopping mall is considered as a factor that affects the prices of residential properties within its vicinity. The population of Esenyurt and Beylikduzu consists of mostly young people, approximately 40% [96], which create a big portion of commuters in Turkey. Therefore, the distance to Central Business Districts is considered as a critical parameter that affects the real estate prices.

According to the legislative regulation of the Ministry of Education in Turkey, 90% of the students that are graduated from primary school have to be registered to high schools based on their residential addresses. Remaining 10% will enter the exam. Only top high schools of Turkey still require taking an entrance exam but rest of the high schools accept student who lives in the vicinity of the school. Therefore, a good quality high school in the vicinity of a residential property probably affects the price of the property. The real estate experts are also asked to evaluate the effect of proximity to high schools on real estate prices. In other words a high quality high school in the vicinity of the residential property whether makes the residential property more valuable or not.

Beylikduzu has a large seaside. At the south side of the county, there is Marmara Sea and in summer time, the habitants of the county join sea activities. Also in summer time, the population of the quarters next to seaside is increasing. Therefore, the residential properties with sea view or the ones with easy access to the seaside are more valuable.

In the final part of the survey, the real estate experts are asked to evaluate the effect of proximity to public transportation systems on residential property prices. Since the study area of this dissertation is Esenyurt and Beylikduzu Counties experts are directed to concentrate on the experiences related to BRT line especially. Thereafter, depending upon their personal and professional opinions the real estate experts are asked to declare if there is any other factor that affects the real estate prices.

4.4. Analyses and Results

Analyses and results chapter of dissertation consists of the ANOVA analysis results of survey data and the analysis of the dataset by OLS, SAR, GWR and MGWR respectively. Thereafter, the results of OLS, SAR, GWR and MGWR are compared.

4.4.1. Results of Survey Analysis

The survey dataset is analyzed by using ANOVA technique. For each defined parameter, a specific question is designed and directed to real estate experts. The survey questions are presented in the Appendix. The ANOVA analysis is performed in order to determine whether there is a significant difference between the variances of the experience levels of real estate experts. The question (D2) measures the experience level of the real estate experts by asking the number of the clients that the real estate experts interviewed with. It does not matter whether the transactions are successful or not because the interview process is enough to obtain the impact of the parameters. The question D2 is presented in Table 4.1.

Table 4.1. The (D2) question of the survey.

D2	How many clients have you been interviewed for selling or renting of a residential property?					
	0 - 200	201 - 400	401 - 600	601 - 800	801 -1000	1001+
	1	2	3	4	5	6

According to Table 4.1 as the number of the people interviewed by a real estate expert increase; the experience level increases. The real estate experts categorized in to the subgroups based on their experience levels. The statistics of these groups are presented in Table 4.2.

Table 4.2. Descriptive of the real estate experts.

Experience levels		**Frequency**	**Valid Percent**
(D2)	1	22	27.2
	2	18	22.2
	3	14	17.3
	4	8	9.9
	5	9	11.1
	6	10	12.3
	Total	81	100

According to the Table 4.2 the experience levels are distributed into the groups where “6” denotes for highest experience level and “1” denotes for lowest experience level. The distribution of the real estate experts into the experience level groups is presented in the histogram in the Figure 4.21.

Figure 4.21. The frequencies of the experts’ experience level groups.

Afterwards, each parameter and their effects are asked to real estate experts through the survey questions. The answers of the real estate experts are analyzed by using ANOVA, in order to determine whether there is a difference between the variances of each group. The first question (Q1) is aimed to measure the effect of the “age” factor on real estate prices. First question of the survey is presented in Table

4.3.

Table 4.3. 1st question of the survey.

	What is the effect of residential property's age on prices?					
	None	Very Low	Low	Medium	High	Very High
Q1	0	1% - 5%	6%-10%	11%-15%	16%-20%	%21 +
	1	2	3	4	5	6

The descriptive statistics of the answers to the first question is presented in Table 4.4. According to descriptive statistics of the first question, the real estate experts mostly evaluated the effect of the "age" factor at very low and low levels.

Table 4.4. Descriptive statistics of the 1st question of the survey.

(Q1) What is the effect of residential property's age on prices?								
	Number of the experts	Mean of the experience levels	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (None)	2	1	0	0	1	1	1	1
2 (Very Low)	28	2.18	1.588	0.3	1.56	2.79	1	6
3 (Low)	25	3.12	1.616	0.323	2.45	3.79	1	6
4 (Medium)	18	3.67	1.68	0.396	2.83	4.5	1	6
5 (High)	7	3.57	1.813	0.685	1.9	5.25	1	6
6 (Very High)	1	5	-	-	-	-	5	5
Total	81							

Chi-square test is applied and based on the p value "0.034" which is lower than the significance level used within this study (0.05), there is a significant relationship between the experience levels and the evaluation of the age factor's effect on real estate prices. Also, ANOVA analysis is performed to test the relation between them. First, the homogeneity of the variances is tested. According to Levene's test presented in Table 4.5, which is the test of homogeneity of variances, p value is 0.211. This value is greater than the significance level for this study, which is 5%. This means that variances for experience levels are distributed homogeneously.

Table 4.5. Test results for the homogeneity of variances for Q1.

Levene Statistic			df1	df2	Sig.
Q1	Based on Mean	1.498	4	75	0.211
	Based on Median	1.075	4	75	0.375
	Based on Median and with adjusted df	1.075	4	66.968	0.376
	Based on trimmed mean	1.523	4	75	0.204

Then, the ANOVA results of the first question (Q1) are presented in Table 4.6. According to ANOVA results, p value is 0.013, which indicates that at least one response category has a different mean experience level. Hence, it can be continued with Scheffe test for grouping the response categories of Q1.

Table 4.6. ANOVA Test results for Q1.

ANOVA					
(Q1) What is the effect of residential property's age on prices?					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	41.094	5	8.219	3.106	0.013
Within Groups	198.461	75	2.646		
Total	239.556	80			

Scheffe test is performed and the results are presented in Table 4.7. According to the results; in answering Q1 as "none" or "high" experience level is significantly important. In detail, more experienced experts tended to answer the question as "high" instead of "none".

Table 4.7. The comparisons of mean values for the first question of survey (Q1).

Multiple Comparisons						
Dependent variable : (Q1)		Scheffe				
		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-0.424	0.308	0.861	-1.48	0.63
	3	-1.019	0.331	0.104	-2.15	0.11
	4	-0.716	0.399	0.668	-2.08	0.65
	5	-1,591*	0.383	0.007	-2.9	-0.28
	6	-0.891	0.369	0.334	-2.15	0.37
2	1	0.424	0.308	0.861	-0.63	1.48
	3	-0.595	0.345	0.703	-1.77	0.58
	4	-0.292	0.411	0.992	-1.7	1.11
	5	-1.167	0.395	0.135	-2.52	0.18
	6	-0.467	0.382	0.912	-1.77	0.84
3	1	1.019	0.331	0.104	-0.11	2.15
	2	0.595	0.345	0.703	-0.58	1.77
	4	0.304	0.429	0.992	-1.16	1.77
	5	-0.571	0.413	0.86	-1.98	0.84
	6	0.129	0.401	1	-1.24	1.5
4	1	0.716	0.399	0.668	-0.65	2.08
	2	0.292	0.411	0.992	-1.11	1.7
	3	-0.304	0.429	0.992	-1.77	1.16
	5	-0.875	0.47	0.631	-2.48	0.73
	6	-0.175	0.459	1	-1.74	1.39
5	1	1,591*	0.383	0.007	0.28	2.9
	2	1.167	0.395	0.135	-0.18	2.52
	3	0.571	0.413	0.86	-0.84	1.98
	4	0.875	0.47	0.631	-0.73	2.48
	6	0.7	0.445	0.778	-0.82	2.22
6	1	0.891	0.369	0.334	-0.37	2.15
	2	0.467	0.382	0.912	-0.84	1.77
	3	-0.129	0.401	1	-1.5	1.24
	4	0.175	0.459	1	-1.39	1.74
	65	-0.7	0.445	0.778	-2.22	0.82
*. The mean difference is significant at the 0.05 level.						

The second question (Q2) is aimed to measure the effect of the "facility" factor on real estate prices. Second question of the survey is presented in Table 4.8.

Table 4.8. 2nd question of the survey.

Q2	What is the effect of that whether the residential property has parking and other facilities or not, on prices?					
	None	Very Low	Low	Medium	High	Very High
	0	1% - 5%	6%-10%	11%-15%	16%-20%	%21 +
	1	2	3	4	5	6

Table 4.8 presents the second question and the categorized answers. These answers are enumerated in order to provide easiness for computational process for ANOVA

analysis. The descriptive statistics of the answers to the second question is presented in Table 4.9. According to descriptive statistics of the second question, the real experts mostly evaluated the effect of the “facility” factor at very low, medium, and high levels.

Table 4.9. Descriptive statistics of the 2nd question of the survey.

(Q2) What is the effect of that whether the residential property has parking and other facilities or not, on prices?								
	Number of the experts	Mean of the experience levels	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (None)	2	1	0	0	1	1	1	1
2 (Very Low)	20	2.55	1.932	0.432	1.65	3.45	1	6
3 (Low)	9	2.22	1.302	0.434	1.22	3.22	1	4
4 (Medium)	17	3.12	1.799	0.436	2.19	4.04	1	6
5 (High)	20	3.1	1.373	0.307	2.46	3.74	1	6
6 (Very High)	13	3.77	1.878	0.521	2.63	4.9	1	6
Total	81							

Chi-square test is applied and based on the p value (0.197) which is higher than the significance level used for this study (0.05), there is not a significant relationship between the experience levels and the evaluation of the facility factor’s effect on real estate prices. Afterwards, ANOVA analysis is also performed. The homogeneity of the variances is tested and p-value of Levene’s test is 0.035 which is lower than 0.05 indicating that the variances are heterogeneous (Table 4.10).

Table 4.10. Test results for the homogeneity of variances for Q2.

Test of Homogeneity of Variances					
Levene Statistic			df1	df2	Sig.
Q2	Based on Mean	2.548	5	75	0.035
	Based on Median	1.623	5	75	0.164
	Based on Median and with adjusted df	1.623	5	59,431	0.168
	Based on trimmed mean	2.355	5	75	0.048

Then, the ANOVA results of the second question (Q2) are presented in Table 4.11. It can be observed that mean experience level among all answer categories are similar to each other. This is because the p-value in Table 4.11 is higher than 0.05. Hence, experience level does not affect the judgement of the effect of parking and other facilities on property prices. This finding is in accordance with the chi-squared test result for this question.

Table 4.11. ANOVA Test results for 2nd question of the survey.

ANOVA					
(Q2) What is the effect of that whether the residential property has parking and other facilities or not, on prices?					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	25.178	5	5.036	1.762	0.131
Within Groups	214.378	75	2.858		
Total	239.556	80			
*. The mean difference is significant at the 0.05 level.					

Since there is not a significant difference in the mean experience level of the experts for each answer category, all experts can be considered as a single group and the mean evaluation value of the real estate experts about the effect of the "facility" factor on real estate prices is 3.89 which is very close to "4" and the value of "4" represents the effect at medium level (11% - 15%).

The third question (Q3) is aimed to measure the effect of the "floor level" factor on real estate prices. The third question of the survey is presented in Table 4.12.

Table 4.12. 3rd question of the survey.

Q3	What is the effect of residential property's floor level on prices?					
	None	Very Low	Low	Medium	High	Very High
	0	1% - 5%	6%-10%	11%-15%	16%-20%	%21 +
	1	2	3	4	5	6

The descriptive statistics of the answers to the third question is presented in Table 4.13. According to descriptive statistics of the second question, the real experts mostly evaluated the effect of the "floor level" factor at very low, low and medium levels.

Table 4.13. Descriptive statistics of the 3rd question of the survey.

(Q3) What is the effect of residential property's floor level on prices?								
	Number of the experts	Mean of the experience levels	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (None)	2	2	1.414	1	-10.71	14.71	1	3
2 (Very Low)	31	1.97	1.197	0.215	1.53	2.41	1	6
3 (Low)	18	2.89	1.711	0.403	2.04	3.74	1	6
4 (Medium)	19	3.68	1.455	0.334	2.98	4.39	1	6
5 (High)	9	4.33	2.062	0.687	2.75	5.92	1	6
6 (Very High)	2	5.5	0.707	0.5	-0.85	11.85	5	6
Total	81							

Chi-square test is applied and based on the p value "0.006" which is lower than the significance level used within this study (0.05), there is a significant relationship between the experience levels and the evaluation of the floor level factor's effect on real estate prices. ANOVA test is also applied. First, the homogeneity of the variances is tested by Levene's test as presented in Table 4.14. P value is obtained as 0.080, which indicates that the variances are homogenous.

Table 4.14. Test results for the homogeneity of variances for Q3.

Test of Homogeneity of Variances					
	Levene Statistic		df1	df2	Sig.
Q3	Based on Mean	2.062	5	75	0.08
	Based on Median	1.106	5	75	0.365
	Based on Median and with adjusted df	1.106	5	59.924	0.367
	Based on trimmed mean	1.885	5	75	0.107

Then, the ANOVA results of the third question (Q3) are presented in Table 4.15. According to ANOVA results, at least in one answer category, experience levels of experts is different from others in 5% level of significance.

Table 4.15. ANOVA Test results for the 3rd question of the survey.

ANOVA					
(Q3) What is the effect of residential property's floor level on prices?					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	72.205	5	14.441	6.472	0
Within Groups	167.351	75	2.231		
Total	239.556	80			
*. The mean difference is significant at the 0.05 level.					

Based on the homogenous variances, Scheffe test is performed and the results are presented in Table 4.16. According to Scheffe test there are significant difference in means between the groups 2 and 4, 5, 6. Also, between groups 1 and 4, 6 the means are significantly different. The experts with higher experience levels tend to evaluate the effect of floor level at higher levels.

Table 4.16. Comparison of mean values for Q3.

Multiple Comparisons							
Dependent variable : (Q3)		Scheffe					
		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	0.146	0.314	0.999	-0.93	1.22
	3	-0.338	0.338	0.962	-1.49	0.82
	4	-1,409*	0.408	0.046	-2.8	-0.02
	5	-1.298	0.391	0.062	-2.63	0.04
	6	-1,609*	0.377	0.005	-2.9	-0.32
2	1	-0.146	0.314	0.999	-1.22	0.93
	3	-0.484	0.352	0.862	-1.69	0.72
	4	-1,556*	0.42	0.025	-2.99	-0.12
	5	-1,444*	0.403	0.034	-2.82	-0.07
	6	-1,756*	0.39	0.003	-3.09	-0.42
3	1	0.338	0.338	0.962	-0.82	1.49
	2	0.484	0.352	0.862	-0.72	1.69
	4	-1.071	0.438	0.318	-2.57	0.42
	5	-0.96	0.422	0.403	-2.4	0.48
	6	-1.271	0.409	0.099	-2.67	0.13
4	1	1,409*	0.408	0.046	0.02	2.8
	2	1,556*	0.42	0.025	0.12	2.99
	3	1.071	0.438	0.318	-0.42	2.57
	5	0.111	0.48	1	-1.53	1.75
	6	-0.2	0.469	0.999	-1.8	1.4
5	1	1.298	0.391	0.062	-0.04	2.63
	2	1,444*	0.403	0.034	0.07	2.82
	3	0.96	0.422	0.403	-0.48	2.4
	4	-0.111	0.48	1	-1.75	1.53
	6	-0.311	0.454	0.993	-1.86	1.24
6	1	1,609*	0.377	0.005	0.32	2.9
	2	1,756*	0.39	0.003	0.42	3.09
	3	1.271	0.409	0.099	-0.13	2.67
	4	0.2	0.469	0.999	-1.4	1.8
	5	0.311	0.454	0.993	-1.24	1.86
*. The mean difference is significant at the 0.05 level.						

The 4th question (Q4) is aimed to measure the effect of the "credit viability" factor on real estate prices. Second question of the survey is presented in Table 4.17.

Table 4.17. 4th question of the survey.

Q4	What is the effect of residential property's credit viability on prices?					
	None	Very Low	Low	Medium	High	Very High
	0	1% - 8%	9%-16%	17%-24%	25%-32%	%33+
	1	2	3	4	5	6

The descriptive statistics of the answers to the fourth question are presented in Table 4.18. According to descriptive statistics of the fourth question, the real experts mostly evaluated the effect of the "credit viability" factor homogenously.

Table 4.18. Descriptive statistics of the 4th question of the survey

(Q4) What is the effect of residential property's credit viability on prices?								
	Number of the experts	Mean of the experience levels	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (None)	1	1					1	1
2 (Very Low)	17	1.94	0.899	0.218	1.48	2.4	1	4
3 (Low)	18	1.78	0.943	0.222	1.31	2.25	1	4
4 (Medium)	19	2.84	1.675	0.384	2.03	3.65	1	6
5 (High)	16	4	1.506	0.376	3.2	4.8	1	6
6 (Very High)	10	5.3	0.949	0.3	4.62	5.98	3	6
Total	81							

Chi-square test is applied and based on the p value "0.000" which is very low compared to the significance level used within this study (0.05), there is a significant relationship between the experience levels and the evaluation of the credit viability factor's effect on real estate prices. Also, ANOVA test is applied. First, the homogeneity of the variances are tested and presented in Table 4.19. Based on Levene's statistic's p value 0.055 is obtained, which indicates that the variances are homogeneous.

Table 4.19. Test results for the homogeneity of variances for Q4.

Test of Homogeneity of Variances					
Levene Statistic			df1	df2	Sig.
Q4	Based on Mean	2.435	4	75	0.055
	Based on Median	2.292	4	75	0.067
	Based on Median and with adjusted df	2.292	4	60.772	0.07
	Based on trimmed mean	2.461	4	75	0.052

ANOVA results of the fourth question Q4 are presented in Table 4.2. According to ANOVA results, the null hypothesis that “the means are not significantly different” can be rejected. In other words, the means are significantly different from each other.

Table 4.20. ANOVA Test results for the 4th question of the survey.

ANOVA					
(Q4) What is the effect of residential property’s credit viability on prices?					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	118.877	5	23.775	14.776	0
Within Groups	120.679	75	1.609		
Total	239.556	80			
*. The mean difference is significant at the 0.05 level.					

The Scheffe test is used in order to investigate the differences between means of the groups and presented in Table 4.21. According to Scheffe test there are significant difference in means between the groups 1 and 5, 6. In addition, the means of group 2 and 5, 6 are significantly different from each other. Another significant difference is between the groups 3 and 5, 6 again. Based on the results, it can be concluded that the mean experience level of answer categories 5 and 6 are higher. In other words, the effect of credit viability on real estate prices, is considered high according to the experts with higher experience levels.

Table 4.21. Comparison of mean values for Q4.

Multiple Comparisons						
Dependent Variable: Q4		Scheffe				
		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-0.101	0.325	1	-1.21	1.01
	3	-0.688	0.349	0.569	-1.88	0.51
	4	-1.295	0.422	0.107	-2.74	0.15
	5	-2,268*	0.404	0	-3.65	-0.89
	6	-2,345*	0.39	0	-3.68	-1.01
2	1	0.101	0.325	1	-1.01	1.21
	3	-0.587	0.364	0.76	-1.83	0.66
	4	-1.194	0.434	0.196	-2.68	0.29
	5	-2,167*	0.417	0	-3.59	-0.74
	6	-2,244*	0.403	0	-3.62	-0.87
3	1	0.688	0.349	0.569	-0.51	1.88
	2	0.587	0.364	0.76	-0.66	1.83
	4	-0.607	0.453	0.874	-2.15	0.94
	5	-1,579*	0.436	0.031	-3.07	-0.09
	6	-1,657*	0.423	0.014	-3.1	-0.21
4	1	1.295	0.422	0.107	-0.15	2.74
	2	1.194	0.434	0.196	-0.29	2.68
	3	0.607	0.453	0.874	-0.94	2.15
	5	-0.972	0.496	0.576	-2.67	0.72
	6	-1.05	0.485	0.461	-2.71	0.61
5	1	2,268*	0.404	0	0.89	3.65
	2	2,167*	0.417	0	0.74	3.59
	3	1,579*	0.436	0.031	0.09	3.07
	4	0.972	0.496	0.576	-0.72	2.67
	6	-0.078	0.469	1	-1.68	1.53
6	1	2,345*	0.39	0	1.01	3.68
	2	2,244*	0.403	0	0.87	3.62
	3	1,657*	0.423	0.014	0.21	3.1
	4	1.05	0.485	0.461	-0.61	2.71
	5	0.078	0.469	1	-1.53	1.68
*. The mean difference is significant at the 0.05 level.						

The fifth question (Q5) is aimed to measure the effect of the "proximity to hospital" factor on real estate prices. The fifth question of the survey is presented in Table 4.22.

Table 4.22. 5th question of the survey.

Q5	What is the effect of residential property's proximity to hospitals on prices?					
	None	Very Low	Low	Medium	High	Very High
	0	1% - 3%	4%-6%	7%-9%	10%-12%	%13 +
	1	2	3	4	5	6

The descriptive statistics of the answers to the fifth question is presented in Table 4.23. According to descriptive statistics of the fifth question, the real experts mostly evaluated the effect of the "proximity to hospitals" factor at none and very low levels.

Table 4.23. Descriptive statistics of the 5th question of the survey.

(Q5) What is the effect of residential property's proximity to hospitals on prices?								
	Number of the experts	Mean of the experience levels	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (None)	41	3.07	1.738	0.271	2.52	3.62	1	6
2 (Very Low)	27	3	1.732	0.333	2.31	3.69	1	6
3 (Low)	11	2.18	1.601	0.483	1.11	3.26	1	6
5 (High)	2	3	2.828	2	-22.41	28.41	1	5
Total	81							

Chi-square test is applied and based on the p value "0.641" which is higher than the significance level used within this study (0.05), there is not a significant relationship between the experience levels and the evaluation of the effect of proximity to hospital on real estate prices. ANOVA analysis is also performed for further investigations. Thereafter, the homogeneity of the variances is tested and 0.660 p value is obtained as presented in Table 4.24. The p value, 0.060, is lower than the significance value used for this study (0.05) which indicates that the variances are homogenous.

Table 4.24. Test results for the homogeneity of variances for Q5.

Test of Homogeneity of Variances					
Levene Statistic			df1	df2	Sig.
Q5	Based on Mean	0.534	3	77	0.66
	Based on Median	0.64	3	77	0.592
	Based on Median and with adjusted df	0.64	3	74.707	0.592
	Based on trimmed mean	0.635	3	77	0.595

Then, the ANOVA results of the fifth question (Q5) are presented in Table 4.25. According to ANOVA results, the null hypothesis that "the means answers of all real estate expert groups are equal to each other" cannot be rejected. In other words the means are not significantly different from each other. In general the real estate experts evaluated the effect of the hospital proximity as "1.70" which indicates that it is more than none, close to very low level (1%-3%).

Table 4.25. ANOVA Test results for 5th question of the survey.

ANOVA					
(Q5) What is the effect of residential property's proximity to hospitals on prices?					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.139	3	2.38	0.788	0.504
Within Groups	232.417	77	3.018		
Total	239.556	80			
*. The mean difference is significant at the 0.05 level.					

The sixth question (Q6) is aimed to measure the effect of the "proximity to shopping malls" factor on real estate prices. The sixth question of the survey is presented in Table 4.26.

Table 4.26. 6th question of the survey.

	What is the effect of residential property's proximity to shopping malls on prices?					
	None	Very Low	Low	Medium	High	Very High
Q6	0	1% - 5%	6%-10%	11%-15%	16%-20%	%21 +
	1	2	3	4	5	6

The descriptive statistics of the answers to the sixth question is presented in Table 4.27. According to descriptive statistics of the sixth question, the real experts mostly evaluated the effect of the "proximity to shopping malls" factor at none and very low levels.

Table 4.27. Descriptive statistics of the 6th question of the survey.

(Q6) What is the effect of residential property's proximity to shopping malls on prices?								
	Number of the experts	Mean of the experience levels	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (None)	21	3.1	1.841	0.402	2.26	3.93	1	6
2 (Very Low)	37	2.89	1.792	0.295	2.29	3.49	1	6
3 (Low)	13	2.23	1.166	0.323	1.53	2.94	1	4
4 (Medium)	5	4	1.871	0.837	1.68	6.32	2	6
5 (High)	5	3.2	1.789	0.8	0.98	5.42	1	5
Total	81							

Chi-square test is applied and based on the p value "0.161" which is higher than the significance level used within this study (0.05), there is not a significant relationship between the experience levels and the evaluation of the effect of proximity to shopping malls on real estate prices. The homogeneity of the variances is tested by Levene's test and obtained p value is 0.256 (Table 4.28), which is higher than 0.05 referring that the null hypothesis that calls the variances do not differ significantly cannot be rejected. In other words, the variances are homogenous.

Table 4.28. Test results for the homogeneity of variances for Q6.

Test of Homogeneity of Variances					
Levene Statistic			df1	df2	Sig.
Q6	Based on Mean	1.36	4	76	0.256
	Based on Median	0.536	4	76	0.71
	Based on Median and with adjusted df	0.536	4	54.98	0.71
	Based on trimmed mean	1.322	4	76	0.269

Then, the ANOVA results of the sixth question (Q6) are presented in Table 4.29. According to ANOVA results, the null hypothesis that "the means are equal to each other" cannot be rejected since the significance value is 0.364>>0.05. In other words, the means are not significantly different from each other. The general opinion of the real estate experts regarding the effect of shopping malls on real estate prices is "2.21" indicating that the impact level is very low (1% -5%).

Table 4.29. ANOVA Test results for the 6th question of the survey.

ANOVA					
(Q6) What is the effect of residential property's proximity to shopping malls on prices?					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	13.071	4	3.268	1.097	0.364
Within Groups	226.485	76	2.98		
Total	239.556	80			
*. The mean difference is significant at the 0.05 level.					

The sixth question (Q7) is aimed to measure the effect of the "facility" factor on real estate prices. The seventh question of the survey is presented in Table 4.30.

Table 4.30. The 7th question of the survey.

Q7	What is the effect of residential property's proximity to CBDs on prices?					
	None	Very Low	Low	Medium	High	Very High
	0	1% - 8%	9%-16%	17%-24%	25%-32%	%33+
	1	2	3	4	5	6

The descriptive statistics of the answers to the seventh question are presented in Table 4.31. According to descriptive statistics of the seventh question, the real experts mostly evaluated the effect of the "proximity to CBD" factor at very low and low levels.

Table 4.31. Descriptive statistics of the 7th question of the survey.

(Q7) What is the effect of residential property's proximity to CBDs on prices?								
	Number of the experts	Mean of the experience levels	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (None)	12	2.67	1.303	0.376	1.84	3.49	1	5
2 (Very Low)	21	2.52	1.47	0.321	1.85	3.19	1	6
3 (Low)	23	2.96	1.965	0.41	2.11	3.81	1	6
4 (Medium)	11	2.91	1.921	0.579	1.62	4.2	1	6
5 (High)	7	3.43	1.902	0.719	1.67	5.19	1	6
6 (Very High)	7	4	1.826	0.69	2.31	5.69	1	6
Total	81							

Chi-square test is applied and based on the p value "0.706" which is higher than the significance level used within this study (0.05), there is not a significant relationship between the experience levels and the evaluation of the effect of proximity to CBD on real estate prices. ANOVA is also applied for further investigation of this relationship. The homogeneity of the variances is tested by Levene's test and presented in Table 4.32. The obtained p value is 0.299 which is higher than 0.05 referring that the null hypothesis that calls the variances do not differ significantly cannot be rejected. In other words, the variances are homogenous.

Table 4.32. Test results for the homogeneity of variances for Q7.

Test of Homogeneity of Variances					
Levene Statistic			df1	df2	Sig.
Q7	Based on Mean	1.239	5	75	0.299
	Based on Median	0.747	5	75	0.591
	Based on Median and with adjusted df	0.747	5	65.644	0.591
	Based on trimmed mean	1.233	5	75	0.302

Then, the ANOVA results of the seventh question (Q7) are presented in Table 4.33. According to ANOVA results, the null hypothesis that "the means are equal to each other" cannot be rejected since the significance value is 0.463>>0.05. In other words, the means are not significantly different from each other statistically. The general opinion of the real estate experts regarding the effect of CBD on real estate prices is "3.01" indicating that the effect is low (9% - 16%).

Table 4.33. ANOVA Test results for 7th question of the survey.

ANOVA					
(Q7) What is the effect of residential property's proximity to CBDs on prices?					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	14.071	5	2.814	0.936	0.463
Within Groups	225.485	75	3.006		
Total	239.556	80			
*. The mean difference is significant at the 0.05 level.					

The eighth question (Q8) is aimed to measure the effect of the "proximity to high schools" factor on real estate prices. The eighth question of the survey is presented in Table 4.34.

Table 4.34. 8th question of the survey.

Q8	What is the effect of residential property's proximity to high schools on prices?					
	None	Very Low	Low	Medium	High	Very High
	0	1% - 3%	4%-6%	7%-9%	10%-12%	%13 +
	1	2	3	4	5	6

The descriptive statistics of the answers to the eighth question are presented in Table 4.35. According to descriptive statistics of the eighth question, the real experts mostly evaluated the effect of the "proximity to high schools" factor at none, very low, low and medium levels.

Table 4.35. Descriptive statistics of the 8th question of the survey.

(Q8) What is the effect of residential property's proximity to high schools on prices?								
	Number of the experts	Mean of the experience levels	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (None)	17	2.29	1.448	0.351	1.55	3.04	1	6
2 (Very Low)	22	2.68	1.615	0.344	1.97	3.4	1	6
3 (Low)	18	3.61	1.754	0.413	2.74	4.48	1	6
4 (Medium)	16	3.25	2.049	0.512	2.16	4.34	1	6
5 (High)	7	3	1.528	0.577	1.59	4.41	2	6
6 (Very High)	1	1					1	1
Total	81							

Chi-square test is applied and based on the p value "0.295" which is higher than the significance level used within this study (0.05), there is not a significant relationship between the experience levels and the evaluation of the effect of proximity to school on real estate prices. The homogeneity of the variances is tested and presented in Table 4.36. According to Levene's test p value is 0.170 which is higher than 0.05. Hence, the null hypothesis that calls the variances do not differ significantly cannot be rejected. In other words, the variances are homogenous.

Table 4.36. Test results for the homogeneity of variances for Q8.

Test of Homogeneity of Variances					
Levene Statistic			df1	df2	Sig.
Q8	Based on Mean	1.651	4	75	0.17
	Based on Median	1.411	4	75	0.239
	Based on Median and with adjusted df	1.411	4	65.669	0.24
	Based on trimmed mean	1.72	4	75	0.155

Table 4.37. ANOVA Test results for 8th question of the survey.

ANOVA					
(Q8) What is the effect of residential property's proximity to high schools on prices?					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	21.976	5	4.395	1.515	0.195
Within Groups	217.58	75	2.901		
Total	239.556	80			
*. The mean difference is significant at the 0.05 level.					

Then, the ANOVA results of the eighth question (Q8) are presented in Table 4.37. According to ANOVA results, the null hypothesis that "the means of all groups are equal to each other" cannot be rejected. In other words the means are not significantly different from each other (0.195>>0.05). In general the real estate experts evaluated the effect of the high school proximity on real estate prices as "2.71" indicating that the impact level is low (4%-6%).

The ninth question (Q9) is aimed to measure the effect of the "proximity to seaside" factor on real estate prices. The ninth question of the survey is presented in Table 4.38.

Table 4.38. 9th question of the survey.

Q9	What is the effect of residential property's proximity to seaside on prices?					
	None	Very Low	Low	Medium	High	Very High
	0	1% - 3%	4%-6%	7%-9%	10%-12%	%13 +
	1	2	3	4	5	6

The descriptive statistics of the answers to the ninth question is presented in Table 4.39. According to descriptive statistics of the ninth question, the real experts mostly evaluated the effect of the "proximity to seaside" factor at very low, medium and high levels. The distribution of the evaluations of the impact levels are close to each other.

Table 4.39. Descriptive statistics of the 9th question of the survey.

(Q9) What is the effect of residential property's proximity to seaside on prices?								
	Number of the experts	Mean of the experience levels	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (None)	12	2.83	1.642	0.474	1.79	3.88	1	6
2 (Very Low)	23	2.39	1.27	0.265	1.84	2.94	1	6
3 (Low)	11	3.18	1.94	0.585	1.88	4.49	1	6
4 (Medium)	15	3.07	1.907	0.492	2.01	4.12	1	6
5 (High)	16	3	1.897	0.474	1.99	4.01	1	6
6 (Very High)	4	4.75	1.893	0.946	1.74	7.76	2	6
Total	81							

Chi-square test is applied and based on the p value "0.271" which is higher than the significance level used within this study (0.05), there is not a significant relationship between the experience levels and the evaluation of the effect of proximity to seaside on real estate prices. The homogeneity of the variances is tested by Levene's test and presented in Table 4.40. The obtained p value is 0.218 which is higher than 0.05. Hence, the null hypothesis that calls the variances do not differ significantly cannot be rejected. In other words, the variances are homogenous.

Table 4.40. Test results for the homogeneity of variances for Q9.

Test of Homogeneity of Variances					
Levene Statistic			df1	df2	Sig.
Q9	Based on Mean	1.445	5	75	0.218
	Based on Median	1.343	5	75	0.256
	Based on Median and with adjusted df	1.343	5	63.834	0.258
	Based on trimmed mean	1.493	5	75	0.202

Then, the ANOVA results of the ninth question (Q9) are presented in Table 4.41. According to ANOVA results for ninth question of the survey, the null hypothesis that "the means of all groups are equal to each other" cannot be rejected. In other words the means do not differ significantly. The real estate experts evaluated the effect of the seaside proximity as “3.15” which indicates that the effect is low (4% - 6%).

Table 4.41. ANOVA Test results for 9th question of the survey.

ANOVA					
(Q9) What is the effect of residential property’s proximity to seaside on prices?					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	21,091	5	4,218	1,448	0.217
Within Groups	218,465	75	2,913		
Total	239,556	80			
*. The mean difference is significant at the 0.05 level.					

The tenth question (Q10) is aimed to measure the effect of the “proximity to the BRT line” factor on real estate prices. The tenth question of the survey is presented in Table 4.42.

Table 4.42. 10th question of the survey.

Q10	What is the effect of residential property’s proximity to public transportation systems on prices?					
	None	Very Low	Low	Medium	High	Very High
	0	1% - 8%	9%-16%	17%-24%	25%-32%	%33+
	1	2	3	4	5	6

The descriptive statistics of the answers to the tent question is presented in Table 4.43. According to descriptive statistics, the distribution of individuals in evaluations is homogenous.

Table 4.43. Descriptive Statistics of the 10th question of the survey.

(Q10) What is the effect of residential property's proximity to public transportation systems on prices?								
	Number of the experts	Mean of the experience levels	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
2 (Very Low)	19	1.63	0.831	0.191	1.23	2.03	1	3
3 (Low)	14	1.64	0.633	0.169	1.28	2.01	1	3
4 (Medium)	18	3.39	1.539	0.363	2.62	4.15	1	6
5 (High)	17	3.47	1.7	0.412	2.6	4.34	1	6
6 (Very High)	13	4.85	1.405	0.39	4	5.7	1	6
Total	81							

The means of each evaluation group is represented by a graph in Figure 4.22.

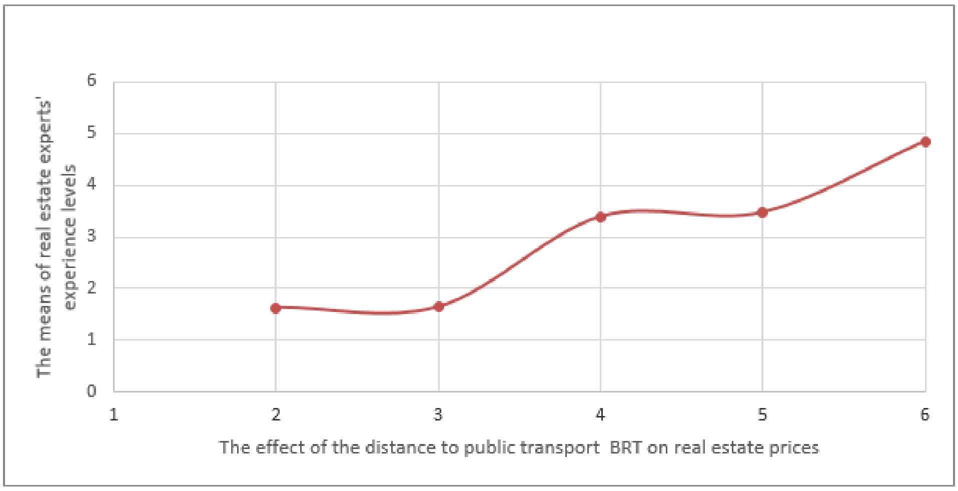

Figure 4.22. The relation between the experience level of experts and their opinions on the effect of proximity to the BRT line.

The Figure 4.22 represents the relation between the experience level of the real estate experts and the opinions of the real estate experts regarding the effect of the BRT line proximity on real estate prices. According to Figure 4.22 the relation has a positive ratio, in other words the experts with higher experience level thinks that proximity to the BRT line has higher effect on real estate prices. Chi-square test is applied and based on the p value "0.000" which is very low compared to the significance level used within this study (0.05), there is a very significant relationship between the experience levels and the evaluation of the effect of proximity to the BRT line on real estate prices. Also, ANOVA analysis is applied for better understanding this relationship. The homogeneity test, Levene's statistics is applied and the p value of 0.003 is obtained as presented in Table 4.44. This p value is smaller than the significance value used for this study (0.005) which indicates that the null hypothesis "the variances do not differ significantly from each other" can be rejected. In other words, the variances are heterogeneous at a significance level of 95%. Therefore, based on the ANOVA results, if the means area significantly different from each other, the post hoc test will be selected from the ones that assume the variances are not equal to each other.

Table 4.44. Test of Homogeneity of Variances for Q10.

Test of Homogeneity of Variances					
Levene Statistic			df1	df2	Sig.
(Q10)	Based on Mean	4,385	4	76	0.003
	Based on Median	2,763	4	76	0.033
	Based on Median and with adjusted df	2,763	4	67,349	0.034
	Based on trimmed mean	4,181	4	76	0.004

The ANOVA results of the ninth question (Q9) are presented in Table 4.45. According to ANOVA results there is a significant difference in the mean values.

Table 4.45. ANOVA Test results for 10th question of the survey.

ANOVA					
(Q10) What is the effect of residential property's					
proximity to public transportation systems on prices?					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	111,715	4	27,929	16,603	0.000
Within Groups	127,841	76	1,682		
Total	239.556	80			
*. The mean difference is significant at the 0.05 level.					

Games-Howell test is used in order to see the differences in variances. In order to see the differences in the variances for each group of real estate experts, Games-Howell test is applied and the results are presented in Table 4.46. According to Games-Howell post hoc test results, the variances of groups 2 and 3 are significantly different from the variances of the groups 4, 5 and 6. Based on the results, it is revealed that the experts with higher experience levels evaluated the effect of the proximity to the BRT line at higher rates.

Table 4.46. The results of Games-Howell Test for Q10.

Multiple Comparisons						
Dependent variable: Q10		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
2	3	-0.011	0.255	1,000	-0.75	0.73
	4	-1.757*	0.410	0.002	-2.96	-0.56
	5	-1.839*	0.454	0.004	-3.18	-0.49
	6	-3.215*	0.434	0.000	-4.53	-1.90
3	2	0.011	0.255	1,000	-0.73	0.75
	4	-1.746*	0.400	0.002	-2.93	-0.57
	5	-1.828*	0.446	0.004	-3.15	-0.50
	6	-3.203*	0.425	0.000	-4.50	-1.91
4	2	1.757*	0.410	0.002	0.56	2.96
	3	1.746*	0.400	0.002	0.57	1.93
	5	-0.082	0.549	1,000	-1.67	1.50
	6	-1,457	0.532	0.074	-3.01	0.10
5	2	1.839*	0.454	0.004	0.49	3.18
	3	1.828*	0.446	0.004	0.50	3.15
	4	0.082	0.549	1,000	-1.50	1.67
	6	-1.376	0.567	0.138	-3.03	0.28
6	2	3.215*	0.434	0.000	1.90	4.53
	3	3.203*	0.425	0.000	1.91	4.50
	4	1,457	0.532	0.074	-0.10	3.1
	5	1,376	0.567	0.138	-0.28	3.3
*. The mean difference is significant at the 0.05 level.						

The relation of the experience level and all selected parameters are provided in the Table 4.49. According to correlation Table 4.47, the experience level is highly correlated with the first, the third, the fourth and the tenth questions indicating that the real estate experts with higher level of experience evaluated the effect of the parameters; “age, floor level, credit viability, and proximity to the BRT line” on real estate prices at higher levels.

Table 4.47. Correlations of survey questions.

		D2	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
D2	Pearson Correlation	1	0.388**	0.282*	0.543**	0.665**	-0.112	0.015	0.218	0.151	0.195	0.649**
	Sig. (2-tailed)		0.000	0.011	0.000	0.000	0.318	0.895	0.051	0.179	0.082	0.000
	N	81	81	81	81	81	81	81	81	81	81	81
*. The mean difference is significant at the 0.05 level.												
**. The mean difference is significant at the 0.001 level.												

4.4.2. Results for the BRT Zone Analysis

The dataset within the BRT zone is analyzed within two zones namely, the primary catchment area that is between 0 and 850 m distances from the BRT line and the secondary catchment area, which is between 850 m and 1900 m. The distance of 850 m is considered as the average 10 min walking distance. Many studies in the literature utilized average walking distances and catchment areas up to 1000 m from the transportation systems [23, 29, 31, 38, 41]. Based on the parameters which are selected by comprehensive literature review and the survey with the real estate experts the hedonic price model is established.

The established model is:

$$\begin{aligned} y = \alpha + \beta_1\,(size) + \beta_2\,(age) + \beta_3\,(creditvia) + \beta_4\,(floorlev) + \\ \beta_5\,(facility) + \beta_6\,(rooms) + \beta_7\,(distHosp) + \beta_8\,(distMall) + \\ \beta_9\,(distBRT) + \beta_{10}\,(distSchool) + \beta_{11}\,(distCBD) + \beta_{12}\,(distSea) \end{aligned} \tag{4.1}$$

where, y is the average price (TL/m^2), α is the constant value, β_i (i = 1, 2, 3...i) is the coefficient of each explanatory variable in the model. “size” is the size of the real estate in m^2, “age” is the age of the real estate in terms of years, “creditvia” is the credit viability condition of the real estate, “floorlev” is the floor level of the real estate, “facility” is the term for the existence of parking and other facilities for the real estate, “rooms” is the number of the rooms of the real estate. “distHosp” is the distance from closest hospital, "distMall" is the distance from closest shopping mall, "distBRT" is the distance from closest BRT station, "distSchool" is the distance from closest school, "distCBD" is the distance from closest central business district and "distSea" is the distance from the closest seaside point.

The information about the data within the primary catchment area which is between 0 ? 850m distance from the BRT line, is presented in the Table 4.48 The descriptive statistics table consists of the information about the data, in terms of the total number of the observation point, minimum and maximum values mean, standard deviation and variance values of each explanatory variable.

Table 4.48. The descriptive statistics of the primary catchment area (0-850m) of the BRT line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	366.0	180.0	7335.0	2446.0	1059.0	1120987.0
Area (m^2)	366	40	260	111	31.2	974.1
Age	366	0.0	29.0	5.1	6.2	39.0
Floor	366	0.0	35.0	3.9	4.1	16.6
Facility	366	0.0	1.0	1.3	0.5	0.2
CreditVia	366	0.0	1.0	1.5	0.6	0.3
DistShop (m)	366	68.1	2430.0	718.9	361.0	130306.0
DistHosp(m)	366	23.0	1920	728.5	349.3	122031.0
DistSchool (m)	366	42.1	2183	980.4	309.0	95446.0
DistBRT (m)	366	633.0	4598.0	3353.0	793.0	627940.0
DistCBD (m)	366	2546.0	6546.0	4482.0	1316.0	1731043.0
DistSea (m)	366	81.5	849.2	576.3	227.0	51355.0
Valid N	366					

The analysis results of OLS, SAR, GWR and MGWR methods area presented in Table 4.49. Based on the RSS and AIC values, the best performance in prediction of the estimates of the model belongs to GWR. According to GWR, the coefficient of the explanatory variable "DistBRT" is "0.546" which indicates that the proximity to the BRT line has a premium on the values of the residential properties within the primary catchment area of the BRT line.

Table 4.49. Analysis results of the primary catchment area (0 - 850m) of the BRT line.

Primary Cathment Area (0 - 850m) of the BRT line													
	OLS		**SAR**		**GWR**			**MGWR**					
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**	
Constant	4486.4	0.000	3486.4	0.019	-33650.8	10026.8	27270.1	89.4	92.4	96.5	91.0	0.022	
Area (m^2)	-3.1	0.027	-3.1	0.635	-9.9	-3.5	0.8	-1.8	-1.6	-0.7	365.0	0.045	
Age	-7.7	0.453	-3.2	0.116	-126.3	-18.8	121.9	-135.0	19.1	41.6	100.0	0.009	
Floor	31.4	0.008	27.0	0.000	-59.4	54.5	263.2	-35.2	63.3	265.4	153.0	0.019	
Facility	655.7	0.000	549.2	0.000	-219.4	440.5	1027.0	682.1	739.7	740.9	365.0	0.047	
CreditVia	600.5	0.000	540.6	0.000	-604.9	579.2	1074.6	-65.1	-52.0	26.8	365.0	0.047	
DistShop (m)	0.267	0.085	0.148	0.033	-2.197	-0.768	2.055	-1.580	-1.578	-1,563	223.0	0.040	
DistHosp (m)	0.174	0.321	0.020	0.118	-15.536	-0.364	3.598	0.178	0.187	0.190	45.0	0.008	
DistSchool (m)	-0.593	0.001	-0.323	0.712	-3,558	-0.585	4.560	0.041	0.139	0.366	365.0	0.049	
DistBRT (m)	-0.657	0.007	-0.411	0.167	-4.880	-0.546	5.247	-0.754	-0.688	-0.496	225.0	0.035	
DistCBD (m)	-0.171	0.107	-0.141	0.880	-2,644	-0.200	1,653	0.821	0.822	0.841	100.0	0.019	
DistSea (m)	-0.115	0.091	-0.097	0.531	-3.523	-0.888	16,055	0.194	0.196	0.196	26.0	0.002	
R^2	0.436		0.462		0.669								
RSS	230.782.628		209.013.965		135.419,516			173.982.758					
AIC	5.950.35		5.936.60		5,862.44			5.932.56					
			Rho: 0.273 p-val: 0.000		Bandwidth=146.0								
			Morans' I: 0.423		Adj. Alpha(95%)= 0.009 < 0.05								

The secondary catchment area that is from 850m to 1900m is analyzed using the same analysis techniques. Descriptive statistics of the secondary catchment area (850m - 1900m) of the BRT line is presented in Table 4.50.

Table 4.50. Descriptive statistics of the secondary catchment area (850m-1900m) of the BRT line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	680	550.0	27586.2	2475.0	1348.7	1818930.7
Area (m^2)	680	45.0	360.0	116.8	40.7	1655.2
Age	680	0.0	26.0	5.6	5.4	29.5
Floor	680	0.0	30.0	4.8	5.8	34.0
Facility	680	0.0	1.0	1.3	0.5	0.2
CreditVia	680	0.0	1.0	1.4	0.5	0.2
DistShop (m)	680	13.8	2996.2	912.8	461.3	212841.1
DistHosp (m)	680	1.7	3905.0	864.1	751.0	564039.9
DistSchool (m)	680	8.2	2232.2	811.9	432.0	186602.3
DistBRT (m)	680	32.5	7081.5	3783.5	1015.3	1030876.1
DistCBD (m)	680	2125.1	6978.7	4807.6	1539.1	2368797.3
DistSea (m)	680	851.0	1803.4	1224.9	264.3	69837.7
Valid N	680					

The analysis results of the secondary catchment area (850m - 1900m) of the BRT line is presented in Table 4.51. The best performance belongs to GWR based on the AIC and RSS values. The coefficient of the BRT distance parameter is “0.438”, which indicates that the prices of the real estates within the secondary catchment area of the BRT line are negatively affected by proximity to the BRT line.

Table 4.51. The analysis results of the secondary catchment area (850m - 1900m) of the BRT line.

Secondary Cathment Area (850m - 1900m) of the BRT line													
	OLS		**SAR**		**GWR**			**MGWR**					
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**
Constant	4060.9	0.000	3777.9	0.000	-555.4	2495.7	10325.0	2362.6	2785.0	3177.1	336.0	0.039
Area (m^2)	-1.6	0.227	-1.9	0.124	-5.5	-3.8	1.4	-4.6	-4.5	-3.9	678.0	0.045
Age	8.6	0.503	7.1	0.574	-34.4	11.5	37.3	-33.7	-2.3	9.6	527.0	0.028
Floor	-2.8	0.791	-1.7	0.864	-56.6	-5.8	26.9	-137.3	55.1	126.5	172.0	0.007
Facility	707.7	0.000	604.1	0.000	-504.8	552.0	910.7	238.9	271.0	293.6	631.0	0.046
CreditVia	223.3	0.101	192.2	0.147	-563.8	17.3	559.4	-55.7	62.0	66.0	679.0	0.046
DistShop (m)	-0.513	0.003	-0.443	0.009	-1,799	-0.066	0.491	0.580	1,314	1,333	334.0	0.022
DistHosp (m)	0.423	0.000	0.336	0.003	-0.996	0.354	2,106	-0.557	-0.550	-0.508	679.0	0.049
DistSchool (m)	-0.230	0.116	-0.216	0.130	-0.611	-0.053	0.790	0.483	1,040	1,907	251.0	0.018
DistBRT (m)	1,196	0.000	0.982	0.000	-0.394	0.438	3,171	-2,724	0.789	1,648	75.0	0.003
DistCBD (m)	-0.435	0.000	-0.348	0.000	-0.754	-0.193	0.533	-1,518	-1,203	-0.828	252.0	0.028
DistSea (m)	-0.331	0.000	-0.276	0.000	-1,786	-0.074	0.238	0.166	0.364	1,852	172.0	0.017
R^2	0.181		0.201		0.326							
RSS	1.011.669.741		986.256.351		832.467.925			880.596.321				
AIC	11.618.44		11.606.34		11.537.32			11.550.28				
			Rho: 0.204									
			p-val: 0.000		Bandwidth=419.0							
			Morans' I: 0.251		Adj. Alpha(95%)= 0.016 < 0.05							

The prices of the real estates within various neighborhoods with different income levels are investigated. The dataset is divided into subgroups based on the income levels of the neighborhood and same analysis techniques are applied. The criterion for dividing the dataset into income level groups is based the socio economic condition of the neighborhood [105]. First, the high income neighborhoods are investigated. Descriptive statistics of the high income group in the primary catchment area of the BRT line is presented in Table 4.52.

Table 4.52. Descriptive statistics of the high income group in the primary catchment area (0 - 850m) of the BRT line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	300	807.7	5454.5	2424.1	1061.5	1126779.0
Area (m^2)	300	30.0	280.0	110.1	35.8	1283.5
Age	300	0.0	27.0	3.3	4.4	19.4
Floor	300	0.0	22.0	3.9	4.4	19.5
Facility	300	0.0	1.0	1.3	0.5	0.2
CreditVia	300	0.0	1.0	1.7	0.5	0.2
DistShop (m)	300	195.1	1999.4	1108.4	293.2	85990.4
DistHosp(m)	300	279.5	2681.6	1016.6	365.7	133735.0
DistSchool (m)	300	1.6	2515.4	648.7	360.0	129566.8
DistBRT (m)	300	47.7	849.1	438.3	204.3	41741.3
DistCBD (m)	300	1515.9	5160.6	2339.2	659.2	434502.2
DistSea (m)	300	2717.3	6310.7	5680.4	648.8	420942.0
Valid N	300					

The result for high income group in the primary catchment area of the BRT line is presented in Table 4.53. Based on the RSS and AIC values, GWR performed the best analysis. According to the results the coefficient of the “DistBRT” variable is positive (0.332), which means that the high income neighborhood is negatively affected by the proximity to the BRT line.

Table 4.53. The analysis results of the high income neighborhood in the primary catchment area (0 - 850m) of the BRT line.

Primary Cathment Area (0 - 850m) of the BRT line													
	OLS		**SAR**		**GWR**			**MGWR**					
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**
Constant	2459.9	0.233	2177.1	0.019	-9732.5	5585.8	15376.2	89.4	92.4	96.5	298.0	0.048
Area (m^2)	-0.6	0.684	-0.6	0.635	-6.8	-1.7	2.5	-1.8	-1.6	-0.7	282.0	0.040
Age	-30.6	0.106	-28.6	0.116	-251.7	-2.3	70.8	-135.0	19.1	41.6	152.0	0.011
Floor	59.9	0.008	58.6	0.000	-9.9	59.3	168.8	-35.2	63.3	265.4	43.0	0.003
Facility	600.9	0.000	510.3	0.000	-808.7	649.0	1745.9	682.1	739.7	740.9	298.0	0.046
CreditVia	214.9	0.000	197.7	0.000	-1225.5	31.5	348.0	-65.1	-52.0	26.8	282.0	0.042
DistShop (m)	-0.918	0.024	-0.774	0.033	-3,613	-1,649	1,032	-1.58	-1,578	-1,563	298.0	0.048
DistHosp (m)	0.962	0.068	0.703	0.118	-1,322	1,353	4,854	0.178	0.187	0.190	298.0	0.048
DistSchool (m)	-0.108	0.727	-0.102	0.712	-5,922	-0.384	1,288	0.041	0.139	0.366	273.0	0.033
DistBRT (m)	-0.763	0.001	0.582	0.167	-1,783	0.332	2,628	-0.754	-0.688	-0.496	283.0	0.037
DistCBD (m)	-0.011	0.970	0.011	0.880	-4,182	0.916	5,877	0.821	0.822	0.841	298.0	0.043
DistSea (m)	-0.126	0.619	-0.072	0.531	-1,490	-0.193	1,500	0.194	0.196	0.196	298.0	0.049
$\mathbf{R^2}$	0.439		0.451		0.665							
RSS	189,056,307		209,013,965		119,600,586			143,039,512				
AIC	4881.00		4879.00		4828.00			4839.00				
			Rho: 0.207									
			p-value: 0.01		Bandwidth=146.0							
			Morans' I: 0.411		Adj. Alpha(95%)= 0.011 < 0.05							

The real estates in the high income neighborhood of the secondary catchment area of the BRT line are analyzed by using same analysis techniques respectively. The descriptive statistics of the high income group in the secondary catchment area (850m - 1900m) is presented in the Table 4.54.

Table 4.54. Descriptive statistics of the high income group in the secondary catchment area (850m -1900m) of the BRT line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	73	1900.0	6967.2	3504.3	1143.4	1307318.4
Area (m^2)	73	59.0	360.0	163.8	52.5	2754.3
Age	73	0.0	21.0	10.2	6.1	37.6
Floor	73	0.0	15.0	5.2	3.9	15.6
Facility	73	0.0	1.0	1.6	0.5	0.3
CreditVia	73	0.0	1.0	1.1	0.3	0.1
DistShop (m)	73	313.0	1427.8	868.8	279.4	78044.4
DistHosp (m)	73	155.9	1304.4	704.7	291.0	84665.9
DistSchool (m)	73	8.2	1410.7	631.9	302.6	91588.4
DistCBD (m)	73	3780.7	5419.8	4404.6	376.4	141712.1
DistSea (m)	73	2725.0	4383.9	3523.7	361.5	130688.7
DistBRT (m)	73	852.4	1799.3	1361.9	317.0	100473.4
Valid N	73					

The results for high income group in the secondary catchment area (850m-1900m) are presented in Table 4.55. Based on RSS and AIC values, GWR prediction is the best one. The coefficient of the BRT distance parameter "DistBRT" obtained from GWR analysis is "1.135" which indicates that the prices of the residential properties in the high income neighborhood of the secondary catchment area are negatively affected by proximity to the BRT line.

Table 4.55. The analysis results of the high income neighborhood in the secondary catchment area (850m- 1900m) of the BRT line.

Primary Cathment Area (850m- 1900m) of the BRT line													
	OLS		SAR		GWR			MGWR					
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**
Constant	57.5	0.993	-1043.7	0.856	-6554.4	2327.6	13615.2	-331.9	2629.2	3803.1	18.0	0.008
Area (m^2)	-0.4	0.884	-0.6	0.778	-2.6	-0.5	2.4	1.2	1.6	1.9	72.0	0.048
Age	-70.9	0.017	-60.1	0.018	-86.1	-48.2	-25.0	-7.5	-5.3	-3.8	72.0	0.043
Floor	15.0	0.636	21.1	0.438	0.8	15.8	28.5	18.9	22.2	26.5	72.0	0.036
Facility	198.8	0.406	171.7	0.403	-19.9	346.3	558.0	388.4	403.0	447.1	72.0	0.043
CreditVia	1005.1	0.037	783.0	0.059	-385.9	1064.6	1625.7	67.1	331.0	512.8	70.0	0.042
DistShop (m)	-1.415	0.278	-0.296	0.792	-4.441	-2.100	0.924	-0.038	0.034	0.112	72.0	0.048
DistHosp (m)	0.658	0.454	0.295	0.699	-1.109	0.675	1.282	1.463	1.555	1.713	72.0	0.046
DistSchool (m)	0.597	0.278	0.280	0.568	-0.024	0.145	1,172	0.279	0.421	0.702	72.0	0.046
DistBRT (m)	0.720	0.344	0.014	0.983	-1.094	1.135	2.345	2.530	2.569	2.603	72.0	0.049
DistCBD (m)	0.093	0.908	0.297	0.672	-1,717	0.093	0.808	-0.569	-0.558	-0.546	72.0	0.048
DistSea (m)	1,675	0.221	0.644	0.585	-1.104	1.414	4.612	1.334	1.347	1.362	72.0	0.049
$\mathbf{R^2}$	0.382		0.439		0.621							
RSS	58.176.960		51.236.598		35.629.058			41.962.703				
AIC	1223.12		1220.00		1205.72			1214.80				
			Rho: 0.418									
			p-value: 0.007		Bandwidth=72.0							
			Morans' I: 0.469		Adj. Alpha(95%)= 0.03 < 0.05							

The second income level group is the middle income group. Descriptive statistics of the middle income group in the primary catchment area of the BRT line is presented in Table 4.56.

Table 4.56. Descriptive Statistics of the middle income group in the primary catchment area (0 - 850m) of the BRT line.

Descriptive Statistics.						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	256	180.0	21000.0	2623.3	1567.3	2456574.2
Area (m^2)	256	45.0	221.0	116.1	33.4	1114.3
Age	256	0.0	29.0	5.3	6.9	47.1
Floor	256	0.0	27.0	4.3	4.2	17.4
Facility	256	0.0	1.0	1.4	0.5	0.2
CreditVia	256	0.0	1.0	1.6	0.5	0.2
DistShop (m)	256	77.3	3762.4	1208.7	710.9	505404.7
DistHosp (m)	256	23.0	3915.5	1002.1	638.4	407528.5
DistSchool (m)	256	42.1	3518.2	1245.1	609.9	371924.6
DistBRT (m)	256	92.0	848.5	428.4	187.8	35276.9
DistCBD (m)	256	633.0	5112.3	2782.0	827.0	683928.9
DistSea (m)	256	3408.3	6049.3	4949.7	672.2	451841.2
Valid N	256					

The results for the middle income group in the primary catchment area of the BRT line are presented in Table 4.57. The best performance belongs to MGWR analysis based on the RSS and AIC values. According to coefficient of “-0.674” the proximity to the BRT line contributes to the prices of the real estates within the middle income neighborhood in the primary catchment area.

Table 4.57. Analysis results of the middle income neighborhood in the primary catchment area (0 - 850m) of the BRT line.

Middle Income Neighborhood in the Primary Catchment Area (0 - 850 m) of the BRT line												
	OLS		**SAR**		**GWR**			**MGWR**				
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**
Constant	3934.4	0.038	3576.0	0.044	2806.5	6849.6	10969.6	6786.5	6796.8	6808.9	255.0	0.048
Area (m^2)	-7.7	0.005	-7.5	0.004	-14.1	-8.2	-5.2	-6.7	-6.6	-6.5	255.0	0.045
Age	-8.8	0.642	-8.3	0.651	-30.2	-15.0	-5.6	-228.0	-1.8	729.7	25.0	0.002
Floor	0.8	0.972	-0.1	0.996	-89.0	-9.6	21.1	-92.2	3.1	26.5	136.0	0.023
Facility	802.6	0.000	789.2	0.000	572.5	633.2	1450.8	628.7	632.5	643.6	255.0	0.046
CreditVia	1027.0	0.000	1021.0	0.000	-1005.0	1103.7	1701.7	-817.1	830.8	843.8	255.0	0.046
DistShop (m)	-0.210	0.415	-0.194	0.439	-1,397	-0.898	0.009	-0.549	-0.129	0.106	122.0	0.020
DistHosp (m)	-0.226	0.596	-0.220	0.597	-1,103	-0.438	-0.148	-0.526	-0.504	-0.418	255.0	0.043
DistSchool (m)	0.266	0.451	0.277	0.420	-1,044	-0.301	0.713	-0.246	-0.224	-0.174	255.0	0.046
DistBRT (m)	-0.511	0.386	-0.507	0.378	-0.530	-0.523	-0.704	-0.674	-0.611	0.725	255.0	0.045
DistCBD (m)	-0.192	0.381	-0.191	0.370	-0.500	-0.195	0.100	-0.113	-0.106	-0.087	255.0	0.046
DistSea (m)	0.122	0.594	0.100	0.655	-0.419	-0.246	0.187	-0.451	-0.449	-0.447	255.0	0.048
R^2	0.266		0.268		0.665							
RSS	459,817,715		209,013,965		411,449,068			318,531,140				
AIC	4439.00		4440.00		4434.00			4395.00				
			Rho: 0.071									
			p-value: 0.390		Bandwidth=184.0							
			Morans' I: 0.133		Adj. Alpha(95%)= 0.025 < 0.05							

Then, real estate prices in the middle income neighborhood of the secondary catchment area (850m - 1900m) are analyzed. Descriptive statistics of the middle income group in the secondary catchment area is presented in Table 4.58.

Table 4.58. Descriptive statistics of the middle income group in the secondary catchment area (850m - 1900m) of the BRT line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m2)	170	1176.5	27586.2	3084.7	2102.9	4422089.1
Area (m2)	170	46.0	276.0	109.2	41.9	1752.8
Age	170	0.0	26.0	8.4	6.0	36.1
Floor	170	0.0	30.0	10.0	8.5	72.3
Facility	170	0.0	1.0	1.8	0.4	0.2
CreditVia	170	0.0	1.0	1.2	0.4	0.2
DistShop (m)	170	244.0	2996.2	1284.6	478.4	228888.5
DistHosp (m)	170	32.6	2054.8	1259.6	500.1	250113.9
DistSchool (m)	170	8.2	2232.2	1097.8	630.7	397771.9
DistCBD (m)	170	32.6	4565.8	3114.0	833.0	693951.3
DistSea (m)	170	3416.4	6978.7	5153.3	680.9	463595.1
DistBRT (m)	170	867.9	1800.8	1258.8	241.3	58214.8
Valid N	170					

The result for middle income group in the secondary catchment area is presented in Table 4.59. AIC scores of MGWR and GWR are almost equal but in terms of RSS values GWR performed better in prediction of the model. According to GWR analysis, the coefficient value of the BRT distance is “1.717” which indicates that the there is a negative relation between the real estate prices and the proximity to the BRT line.

Table 4.59. Analysis results of the middle income group in the secondary catchment area (850m - 1900m) of the BRT line.

Middle Income Neighborhood in the Secondary Catchment Area (850 m - 1900 m) of the BRT line													
	OLS		**SAR**		**GWR**			**MGWR**					
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**	
Constant	6804.5	0.005	8100.7	0.000	3949.3	4762.0	12308.5	5749.6	5757.8	5851.7	169.0	0.047	
Area (m^2)	-1.2	0.794	-1.0	0.822	-4.5	-0.8	-0.1	-1.2	-1.0	0.1	169.0	0.040	
Age	25.8	0.469	27.6	0.420	-11.2	13.3	56.5	30.3	31.0	47.1	169.0	0.038	
Floor	-22.0	0.304	-23.7	0.250	-98.2	-13.5	-11.1	-142.0	-41.6	4.6	80.0	0.014	
Facility	127.9	0.782	144.0	0.746	-509.1	300.7	970.0	107.3	195.7	200.3	169.0	0.044	
CreditVia	370.8	0.462	399.0	0.410	393.3	597.0	758.5	605.1	610.2	690.4	169.0	0.041	
DistShop (m)	-1,423	0.003	-1,539	0.002	-2,255	-0.121	0.484	-1,400	-1,331	-1,328	169.0	0.043	
DistHosp (m)	-0.673	0.359	-0.763	0.280	-2,833	-1,073	0.347	-1,001	-0.817	-0.801	169.0	0.043	
DistSchool (m)	0.729	0.194	0.808	0.136	0.069	0.340	1,314	0.784	0.797	1,018	169.0	0.041	
DistBRT (m)	0.664	0.494	0.612	0.514	-2,798	1,717	2,739	0.422	0.438	0.771	169.0	0.045	
DistCBD (m)	0.300	0.332	0.346	0.244	0.205	0.510	1,042	0.147	0.151	0.195	169.0	0.046	
DistSea (m)	-0.806	0.013	-0.869	0.007	-1,699	-0.265	-0.047	-0.562	-0.552	-0.547	169.0	0.047	
R^2	0.119		0.123		0.24								
RSS	658,512,590		671,214,035		567,939,880			615,481,271					
AIC	3085.29		3088.50		3084.31			3084.29					
			Rho: 0.135										
			p-value: 0.79		Bandwidth=159.0								
			Morans' I: 0.035		Adj. Alpha(95%)= 0.026 < 0.05								

The last income group is the low income group. It is analyzed also for primary and secondary catchment areas of the BRT line. The descriptive statistics of this group is presented in Table 4.60.

Table 4.60. Descriptive statistics of the low income group in the primary catchment area (0 - 850m) of the BRT line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	205	544.4	5416.7	2068.7	885.9	784890.2
Area (m^2)	205	40.0	260.0	110.9	30.6	938.3
Age	205	0.0	19.0	2.8	3.0	8.9
Floor	205	0.0	35.0	3.1	3.5	12.2
Facility	205	0.0	1.0	1.2	0.4	0.1
CreditVia	205	0.0	1.0	1.6	0.5	0.2
DistShop (m)	205	68.1	1000.5	526.8	237.9	56577.1
DistHosp (m)	205	185.4	1583.7	682.8	360.1	129673.8
DistSchool (m)	205	674.7	1477.1	988.1	143.8	20681.1
DistBRT (m)	205	87.8	849.3	700.2	167.3	27990.8
DistCBD (m)	205	2449.8	4598.4	3586.4	715.6	512042.1
DistSea (m)	205	2543.6	6546.2	4262.5	1610.6	2594038.2
Valid N	205					

The analysis results of the low level income neighborhood in the primary catchment area are presented in Table 4.61 Based on RSS and AIC values, GWR is the most successful technique in prediction of the model. According to the results, estimated value of "DistBRT" variable is -0.687, which indicates that the real estate prices in the low income neighborhood tend to increase as the distance to the BRT line decreases.

Table 4.61. Analysis results of the low income group in the primary catchment area (0 - 850m) of the BRT line.

Low Income Neighborhood in the Primary Catchment Area (0 - 850m) of the BRT line														
	OLS		**SAR**		**GWR**			**MGWR**						
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**		
Constant	4973.6	0.331	4921.8	0.032	-49172.8	-2951.9	55773.9	-14106.1	-2602.4	53606.1	13.0	0.008		
Area (m^2)	-4.4	0.007	-4.5	0.003	-9.0	-3.9	-0.8	-8.4	-7.8	-7.8	204.0	0.044		
Age	-34.8	0.167	-30.5	0.209	-90.6	-43.8	134.3	-105.6	-83.5	160.6	115.0	0.024		
Floor	49.4	0.003	49.6	0.001	26.4	59.6	140.2	41.9	70.0	82.2	119.0	0.027		
Facility	377.3	0.031	306.1	0.073	-430.7	289.0	865.9	-947.0	-946.3	-771.8	133.0	0.046		
CreditVia	496.9	0.002	470.0	0.002	-611.7	181.2	812.3	46.4	805.8	807.1	133.0	0.028		
DistShop (m)	0.52	0.345	0.425	0.425	-3.96	-0.939	0.454	-1,225	-1,221	-0.423	133.0	0.049		
DistHosp (m)	0.324	0.625	0.140	0.829	-18,212	0.345	1,137	-1,554	-1,459	1,548	90.0	0.038		
DistSchool (m)	-1,618	0.005	-1,337	0.234	-5,354	-3,084	-0.607	-5,486	-5,451	-2,447	113.0	0.036		
DistBRT (m)	-1,318	0.242	-1,246	0.253	-5,079	-0.687	3,356	-2,355	-2,353	1,076	133.0	0.040		
DistCBD (m)	-0.1	0.909	-0.057	0.946	-6,138	0.938	3,269	-4,396	-1,339	1,885	25.0	0.098		
DistSea (m)	-0.108	0.787	-0.093	0.807	-6,923	0.520	19,939	-6.53	0.494	10,604	13.0	0.001		
R^2	0.488		0.451		0.684									
RSS	81,957,455		209,013,965		50,629,421			52,022,104						
AIC	3249.00		3251.00		3201.00			3213.00						
			Rho: 0.154											
			p-value: 0.136		Bandwidth=94.0									
			Morans' I: 0.452		Adj. Alpha(95%)= 0.017 < 0.05									

Additionally, all analyses are performed for low income group in the secondary catchment area. Descriptive statistics of the low income group in the secondary catchment area (850m - 1900m) is presented in Table 4.62.

Table 4.62. Descriptive statistics of the low income group in the secondary catchment area (850m - 1900m) of the BRT line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	437	550.0	4444.4	2065.8	642.3	412587.0
Area (m^2)	437	45.0	300.0	111.9	32.1	1027.5
Age	437	0.0	26.0	3.8	4.0	15.9
Floor	437	0.0	24.0	2.8	2.8	7.6
Facility	437	0.0	1.0	1.1	0.3	0.1
CreditVia	437	0.0	1.0	1.5	0.5	0.2
DistShop (m)	437	13.4	2547.3	775.6	395.9	156757.0
DistHosp (m)	437	1.6	3905.0	736.8	828.3	686003.6
DistSchool (m)	437	25.6	1596.2	730.8	278.2	77404.6
DistCBD (m)	437	2655.6	7081.5	3940.1	1024.3	1049114.2
DistSea (m)	437	2125.1	6804.9	4887.6	1777.3	3158745.8
DistBRT (m)	437	851.0	1803.4	1188.9	254.4	64714.6
Valid N	437					

The results of the low level income group in the secondary catchment area (850m - 1900m) are presented in Table 4.63. Based on the RSS and AIC values, the best performance belongs to the GWR analysis. The coefficient of the BRT distance is also positive (0.651) which indicates that the prices of the properties in the low income neighborhood of the secondary catchment area of the BRT line are decreasing as the distance to the BRT line decreases.

Table 4.63. The analysis results of the low level income group in the secondary catchment area (850m - 1900m) of the BRT line.

Low Income Neighborhood in the Secondary Cathment Area (850m - 1900m) of the BRT line												
	OLS		**SAR**		**GWR**			**MGWR**				
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**
Constant	3049.6	0.000	3209.7	0.000	-9176.4	745.7	6697.4	-1442.5	-1431.9	-368.8	285.0	0.041
Area (m^2)	-6.8	0.000	-6.8	0.000	-9.3	-6.9	-4.1	-7.8	-7.7	-3.8	335.0	0.031
Age	6.8	0.478	6.8	0.470	-1.7	4.6	33.2	-60.6	7.6	40.7	84.0	0.004
Floor	68.3	0.000	68.3	0.000	32.3	47.6	152.8	-2.6	111.1	148.6	86.0	0.004
Facility	378.1	0.000	376.8	0.000	63.6	213.8	590.2	273.2	278.8	530.9	339.0	0.037
CreditVia	196.5	0.011	-195.8	0.010	-168.6	206.6	327.6	-137.1	155.1	162.9	436.0	0.047
DistShop (m)	0.025	0.855	0.025	0.850	-1,695	0.060	1,101	-0.943	-0.930	1,098	230.0	0.019
DistHosp (m)	0.027	0.804	0.027	0.806	-1,426	-0.295	1,679	0.377	0.385	0.408	436.0	0.047
DistSchool (m)	-0.239	0.055	-0.238	0.053	-0.258	-0.136	1,181	0.539	0.572	0.626	436.0	0.046
DistBRT (m)	0.444	0.002	0.437	0.004	-0.256	0.651	3,726	1,384	1,603	2,012	238.0	0.032
DistCBD (m)	-0.137	0.182	-0.135	0.184	-2,766	-0.289	0.845	-0.810	-0.807	-0.738	395.0	0.046
DistSea (m)	-0.084	0.098	-0.083	0.097	-0.544	0.335	1,703	0.713	0.713	0.756	337.0	0.047
$\mathbf{R^2}$	0.344		0.343		0.475							
RSS	118,089,883		406,218,456		94,519,906			101,200,735				
AIC	6729.72		6733.70		6708.16			6715.52				
			Rho: 0.009									
			p-value: 0.900		Bandwidth=191.0							
			Morans' I: 0.098		Adj. Alpha(95%)= 0.012< 0.05							

There might be different effects of the transportation systems on the real estates with different sizes. Hence, the dataset is divided into subgroups based on the size of the real estates and the same analysis techniques are applied. The real estates smaller than 80 m^2 are considered as the small-sized real estates, the ones between 80m^2 and 110m^2 are considered as the medium-sized real estates and the ones larger than 110m^2 are considered as large-sized real estates. Firstly, the large-sized real estates in the primary and secondary catchment areas of the Metro line are analyzed. Descriptive statistics of large-sized real estates in primary catchment area of the BRT line is presented in Table 4.64.

Table 4.64. Descriptive statistics of the large-sized real estates in the primary catchment area (0 - 850m) of the BRT line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	223	461.5	5481.5	2332.1	1074.2	1153947.6
Area (m^2)	223	111.0	260.0	140.7	24.6	612.2
Age	223	0.0	29.0	5.1	6.8	45.8
Floor	223	0.0	27.0	4.4	4.1	16.9
Facility	223	0.0	1.0	1.3	0.5	0.2
CreditVia	223	0.0	1.0	1.6	0.5	0.2
DistShop (m)	223	77.3	3728.1	949.4	666.2	443800.3
DistHosp (m)	223	23.0	3915.5	864.3	573.1	328477.9
DistSchool (m)	223	42.1	3518.2	1136.9	510.4	260545.8
DistBRT (m)	223	81.5	849.3	552.8	224.2	50269.9
DistCBD (m)	223	716.6	5112.3	3166.3	918.2	843171.7
DistSea (m)	223	2543.6	6544.3	4555.6	1218.7	1485280.3
Valid N	223					

The results of the large-sized real estates in the primary catchment area of the BRT line are presented in Table 4.65. MGWR has the best scores in AIC and RSS, hence it is the most successful analysis technique in prediction of the estimates of the model within this analysis. According to the results the coefficient of the explanatory variable “DistBRT” is “0.767”, which indicated that the prices of the large-sized real estates in the primary catchment area is negatively affected by the proximity to the BRT line.

Table 4.65. The analysis results of the large-sized real estates in the primary catchment area (0 - 850m) of the BRT line.

Large-sized Real Estates in the Primary Catchment Area (0 - 850m) of the BRT line													
	OLS		**SAR**		**GWR**			**MGWR**					
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**	
Constant	4716.0	0.0	3983.5	0.0	3948.9	5926.1	6611.6	5420.3	5479.7	5508.5	222.0	0.0	
Area (m^2)	-3.9	0.1	-3.9	0.1	-6.3	-4.9	-2.7	-4.9	-4.7	-4.5	222.0	0.0	
Age	8.1	0.5	10.1	0.4	-0.1	9.2	19.9	-211.2	8.6	85.6	53.0	0.0	
Floor	32.1	0.0	25.2	0.1	13.4	15.0	53.3	4.6	9.6	31.9	202.0	0.0	
Facility	712.9	0.0	683.3	0.0	449.1	482.5	868.6	439.5	473.2	493.7	222.0	0.0	
CreditVia	296.3	0.1	231.9	0.2	-139.0	497.8	801.7	-1065.2	631.5	1412.6	24.0	0.0	
DistShop (m)	0.157	0.385	0.135	0.441	0.133	0.156	0.183	-0.674	-0.65	-0.62	222.0	0.0	
DistHosp (m)	0.369	0.125	0.242	0.299	0.057	0.175	0.629	-1,056	-1,014	-0.973	221.0	0.0	
DistSchool (m)	-0.83	0.000	-0.589	0.013	-1,174	-0.653	-0.562	-0.197	-0.172	-0.147	222.0	0.0	
DistBRT (m)	-0.821	0.008	-0.554	0.089	-0.798	-0.631	-0.387	0.634	0.767	0.827	192.0	0.0	
DistCBD (m)	-0.198	0.105	-0.153	0.019	-0.269	-0.189	-0.17	0.271	0.301	0.311	222.0	0.0	
DistSea (m)	-0.204	0.016	-0.148	0.072	-0.321	-0.309	-0.225	-0.431	-0.42	-0.415	219.0	0.0	
$\mathbf{R^2}$	0.426		0.436		0.684								
RSS	147,094,553		209,013,965		132,590,934			112,259,402					
AIC	3646.00		3644.00		3635.00			3634.00					
			Rho: 0.198										
			p-value: 0.042		Bandwidth=221.0								
			Morans' I: 0.375		Adj. Alpha(95%)= 0.034 < 0.05								

Then, the same size group in the secondary catchment area is analyzed. Descriptive statistics of the large-sized real estates in the secondary catchment area (850m - 1900m) is presented in Table 4.66.

Table 4.66. Descriptive statistics of the large-sized real estates in the secondary catchment area (850m - 1900m) of the BRT line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	301	550.0	27586.2	2612.6	1804.7	3257058.9
Area (m^2)	301	112.0	360.0	150.0	37.3	1393.0
Age	301	0.0	24.0	7.2	6.4	40.4
Floor	301	0.0	29.0	4.9	5.1	25.8
Facility	301	0.0	1.0	1.3	0.5	0.2
CreditVia	301	0.0	1.0	1.4	0.5	0.2
DistShop (m)	301	34.3	2662.2	894.2	419.7	176182.2
DistHosp (m)	301	1.6	3905.0	846.2	737.2	543508.8
DistSchool (m)	301	8.2	2208.7	723.7	385.5	148646.2
DistCBD (m)	301	49.9	7081.5	3886.4	1010.2	1020417.1
DistSea (m)	301	2125.1	6804.9	4501.4	1504.1	2262276.5
DistBRT (m)	301	851.5	1801.2	1224.7	271.7	73840.9
Valid N	301					

The results of the large-sized real estates in the secondary catchment area (850m - 1900m) are presented in Table 4.67. Based on the RSS and AIC values, GWR has the best performance in prediction. According to the results, the coefficient of the BRT distance is positive (0.338). Hence, the prices of the large-sized real estates in the secondary catchment area are also affected negatively by proximity to the BRT line.

Table 4.67. Analysis results of large-sized real estates in the secondary catchment area (850m - 1900m) of the BRT line.

Large-sized Real Estates in the Secondary Catchment Area (850m - 1900m) of the BRT line													
	OLS		SAR		GWR			MGWR					
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**	
Constant	6372.7	0.000	5885.4	0.000	2465.4	7530.9	12256.6	7916.4	8051.4	8100.2	299.0	0.045	
Area (m^2)	-4.1	0.136	-4.5	0.092	-13.7	-6.3	-3.0	-8.1	-7.4	-7.0	299.0	0.042	
Age	-7.1	0.756	-9.7	0.664	-47.3	-8.7	57.6	-29.9	-23.8	-21.7	299.0	0.035	
Floor	-6.1	0.794	-6.4	0.779	-149.3	-20.4	28.3	-22.5	-2.9	1.5	259.0	0.036	
Facility	650.1	0.007	588.8	0.013	-595.9	1128.6	1507.5	522.3	583.2	641.2	299.0	0.044	
CreditVia	-483.3	0.092	-451.8	0.106	-501.9	-252.0	223.3	-577.8	-476.5	-434.1	299.0	0.040	
DistShop (m)	-0.668	0.041	-0.619	0.055	-2,028	0.153	0.677	-0.664	-0.458	-0.322	285.0	0.038	
DistHosp (m)	0.594	0.006	0.528	0.015	-1,078	0.158	1,668	0.432	0.465	0.478	299.0	0.039	
DistSchool (m)	-0.358	0.238	-0.334	0.261	-1,095	-0.165	0.483	-0.140	-0.028	0.098	299.0	0.040	
DistBRT (m)	1,524	0.000	1,378	0.001	-0.178	0.338	3,781	1,142	1,222	1,283	299.0	0.043	
DistCBD (m)	-0.660	0.000	-0.584	0.000	-0.952	-0.324	0.186	-0.714	-0.660	-0.645	299.0	0.040	
DistSea (m)	-0.495	0.000	-0.440	0.000	-1,652	-0.633	-0.079	-0.659	-0.648	-0.644	299.0	0.048	
R^2	0.185		0.190		0.353								
RSS	796,775,359		795,213,569		632,025,526			737,365,984					
AIC	5329.68		5329.50		5299.47			5314.03					
			Rho: 0.149										
			p-val: 0.143		Bandwidth=200.0								
			Morans' I: 0.179		Adj. Alpha(95%)= 0.020 < 0.05								

Secondly, the medium-sized real estates are analyzed by using all analysis techniques. Descriptive statistics of the medium-sized real estates in the primary catchment area is presented in Table 4.68.

Table 4.68. Descriptive statistics of the medium-sized real estates in the primary catchment area (0 - 850m) of the BRT line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	212	180.0	21000.0	2393.0	1603.2	2570332.9
Area (m^2)	212	80.0	110.0	97.8	9.4	88.6
Age	212	0.0	24.0	4.0	5.4	29.5
Floor	212	0.0	13.0	2.9	2.6	6.5
Facility	212	0.0	1.0	1.2	0.4	0.2
CreditVia	212	0.0	1.0	1.6	0.5	0.2
DistShop (m)	212	68.1	3762.4	910.3	672.5	452209.0
DistHosp (m)	212	70.4	2421.8	845.6	555.6	308725.4
DistSchool (m)	212	96.4	2673.3	1129.9	474.7	225357.3
DistBRT (m)	212	100.2	848.7	550.5	219.9	48337.4
DistCBD (m)	212	633.0	4598.4	3031.6	861.7	742445.1
DistSea (m)	212	2547.0	6541.6	4792.8	1217.7	1482896.2
Valid N	212					

The results of the medium-sized real estates in the primary catchment area of the BRT line are presented in Table 4.69. Based on the AIC and RSS values, GWR is the most successful technique in prediction. The coefficient of the BRT distance is negative (-0.266) which indicates that the closer the medium-sized real estates to the BRT line, the higher the prices are.

Table 4.69. Analysis results of the medium-sized real estates in the primary catchment area (0 - 850m) of the BRT line.

Medium-sized Real Estates in the Primary Catchment Area (0 - 850m) of the BRT line													
	OLS		**SAR**		**GWR**			**MGWR**					
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**
Constant	5784.2	0.000	6636.9	0.000	-39351.2	7765.7	86502.3	4364.7	6678.8	46026.6	35.0	0.011
Area (m^2)	3.6	0.737	3.8	0.721	-31.3	-3.4	140.0	-31.2	-31.2	-30.8	211.0	0.049
Age	3.3	0.912	3.6	0.898	-120.3	-17.6	3500.3	-230.2	-48.6	1769.0	33.0	0.005
Floor	19.8	0.635	21.0	0.605	-181.6	100.5	308.1	27.6	33.3	59.7	211.0	0.037
Facility	1253.8	0.000	1268.5	0.000	-506.7	684.8	4037.2	652.7	851.8	881.5	144.0	0.038
CreditVia	871.4	0.003	868.9	0.002	-5890.5	641.8	8007.3	-733.7	1237.8	2038.0	56.0	0.015
DistShop (m)	-0.246	0.380	-0.243	0.372	-11,848	-0.243	9,179	-0.789	-0.786	-0.784	211.0	0.049
DistHosp (m)	-0.308	0.427	-0.274	0.470	-8,743	-0.388	5,304	-1,259	-0.171	0.223	78.0	0.019
DistSchool (m)	0.405	0.374	0.328	0.467	-6,141	-0.303	5,003	0.308	0.310	0.315	211.0	0.049
DistBRT (m)	-0.134	0.791	-0.208	0.677	-15,032	-0.266	5,874	0.579	0.619	0.631	211.0	0.049
DistCBD (m)	-0.736	0.000	-0.780	0.000	-14,693	-1,010	2,455	-0.021	-0.015	-0.013	211.0	0.049
DistSea (m)	-0.333	0.017	-0.347	0.012	-11,076	-0.085	8,950	-6,749	-0.124	0.592	33.0	0.005
R^2	0.272		0.271		0.876							
RSS	394,672,549		406,218,456		67,086,757			113,339,705				
AIC	3686.27		3689.80		3433.76			3474.29				
			Rho: 0.08									
			p-value: 0.48		Bandwidth=50.0							
			Morans' I: 0.09		Adj. Alpha(95%)= 0.008 < 0.05							

Then, the medium-sized real estates in the secondary catchment area are analyzed. Descriptive statistics of the medium-sized real estates in the secondary catchment area (850m - 1900m) is presented in Table 4.70.

Table 4.70. Descriptive statistics of the medium-sized real estates in the secondary catchment area (850m - 1900m) of the BRT line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m2)	266	772.7	5652.2	2228.1	702.9	494077.8
Area (m2)	266	81.0	110.0	99.9	8.5	72.5
Age	266	0.0	26.0	4.1	4.2	18.0
Floor	266	0.0	30.0	3.1	5.4	29.6
Facility	266	0.0	1.0	1.2	0.4	0.2
CreditVia	266	0.0	1.0	1.5	0.5	0.3
DistShop (m)	266	13.4	2996.2	842.1	496.0	245995.4
DistHosp (m)	266	28.0	3633.4	781.6	745.0	554970.6
DistSchool (m)	266	8.2	2232.2	828.0	426.7	182079.2
DistCBD (m)	266	113.1	6877.3	3735.4	1002.2	1004317.7
DistSea (m)	266	2245.5	6780.8	4990.5	1617.0	2614611.8
DistBRT (m)	266	852.3	1803.4	1203.5	261.6	68421.2
Valid N	266					

The results of the medium-sized real estates in secondary catchment area (850m - 1900m) of the BRT line are presented in Table 4.71. Based on the RSS and AIC values, MGWR is the most successful technique in prediction. The coefficient of the BRT distance variable is positive (0.224) which means the prices of the medium-sized real estates subject to decrease as the distance from the BRT line decreases.

Table 4.71. Analysis results of the medium-sized real estates in the secondary catchment area (850m - 1900m) of the BRT line.

Medium-sized Real Estates in the Secondary Catchment Area (850m - 1900m) of the BRT line												
	OLS		**SAR**		**GWR**			**MGWR**				
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**
Constant	3590.1	0.000	3552.9	0.000	-2469.6	1830.3	8648.2	-2855.1	-2852.4	-2823.4	265.0	0.050
Area (m2)	-14.3	0.002	-14.5	0.001	-32.7	-15.4	8.1	-16.9	-16.9	-16.6	265.0	0.049
Age	10.0	0.432	10.0	0.412	-10.5	11.6	61.6	31.0	31.9	36.0	265.0	0.040
Floor	9.1	0.261	9.1	0.249	-8.9	33.1	70.2	-0.3	13.3	122.5	90.0	0.008
Facility	673.2	0.000	637.5	0.000	-775.8	351.7	948.7	543.3	552.8	660.3	170.0	0.036
CreditVia	-139.0	0.192	-120.8	0.239	-584.5	-15.9	780.9	73.5	140.4	150.4	229.0	0.039
DistShop (m)	-0.227	0.150	-0.208	0.171	-2,250	0.152	1,860	0.005	0.123	0.405	150.0	0.023
DistHosp (m)	0.134	0.255	0.087	0.449	-1,351	0.315	1,214	0.748	0.750	0.764	265.0	0.047
DistSchool (m)	-0.051	0.654	-0.045	0.688	-0.537	-0.141	1,960	0.596	0.714	1,494	137.0	0.023
DistBRT (m)	0.849	0.000	0.652	0.001	-1,357	0.403	1,993	0.221	0.224	0.252	265.0	0.049
DistCBD (m)	-0.211	0.013	-0.150	0.073	-0.417	0.098	0.712	-0.030	-0.004	0.076	150.0	0.033
DistSea (m)	-0.143	0.009	-0.119	0.026	-0.803	0.170	0.556	0.370	0.741	1,786	29.0	0.002
$\mathbf{R^2}$	0.337		0.351		0.606							
RSS	86,813,450		84,235,687		51,625,306			51,612,270				
AIC	4155.95		4154.20		4090.77			4078.42				
			Rho: 0.225									
			p-value: 0.734		Bandwidth=140.0							
			Morans' I: 0.246		Adj. Alpha(95%)= 0.008 < 0.05							

The last size group is the small-sized real estates in the catchment areas of the BRT line. Descriptive statistics of the small-sized real estates in the primary catchment area is presented in Table 4.72.

Table 4.72. Descriptive statistics of the small-sized real estates in the primary catchment area (0 - 850m) of the BRT line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	54	1186.7	7400.0	3075.8	1192.7	1422623.3
Area (m^2)	54	40.0	77.0	64.5	10.5	109.7
Age	54	0.0	19.0	4.2	4.3	18.6
Floor	54	0.0	35.0	4.1	6.0	36.0
Facility	54	0.0	1.0	1.5	0.5	0.3
CreditVia	54	0.0	1.0	1.5	0.5	0.3
DistShopping (m)	54	173.5	2258.0	854.4	449.3	201860.0
DistHospital (m)	54	218.0	2159.1	907.3	462.8	214183.0
DistSchool (m)	54	168.0	2431.5	1068.7	434.5	188757.7
DistBRT (m)	54	117.8	846.6	491.2	226.3	51230.1
DistCBD (m)	54	1316.0	4362.5	3230.7	737.0	543191.7
DistSea (m)	54	2760.6	6546.2	4636.9	1113.1	1239088.2
Valid N	54					

The results of the small-sized real estates in the primary catchment area (0 - 850m) of the BRT line are presented in Table 4.73. MGWR has the best scores in AIC and RSS values. Hence, it has the best performance in prediction. The coefficient of the BRT distance parameter is negative (-0.937), which indicates that the prices of the small-sized real estates have a premium due to the proximity to the BRT line.

Table 4.73. Analysis results of the small-sized real estates in the primary catchment area (0 - 850m) of the BRT line.

Small-sized Real Estates in the Primary Catchment Area (0 - 850m) of the BRT line												
	OLS		**SAR**		**GWR**			**MGWR**				
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**
Constant	9002.4	0.000	10655.5	0.000	8353.7	9791.1	10238.1	10064.1	10159.5	10174.8	53.0	0.047
Area (m^2)	5.1	0.099	4.4	0.742	-15.7	6.4	11.1	6.5	7.6	8.2	53.0	0.046
Age	15.1	0.518	16.9	0.665	-21.5	21.1	45.4	7.3	25.6	31.9	53.0	0.039
Floor	4.0	0.047	5.4	0.814	-6.6	-1.2	15.6	-12.2	29.1	37.3	46.0	0.026
Facility	818.7	0.000	830.5	0.003	872.6	1047.5	1355.2	1019.7	1080.9	1189.4	46.0	0.040
CreditVia	830.7	0.109	797.5	0.014	-1023.1	-924.5	541.3	-888.5	893.2	943.6	53.0	0.042
DistShop (m)	0.198	0.385	0.318	0.455	-0.579	-0.064	0.807	-1,035	-0.145	0.433	37.0	0.031
DistHosp (m)	0.295	0.125	0.438	0.285	0.032	0.571	1,072	0.320	0.525	0.596	53.0	0.042
DistSchool (m)	-0.537	0.000	-0.724	0.009	-1,236	-0.568	-0.481	-1,273	-1,185	-1,149	53.0	0.044
DistBRT (m)	-0.346	0.008	-0.377	0.005	-0.435	-0.359	-0.265	-1,034	-0.937	-0.886	53.0	0.043
DistCBD (m)	-1,042	0.105	-1,213	0.000	-1,269	-1,208	-1,148	-0.959	-0.896	-0.882	53.0	0.042
DistSea (m)	-0.584	0.016	-0.688	0.004	-0.729	-0.616	-0.361	-0.754	-0.744	-0.743	53.0	0.048
$\mathbf{R^2}$	0.426		0.499		0.590							
RSS	38,309,442		209,013,965		32,906,463			31,819,010				
AIC	906.80		907.90		907.00			903.00				
			Rho: 0.212									
			p-value: 0.385		Bandwidth=53.0							
			Morans' I: 0.196		Adj. Alpha(95%)= 0.033 < 0.05							

Then, the small-sized group of real estates in the secondary catchment area of the BRT line is analyzed. Descriptive statistics of the small-sized real estates in the secondary catchment area (850m - 1900m) are presented in Table 4.74.

Table 4.74. Descriptive statistics of the small size group in the secondary catchment area (850m - 1900m) of the BRT line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m2)	93	1026.7	8000.0	2770.8	984.6	969397.3
Area (m2)	93	45.0	78.0	65.4	9.0	80.8
Age	93	0.0	21.0	5.2	4.0	16.3
Floor	93	0.0	30.0	8.0	7.1	60.7
Facility	93	0.0	1.0	1.6	0.5	0.2
CreditVia	93	0.0	1.0	1.3	0.5	0.2
DistShop (m)	93	167.0	2547.3	1188.3	415.7	172778.4
DistHosp (m)	93	32.5	3699.2	1152.3	768.5	590553.3
DistSchool (m)	93	63.3	2119.8	1063.2	497.4	247381.6
DistCBD (m)	93	32.5	6851.8	3589.9	1073.1	1151480.9
DistSea (m)	93	2365.2	6978.7	5196.1	1228.8	1509923.6
DistBRT (m)	93	851.0	1797.2	1262.4	248.0	61508.1
Valid N	93					

The analysis results of the small-sized real estates in the secondary catchment area (850m - 1900m) of the BRT line are presented in Table 4.75. Based on the AIC and RSS values, best performance in prediction belongs to the GWR analysis. The coefficient of the explanatory variable “DistBRT” is positive (0.320) which indicates that the prices of the small-sized real estates in the secondary catchment area are subject to decrease as the distance from the BRT line decreases.

Table 4.75. Analysis results of the small-sized real estates in the secondary catchment area (850m - 1900m) of the BRT line.

Small-sized Real Estates in the Secondary Catchment Area (850m - 1900m) of the BRT line												
	OLS		**SAR**		**GWR**			**MGWR**				
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**
Constant	3929.5	0.016	3670.6	0.008	3678.4	4102.3	7363.2	3062.8	3070.7	3121.8	92.0	0.047
Area (m^2)	-22.7	0.073	-21.5	0.063	-29.8	-27.2	-21.1	-25.9	-25.8	-24.9	92.0	0.047
Age	-3.8	0.915	3.3	0.918	-1.2	27.3	34.2	21.6	22.6	27.9	92.0	0.039
Floor	-5.1	0.764	-2.2	0.885	-4.3	0.6	1.4	-3.2	-2.1	-0.3	92.0	0.046
Facility	359.7	0.246	352.6	0.212	117.9	362.1	539.4	227.5	240.4	277.8	92.0	0.047
CreditVia	226.1	0.476	238.9	0.408	206.4	559.0	657.5	546.5	556.7	574.2	92.0	0.046
DistShop (m)	0.157	0.737	0.107	0.803	-0.337	-0.232	-0.043	0.112	0.135	0.408	79.0	0.035
DistHosp (m)	0.289	0.193	0.212	0.297	-0.511	0.799	1,193	0.163	0.357	0.369	81.0	0.030
DistSchool (m)	-0.351	0.245	-0.352	0.202	-1,237	-0.671	-0.204	-0.373	-0.289	0.093	68.0	0.032
DistBRT (m)	0.255	0.612	0.317	0.489	0.150	0.320	0.827	0.337	0.347	0.400	92.0	0.047
DistCBD (m)	-0.119	0.382	-0.110	0.373	-0.179	-0.100	0.449	-0.085	-0.083	-0.067	92.0	0.046
DistSea (m)	-0.106	0.390	-0.119	0.287	-0.951	-0.108	-0.075	-0.054	-0.053	-0.048	92.0	0.048
R^2	0.161		0.193		0.336							
RSS	74,793,080		72,652,349		59,248,078			63,512,273				
AIC	1552.50		1551.00		1544.74			1546.15				
			Rho: 0.308									
			p-val: 0.06		Bandwidth=91.0							
			Morans' I: 0.165		Adj. Alpha(95%)= 0.033 < 0.05							

4.4.3. Results for the Metro Zone Analysis

The established model is:

$$y = \alpha + \beta_1 (size) + \beta_2 (age) + \beta_3 (creditvia) + \beta_4 (floorlev) + \beta_5 (facility) + \beta_6 (rooms) + \beta_7 (distHosp) + \beta_8 (distMall) + \beta_9 (distMetro) + \beta_{10} (distSchool) + \beta_{11} (distCBD) + \beta_{12} (distSea) \tag{4.2}$$

where y is the average price (TL/m^2), α is the constant value, β_i (i = 1, 2, 3...n) is the coefficient of each explanatory variable in the model. “size” is the size in m2, “age” is the age in terms of years, “creditvia” is the credit viability condition, “floorlev” is the floor level, “facility” is the term for the existence of parking and other facilities, “rooms” is the number of the rooms of the real estate. “distHosp” is the distance from closest hospital, “distMall” is the distance from closest shopping mall, “distMetro” is the distance from closest Metro station, “distSchool” is the distance from closest school, “distCBD” is the distance from closest central business district and “distSea” is the distance from the closest seaside point. The analyses are at first performed for primary and secondary catchment areas of the Metro line. Descriptive statistics of the primary catchment area of the Metro line is presented in Table 4.76.

Table 4.76. Descriptive statistics of the primary catchment area (0-850m) of the Metro line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	231	912.4	9466.7	3123.7	1611.5	2596946.8
Area (m^2)	231	45.0	240.0	110.7	31.4	985.1
Age	231	0.0	19.0	5.3	3.9	15.1
Floor	231	0.0	29.0	6.4	6.0	36.3
Facility	231	0.0	1.0	1.5	0.5	0.3
CreditVia	231	0.0	1.0	1.4	0.5	0.2
DistShop (m)	231	8.5	1425.1	659.2	314.5	98918.7
DistHosp (m)	231	128.0	3687.8	1759.4	1109.4	1230784.0
DistSchool (m)	231	353.8	3105.4	1518.3	876.0	767304.1
DistCBD (m)	231	96.3	3045.8	1634.5	808.3	653395.6
DistSea (m)	231	3784.4	7137.3	5404.0	948.6	899898.9
DistMetro (m)	231	9.0	840.3	567.0	209.5	43897.2
Valid N	231					

The results for the primary catchment area (0 - 850 m) of the Metro line are presented in Table 4.7. Based on the RSS and AIC values, the best performance at prediction belongs to the GWR analysis. The coefficient of the “DistMetro” variable is negative (-0.301), which indicates that the proximity to the Metro line contributes to the prices of the real estates in the primary catchment area.

Table 4.77. Analysis results of the primary catchment area (0 - 850 m) of the Metro line.

Primary Catchment Area (0-850m) of the Metro line												
	OLS		**SAR**		**GWR**			**MGWR**				
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**
Constant	10.6	0.991	287.2	0.748	-176.3	2146.1	3604.6	1393.7	1429.4	1441.8	230.0	0.049
Area (m^2)	-4.9	0.006	-4.6	0.007	-7.2	-4.7	-3.5	-5.4	-5.3	-5.2	230.0	0.044
Age	-77.0	0.000	-72.0	0.000	-129.4	-45.4	-28.1	-84.8	-65.2	-58.2	210.0	0.033
Floor	10.0	0.353	7.5	0.471	-13.6	23.1	33.8	-3.5	12.1	13.2	229.0	0.030
Facility	313.1	0.029	296.9	0.032	192.2	342.9	461.0	235.6	266.4	278.2	230.0	0.046
CreditVia	160.9	0.346	160.7	0.329	-37.3	12.9	337.5	-124.3	138.7	155.4	230.0	0.044
DistShop (m)	-1,355	0.000	-1,062	0.000	-1,664	-0.855	0.107	-1,477	-1,443	-1,417	230.0	0.044
DistHosp (m)	0.308	0.074	0.258	0.121	-0.257	0.173	0.512	0.312	0.334	0.344	230.0	0.048
DistSchool (m)	0.499	0.184	0.424	0.247	0.123	0.373	0.925	0.486	0.549	0.572	230.0	0.046
DistCBD (m)	-0.180	0.629	-0.181	0.613	-0.546	-0.049	0.511	0.278	0.324	0.341	230.0	0.047
DistSea (m)	0.700	0.003	0.057	0.014	-0.061	0.156	0.643	0.283	0.289	0.292	230.0	0.049
DistMetro (m)	-0.274	0.366	0.269	0.356	-0.554	-0.301	0.092	-0.226	-0.130	-0.080	230.0	0.044
$\mathbf{R^2}$	0.761		0.765		0.785							
RSS	142,529,953		140,963,161		128,661,477			140,470,203				
AIC	3761.11		3759.39		3756.59			3762.18				
			Rho: 0.178									
			p-value: 0.05		Bandwidth=188.0							
			Moran's I: 0.788		Adj. Alpha(95%)= 0.028 < 0.05							

Then, the real estates in the secondary catchment area of the Metro line is analyzed. Descriptive statistics of the secondary catchment area (850m - 1900m) of the Metro line is presented in Table 4.78.

Table 4.78. Descriptive statistics of the secondary catchment area (850m - 1900m) of the Metro line.

Descriptive Statistics						
	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Price (TL/m^2)	449	925.0	9558.8	2374.7	987.1	974435.9
Area (m^2)	449	45.0	285.0	113.1	32.1	1028.4
Age	449	0.0	24.0	5.1	5.1	26.4
Floor	449	0.0	32.0	4.3	4.6	21.3
Facility	449	0.0	1.0	1.2	0.4	0.2
CreditVia	449	0.0	1.0	1.4	0.5	0.2
DistShop (m)	449	134.0	2204.4	1031.6	470.1	220989.9
DistHosp (m)	449	144.1	4623.0	1620.5	1226.7	1504910.9
DistSchool (m)	449	64.5	4042.6	1334.5	1045.2	1092509.0
DistCBD (m)	449	53.8	3945.3	2178.5	755.2	570354.4
DistSea (m)	449	2936.7	7431.2	5297.7	1052.5	1107850.9
DistMetro (m)	449	855.1	1892.9	1399.1	277.5	77023.4
Valid N	449					

The analysis results of the secondary catchment area (850m - 1900m) of the Metro line are presented in Table 4.79. Based on the RSS and AIC values, the best performance belongs to the MGWR analysis. The coefficient of the Metro line distance parameter is negative (-0.317) which means that the prices of the real estates tend to decrease as the distance from the Metro line increases.

Table 4.79. The analysis results of the secondary catchment area (850m - 1900m) of the Metro line.

Secondary Catchment Area (850m - 1900m) of the Metro Line													
	OLS		**SAR**		**GWR**			**MGWR**					
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**	
Constant	2047.3	0.000	1706.0	0.000	-176.3	2146.1	3604.5	1120.0	3514.2	6729.3	33.0	0.002	
Area (m^2)	0.3	0.821	0.5	0.663	-7.2	-4.7	-3.5	-4.3	-3.5	2.0	159.0	0.021	
Age	-4.4	0.680	-4.9	0.628	-129.4	-45.4	-28.1	-92.2	4.3	286.1	28.0	0.002	
Floor	24.1	0.005	16.1	0.038	-13.6	23.1	33.8	-9.9	17.5	68.6	201.0	0.014	
Facility	399.4	0.000	392.4	0.000	192.2	342.9	461.0	470.2	481.1	520.1	447.0	0.045	
CreditVia	298.6	0.003	320.5	0.000	-37.3	12.9	337.5	345.8	372.0	450.2	361.0	0.042	
DistShop (m)	-0.481	0.000	-0.276	0.029	-1,664	-0.855	0.107	-0.490	-0.473	-0.462	447.0	0.047	
DistHosp (m)	0.289	0.000	0.171	0.012	-0.257	0.173	0.512	-0.138	-0.132	-0.124	447.0	0.048	
DistSchool (m)	0.202	0.038	0.118	0.199	0.123	0.373	0.925	0.175	0.183	0.196	447.0	0.048	
DistCBD (m)	0.277	0.004	0.183	0.047	-0.546	-0.049	0.511	0.527	0.533	0.540	447.0	0.049	
DistSea (m)	-0.156	0.000	-0.113	0.003	-0.061	0.156	0.643	-0.463	-0.461	-0.458	447.0	0.050	
DistMetro (m)	-0.515	0.002	-0.325	0.040	-0.554	-0.301	0.092	-0.331	-0.317	-0.306	447.0	0.049	
R^2	0.453		0.490		0.624								
RSS	238,838,750		207,913,951		163,964,132			140,470,203					
AIC	7220.00		7190.6		7103.00			7059.00					
			Rho: 0.336										
			p-value: 0.00		Bandwidth=251.0								
			Moran's I: 0.515		Adj. Alpha(95%)= 0.028 < 0.05								

Then, the dataset is divided into subgroups based on the income levels of the neighborhood and the analysis techniques are applied. The criterion for dividing the dataset into income level groups is based the socio economic condition of the neighborhood TUIK (2019). Since the socioeconomic conditions of the neighborhood in the vicinity of the Metro line is not very heterogeneous, the dataset is divided into 2 subgroups, namely the upper-middle and lower-middle income groups. Descriptive statistics of upper-middle income group primary catchment area of the Metro line are presented in Table 4.80.

Table 4.80. Descriptive statistics of the upper-middle income group in the primary catchment area (0 - 850m) of the Metro line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	110	1426.0	9466.7	3882.4	1978.6	3914719.5
Area (m^2)	110	48.0	210.0	115.0	32.1	1027.2
Age	110	0.0	9.0	5.2	3.0	9.0
Floor	110	0.0	22.0	5.1	5.0	24.6
Facility	110	0.0	1.0	1.6	0.5	0.2
CreditVia	110	0.0	1.0	1.3	0.5	0.2
DistShop (m)	110	8.5	1329.6	722.7	304.3	92611.0
DistHosp (m)	110	934.7	3687.8	2494.0	1004.7	1009389.2
DistSchool (m)	110	353.8	3105.4	1905.9	1008.5	1017055.5
DistCBD (m)	110	465.3	3045.8	2006.9	841.6	708332.8
DistSea (m)	110	4567.7	7137.3	6078.3	861.4	741963.6
DistMetro (m)	110	9.0	838.5	528.9	245.5	60249.5
Valid N	110					

The analysis results of the upper-middle income group in the primary catchment area (0 - 850m) of the Metro line are presented in Table 4.81. Based on the RSS and AIC values, GWR is the most successful technique at prediction. The coefficient of the Metro distance variable is negative (-0.011) which means that the prices are positively affected by the proximity to the Metro line.

Table 4.81. Analysis results of the upper-middle income neighborhood in the primary catchment area (0 - 850m) of the Metro line.

Upper-middle Income Neighborhood in the Primary Catchment Area (0 - 850m) of the Metro Line												
	OLS		**SAR**		**GWR**			**MGWR**				
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**
					-148836.0							
Constant	-47675.6	0.531	-48325.0	0.501	148836.0	-69555.0	-21696.6	-70540.6	-70520.3	-31043.3	64.0	0.002
Area (m^2)	-5.3	0.106	-5.5	0.078	-8.8	-5.9	-4.3	-8.8	-8.5	-7.8	109.0	0.050
Age	-139.0	0.028	-140.9	0.018	-240.0	-216.8	-35.9	-398.8	-392.6	-150.6	73.0	0.036
Floor	-15.0	0.519	-15.3	0.485	-31.3	-26.8	3.9	-92.9	-91.6	-76.2	109.0	0.044
Facility	405.4	0.219	406.8	0.191	318.5	558.0	632.7	-4938.0	-4914.2	617.1	68.0	0.036
CreditVia	-405.8	0.312	-406.7	0.284	-681.9	-582.5	-35.6	-2031.5	-2021.3	-1366.3	77.0	0.045
DistShop (m)	-0.924	0.101	-1,005	0.079	-1,416	-1,269	-1,129	-0.381	-0.354	-0.205	109.0	0.054
DistHosp (m)	-14,089	0.025	-14,526	0.017	-17,161	-16,807	-7,001	-17,264	-17,258	-12,697	68.0	0.131
DistSchool (m)	14,112	0.019	14,572	0.012	7,169	16,488	16,750	15,612	15,615	15,633	109.0	0.050
DistCBD (m)	-13,387	0.475	-13,590	0.442	-39,749	-19,384	-6,250	-26,128	-11,397	-6,131	19.0	0.002
DistSea (m)	14,616	0.440	14,873	0.405	7,453	20,747	40,385	9,973	21,008	25,939	19.0	0.011
DistMetro (m)	-0.391	0.455	-0.394	0.426	-0.390	-0.011	0.226	-0.578	4,456	9,015	38.0	0.009
R^2	0.756		0.757		0.779							
RSS	104,079,118		98,115,689		94,506,408			127,649,751				
AIC	1855.57		1853.70		1852.36			1902.51				
			Rho: 0.05									
			p-value: 0.112		Bandwidth=109.0							
			Moran's' I: 0.754		Adj. Alpha(95%)= 0.034 < 0.05							

Descriptive statistics of upper-middle income group in the secondary catchment area (850m - 1900m) of the Metro line are presented in Table 4.82.

Table 4.82. Descriptive statistics of the upper-middle income group in the secondary catchment area (850m - 1900m) of the Metro line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	80	1210.5	9558.8	3440.4	1578.7	2492353.3
Area (m^2)	80	45.0	285.0	117.4	37.3	1391.1
Age	80	0.0	24.0	6.6	6.2	38.8
Floor	80	0.0	32.0	5.9	6.9	48.1
Facility	80	0.0	1.0	1.5	0.5	0.3
CreditVia	80	0.0	1.0	1.5	0.5	0.3
DistShop (m)	80	614.0	2204.4	1464.8	414.2	171598.5
DistHosp (m)	80	718.2	4623.0	3097.0	1227.4	1506484.4
DistSchool (m)	80	444.9	4042.6	2640.7	1050.4	1103286.8
DistCBD (m)	80	198.4	3945.3	2739.5	844.5	713258.2
DistSea (m)	80	4059.3	7431.2	5914.1	824.6	679962.0
DistMetro (m)	80	855.1	1827.3	1227.1	292.0	85265.1
Valid N	80					

The analysis results of the upper-middle income group in the secondary catchment area (850m - 1900m) of the Metro line are presented in TTable 4.83. Based on the RSS and AIC values, GWR is the most successful technique at prediction. The coefficient of the Metro distance variable is negative (-1.656) which means that the prices are positively affected by the proximity to the Metro line.

Table 4.83. The analysis results of the upper-middle income group in the secondary catchment area (850m - 1900m) of the Metro line.

Upper-middle income group in the secondary catchment area (850m - 1900m) of the Metro line													
	OLS		**SAR**		**GWR**			**MGWR**					
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**
Constant	-120.7	0.954	-448.1	0.800	-5987.9	-335.2	852.1	-10585.1	-10562.8	-10420.5	79.0	0.049
Area (m^2)	14.6	0.000	15.6	0.000	9.4	14.6	22.1	22.5	22.9	23.9	79.0	0.044
Age	12.1	0.720	16.1	0.597	-15.0	-4.9	33.2	-20.4	-19.0	39.7	69.0	0.040
Floor	60.6	0.008	45.6	0.024	44.2	49.3	68.2	-6.4	-2.7	4.5	79.0	0.047
Facility	926.6	0.006	965.5	0.001	702.2	1137.4	1378.6	830.3	843.6	949.7	79.0	0.045
CreditVia	351.5	0.432	323.5	0.414	-123.1	308.5	604.6	294.4	311.7	330.8	79.0	0.044
DistShop (m)	-0.875	0.320	-0.623	0.423	-0.835	0.005	0.640	-2,308	-2,276	-2,227	79.0	0.049
DistHosp (m)	0.056	0.892	-0.087	0.809	-0.738	0.768	1,291	0.921	0.933	0.938	79.0	0.050
DistSchool (m)	0.936	0.239	0.575	0.429	0.375	0.903	2,416	0.572	0.589	0.611	79.0	0.049
DistCBD (m)	-0.854	0.293	-0.520	0.480	-2,205	-1,429	-1,197	-1,631	-1,615	-1,588	79.0	0.050
DistSea (m)	0.087	0.818	0.109	0.746	-0.114	0.120	0.962	0.605	0.608	0.626	79.0	0.049
DistMetro (m)	-0.034	0.969	0.321	0.678	-2,110	-1,656	2,206	5,294	7,958	10,150	12.0	0.004
R^2	0.556		0.582		0.667							
RSS	87,403,042		84,254,962		65,485,599			72,581,772				
AIC	1363.35		1362.40		1352.00			1362.96				
			Rho: 0.326									
			p-value: 0.02		Bandwidth=79.0							
			Moran's' I: 0.401		Adj. Alpha(95%)= 0.035 < 0.05							

The second income group is lower-middle income group in the catchment areas of the Metro line. Descriptive statistics of the lower-middle income group in the primary catchment area (0 - 850m) of the Metro line is presented in Table 4.84.

Table 4.84. Descriptive statistics of the lower-middle income group in the primary catchment area (0 - 850m) of the Metro line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	121	912.4	4117.7	2434.0	643.7	414398.9
Area (m^2)	121	45.0	240.0	106.9	30.4	923.5
Age	121	0.0	19.0	5.4	4.6	20.1
Floor	121	0.0	29.0	6.9	6.1	46.7
Facility	121	0.0	1.0	1.4	0.5	0.3
CreditVia	121	0.0	1.0	1.4	0.5	0.2
DistShop (m)	121	88.5	1425.1	601.5	313.7	98424.4
DistHosp (m)	121	128.0	3442.8	1091.7	705.7	498003.9
DistSchool (m)	121	371.5	2862.3	1165.9	532.8	283913.6
DistCBD (m)	121	96.3	2765.1	1296.1	605.2	366320.5
DistSea (m)	121	3784.4	6343.6	4791.0	505.2	255247.8
DistMetro (m)	121	141.5	840.3	601.7	163.9	26861.6
Valid N	121					

The analysis results of the lower-middle income group in the primary catchment area (0 - 850m) of the Metro line are presented in Table 4.85. Based on the RSS and AIC values, MGWR is the most successful technique at prediction. The coefficient of the Metro distance variable is negative (-0.421) which means that the prices are positively affected by the proximity to the Metro line.

Table 4.85. The analysis results of the lower-middle income neighborhood in the primary catchment area (0 - 850m) of the Metro line.

Lower-middle Income Neighborhood in the Primary Catchment Area (0 - 850m) of the Metro line												
	OLS		**SAR**		**GWR**			**MGWR**				
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**
Constant	-14.7	0.990	224.4	0.770	1316.7	2765.0	4039.8	2876.9	2885.7	2907.7	119.0	0.049
Area (m^2)	-3.4	0.020	-3.9	0.000	-5.6	-3.7	-3.4	-4.8	-4.6	-4.3	119.0	0.047
Age	-19.8	0.230	-23.4	0.120	-54.6	-49.1	-22.6	-22.2	-21.4	-11.3	119.0	0.041
Floor	29.5	0.000	17.9	0.020	20.9	34.1	37.1	7.4	34.1	60.7	58.0	0.022
Facility	287.9	0.012	218.6	0.040	110.7	356.0	368.4	156.6	166.3	203.9	119.0	0.048
CreditVia	205.5	0.135	129.4	0.300	1.9	25.9	167.0	75.9	296.8	563.8	37.0	0.007
DistShop (m)	-0.848	0.024	-0.638	0.065	-1,329	0.051	0.133	-0.187	-0.145	-0.111	119.0	0.046
DistHosp (m)	0.135	0.287	0.126	0.272	-0.624	-0.401	0.038	-0.411	-0.400	-0.332	119.0	0.046
DistSchool (m)	0.314	0.300	0.241	0.397	0.366	0.422	0.914	0.489	0.490	0.739	111.0	0.042
DistCBD (m)	-0.152	0.542	-0.140	0.538	-0.648	-0.604	0.109	-0.459	-0.458	-0.235	111.0	0.043
DistSea (m)	0.404	0.047	0.326	0.078	-0.292	0.028	0.078	-0.117	-0.114	-0.107	119.0	0.048
DistMetro (m)	0.448	0.335	0.389	0.357	-0.107	-0.024	1,287	-0.446	-0.421	0.392	119.0	0.048
R^2	0.530		0.561		0.605							
RSS	23,371,202		21,265,324		19,639,483			16,993,273				
AIC	1840.50		1836.10		1829.95			1819.51				
			Rho: 0.332									
			p-value: 0.004		Bandwidth=117.0							
			Moran's' I: 0.519		Adj. Alpha(95%)= 0.036 < 0.05							

Descriptive statistics of the lower-middle income group in the secondary catchment area (850m - 1900m) of the Metro line is presented in Table 4.86.

Table 4.86. Descriptive statistics of the lower-middle income group in the secondary catchment area (850m - 1900m) of the Metro line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	369	925.0	5535.7	2143.6	592.2	350758.9
Area (m^2)	369	50.0	279.0	112.2	30.1	948.5
Age	369	0.0	24.0	5.6	4.9	23.5
Floor	369	0.0	26.0	4.0	3.9	14.9
Facility	369	0.0	1.0	1.2	0.4	0.1
CreditVia	369	0.0	1.0	1.4	0.5	0.2
DistShop (m)	369	134.0	1818.4	937.7	427.3	182559.9
DistHosp (m)	369	144.1	4029.5	1300.4	965.4	932047.7
DistSchool (m)	369	64.5	3449.0	1051.3	801.1	641833.5
DistCBD (m)	369	53.8	3351.7	2056.9	676.7	457968.2
DistSea (m)	369	2936.7	6953.7	5164.1	1049.9	1102222.0
DistMetro (m)	369	864.5	1892.9	1436.4	260.1	67636.6
Valid N	369					

The analysis results of the lower-middle income group in the secondary catchment area (850m - 1900m) of the Metro line are presented in Table 4.87. GWR has the best performance in prediction based on the RSS and AIC values. The coefficient of the Metro distance variable is negative (-0.411) which means that the prices are positively affected by the proximity to the Metro line.

Table 4.87. The analysis results of the lower-middle income group in the secondary catchment area (850m - 1900m) of the Metro line.

Lower-middle Income Neighborhood in the Secondary Catchment Area (850m - 1900m) of the Metro line												
	OLS		**SAR**		**GWR**			**MGWR**				
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**
Constant	2548.5	0.000	2789.0	0.000	1525.4	3909.6	9387.7	4788.9	5207.0	5251.1	196.0	0.033
Area (m^2)	-5.6	0.000	-5.4	0.000	-9.4	-7.3	-0.6	-8.5	-5.6	-5.0	194.0	0.027
Age	21.5	0.010	21.0	0.010	-37.7	-18.5	110.7	-81.1	28.9	159.2	29.0	0.002
Floor	16.1	0.020	15.6	0.020	-8.9	18.4	59.1	-6.8	6.2	48.4	195.0	0.015
Facility	155.2	0.030	143.5	0.044	-197.6	147.0	375.2	54.2	89.1	99.2	368.0	0.045
CreditVia	331.3	0.000	328.3	0.000	-123.2	178.0	910.8	287.4	297.8	301.2	368.0	0.047
DistShop (m)	-0.313	0.001	-0.283	0.003	-0.948	-0.33	0.033	-0.479	0.008	0.039	196.0	0.024
DistHosp (m)	0.169	0.002	0.154	0.004	-0.087	0.411	0.688	-0.025	0.001	0.005	368.0	0.045
DistSchool (m)	0.089	0.190	0.071	0.292	-0.474	-0.018	0.252	0.365	0.376	0.380	368.0	0.045
DistCBD (m)	0.247	0.000	0.023	0.000	-0.079	0.474	1,526	-0.05	-0.03	-0.025	368.0	0.049
DistSea (m)	-0.148	0.000	-0.134	0.000	-1,773	-0.287	-0.022	-0.68	-0.64	-0.64	201.0	0.037
DistMetro (m)	-0.267	0.035	-0.263	0.035	-0.782	-0.411	0.381	0.113	0.139	0.144	368.0	0.048
$\mathbf{R^2}$	0.413		0.416		0.607							
RSS	75,832,809		75,416,325		50,792,277			51,471,458				
AIC	5587.24		5587.20		5496.85			5497.68				
			Rho: 0.099									
			p-value: 0.163		Bandwidth=198.0							
			Moran's' I: 0.307		Adj. Alpha(95%)= 0.015 < 0.05							

Then, the dataset is divided into subgroups based on the size of the real estates and the same analysis techniques are applied. The real estates smaller than 80 m2 are considered as the small-sized real estates, the ones between 80m2 and 110m2 are considered as the medium-sized real estates and the ones larger than 110m2 are considered as the large-sized real estates. Firstly, the large-sized real estates in the primary and secondary catchment areas of the Metro line are analyzed. Descriptive statistics of large-sized group in primary catchment area of the Metro line is presented in Table 4.88.

Table 4.88. Descriptive statistics of the large-sized real estates in primary catchment area (0 - 850m) of the Metro line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	107	912.4	6904.8	3120.7	1432.2	2051271.7
Area (m^2)	107	112.0	240.0	137.6	23.2	539.6
Age	107	0.0	19.0	6.1	4.3	18.6
Floor	107	0.0	27.0	6.4	5.6	31.0
Facility	107	0.0	1.0	1.6	0.5	0.2
CreditVia	107	0.0	1.0	1.3	0.5	0.2
DistShop (m)	107	8.5	1300.1	673.1	316.9	100407.4
DistHosp (m)	107	266.7	3687.8	1864.5	1166.8	1361390.4
DistSchool (m)	107	353.8	3105.4	1633.5	906.6	821921.0
DistCBD (m)	107	96.3	3045.8	1743.8	810.8	657476.2
DistSea (m)	107	4161.4	7137.3	5524.0	943.5	890121.8
DistMetro (m)	107	25.6	840.3	564.8	206.1	42479.8
Valid N	107					

The analysis results of the large-sized real estates in the primary catchment area (0 - 850m) of the Metro line are presented in Table 4.89. GWR has the best performance at prediction based on the RSS and AIC values. The coefficient of the Metro distance variable is negative (-1.03) which means that the prices of the large-sized real estates in the primary catchment area, have a premium due to the proximity to the Metro line.

Table 4.89. The analysis results of the large-sized real estates in the primary catchment area (0 - 850m) of the Metro line.

Large-sized real estates in the primary catchment area (0 - 850m) of the Metro line												
	OLS		**SAR**		**GWR**			**MGWR**				
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**
Constant	-2498.9	0.072	-2110.9	0.092	-2649.0	-1473.4	3945.8	-1305.4	-1287.3	-1270.2	105.0	0.049
Area (m^2)	-3.4	0.165	-3.3	0.148	-8.2	-4.5	-2.2	-4.7	-4.6	-4.5	105.0	0.047
Age	-58.4	0.003	-55.4	0.002	-79.8	-66.3	-35.3	-76.0	-71.9	-66.4	105.0	0.038
Floor	14.1	0.209	15.1	0.148	2.5	22.6	38.5	9.6	10.6	13.4	105.0	0.030
Facility	148.0	0.267	138.2	0.268	113.4	192.3	267.4	142.2	172.9	185.6	105.0	0.046
CreditVia	24.3	0.889	-12.9	0.937	-214.1	5.9	227.1	-42.4	82.8	115.5	105.0	0.044
DistShop (m)	-0.580	0.011	-0.420	0.062	-0.950	-0.370	-0.240	-0.600	-0.580	-0.560	105.0	0.044
DistHosp (m)	-0.210	0.379	-0.210	0.358	-0.730	-0.280	0.600	-0.420	-0.410	-0.400	105.0	0.048
DistSchool (m)	1,430	0.002	1,280	0.004	0.000	0.990	2,420	1,590	1,650	1,670	105.0	0.046
DistCBD (m)	-1,250	0.016	-1,190	0.140	-1,810	-0.960	0.820	-1,220	-1,180	-1,160	105.0	0.047
DistSea (m)	1,290	0.000	1,160	0.000	-0.220	0.950	1,380	1,110	1,110	1,120	105.0	0.048
DistMetro (m)	-0.740	0.013	-0.700	0.013	-1,210	-1,030	-0.010	-0.730	-0.700	-0.630	105.0	0.044
R^2	0.880		0.878		0.902							
RSS	26,148,921		27,113,962		21,407,829			26,262,363				
AIC	1655.15		1657.06		1652.00			1657.00				
			Rho: 0.155									
			p-value: 0.211		Bandwidth=86.0							
			Moran's' I: 0.862		Adj. Alpha(95%)= 0.029 < 0.05							

Descriptive statistics of the large-sized real estates in the secondary catchment area (850m - 1900m) of the Metro line is presented in Table 4.90.

Table 4.90. Descriptive statistics of the large-sized real estates in the secondary catchment area (850m - 1900m) of the Metro line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	148	925.0	5535.7	2027.0	570.7	325645.3
Area (m^2)	148	115.0	279.0	140.5	27.1	773.9
Age	148	0.0	24.0	6.3	5.2	27.0
Floor	148	0.0	14.0	3.6	2.4	5.9
Facility	148	0.0	1.0	1.2	0.4	0.2
Credit Viability	148	0.0	1.0	1.3	0.5	0.2
DistShop (m)	148	173.4	1741.7	932.5	368.5	135824.2
DistHosp (m)	148	144.1	4029.5	1314.2	900.2	810389.2
DistSchool (m)	148	64.5	3449.0	966.2	797.4	635857.0
DistCBD (m)	148	53.8	3351.7	1982.5	762.5	581432.2
DistSea (m)	148	3280.1	6556.7	5007.6	1048.6	1099618.3
DistMetro (m)	148	864.5	1892.9	1387.3	273.2	74656.7
Valid N	148					

The analysis results of the large-sized real estates in the secondary catchment area (850m - 1900m) of the Metro line are presented in Table 4.91. The best performance in prediction belongs to the GWR analysis based on the RSS and AIC values. The coefficient of the Metro distance variable is negative (-0.299) which means that the prices of the large-sized real estates in the secondary catchment area increases as the distance to the Metro line decreases.

Table 4.91. The analysis results of the large-sized real estates in the secondary catchment area (850m - 1900m) of the Metro line.

Large-sized real estates in the secondary catchment area (850m - 1900m) of the Metro line												
	OLS		**SAR**		**GWR**			**MGWR**				
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**
Constant	2610.86	0.00	2780.97	0.00	264.81	2913.80	11990.70	3509.60	4462.00	4720.20	45.00	0.02
Area (m^2)	-6.37	0.00	-6.29	0.00	-11.97	-5.92	-3.62	-10.17	-7.15	-6.23	64.00	0.02
Age	29.13	0.01	28.36	0.01	-59.39	-30.13	163.40	-42.65	15.17	168.16	32.00	0.01
Floor	-5.86	0.74	-10.16	0.54	-89.08	-2.22	17.74	-2.24	0.07	Jan-73	147.00	0.04
Facility	273.02	0.02	251.37	0.02	-256.52	227.74	461.34	181.44	194.51	210.38	147.00	0.05
CreditVia	238.28	0.03	245.68	0.02	-341.07	146.63	923.18	-61.91	284.97	660.30	34.00	0.01
DistShop (m)	-0.468	0.00	-0.409	0.01	-1,446	-0.505	0.27	-0.655	-0.515	-0.436	87.00	0.03
DistHosp (m)	0.310	0.00	0.267	0.00	-0.03	0.487	1,163	0.450	0.457	0.477	147.00	0.05
DistSchool (m)	-0.127	0.22	-0.124	0.21	-0.95	-0.543	0.002	0.028	0.030	0.092	147.00	0.04
DistCBD (m)	0.319	0.00	0.286	0.01	-0.047	0.545	2,627	-0.069	-0.065	-0.051	147.00	0.05
DistSea (m)	-0.101	0.02	-0.084	0.06	-2,256	-0.146	0.372	-0.367	-0.367	-0.365	147.00	0.05
DistMetro (m)	-0.344	0.12	-0.320	0.13	-1,659	-0.299	0.149	-0.119	-0.119	-0.110	147.00	0.05
R^2	0.417		0.423		0.838							
RSS	27,920,861		28,326,359		7,734,407			10,770,577				
AIC	2241.00		2224.00		2105.06			2134.03				
			Rho: 0.148									
			p-value: 0.194		Bandwidth=80.0							
			Moran's' I: 0.298		Adj. Alpha(95%)= 0.028 < 0.05							

Descriptive statistics of the medium-sized real estates in the primary catchment area (0 - 850m) of the Metro line is presented in Table 4.92.

Table 4.92. Descriptive statistics of the medium-sized real estates in the primary catchment area (0 - 850m) of the Metro line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	86	1182.8	8000.0	2800.1	1475.7	2177555.5
Area (m^2)	86	82.0	110.0	94.9	9.4	88.0
Age	86	0.0	19.0	4.4	3.3	10.9
Floor	86	0.0	29.0	5.5	6.3	39.9
Facility	86	0.0	1.0	1.3	0.5	0.2
CreditVia	86	0.0	1.0	1.5	0.5	0.3
DistShop (m)	86	88.5	1425.1	740.0	317.0	100460.8
DistHosp (m)	86	128.0	3659.2	1580.7	993.3	986560.8
DistSchool (m)	86	389.9	2984.7	1319.9	789.1	622671.8
DistCBD (m)	86	100.5	3017.3	1501.3	730.5	533594.5
DistSea (m)	86	3900.2	7108.7	5259.5	868.4	754039.5
DistMetro (m)	86	45.2	838.5	604.8	193.8	37556.9
Valid N	86					

The analysis results of the medium-sized real estates in the primary catchment area (0 - 850m) of the Metro line are presented in Table 4.93. GWR has the best performance in prediction based on the RSS and AIC values. The coefficient of the Metro distance variable is positive (0.308) which means that the prices of the medium-sized real estates in the primary catchment area decrease due to the proximity to the Metro line.

Table 4.93. The analysis results of the medium-sized real estates in the primary catchment area (0 - 850m) of the Metro line.

Medium-sized real estates in the primary catchment area (0 - 850m) of the Metro line												
	OLS		**SAR**		**GWR**			**MGWR**				
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**
Constant	10.3	0.996	513.8	0.764	1642.1	2732.1	3690.8	1986.1	2025.1	2036.1	85	0.049
Area (m^2)	-2.4	0.861	-1.1	0.93	-26.5	-22.8	26.5	-17	-16.6	-16	85	0.049
Age	-80.7	0.105	-80.6	0.073	-96.1	-56.5	-31.5	-81.5	-73.9	-68.6	85	0.038
Floor	0.6	0.977	-5.4	0.762	-99.4	9.6	26.2	-87.7	0.6	12.6	78	0.026
Facility	375.8	0.202	390.9	0.141	-386.8	226.7	408.7	102	118.7	128.3	85	0.046
CreditVia	318.7	0.323	362.9	0.213	-71.1	67.6	690	-180.1	199.6	237.8	85	0.045
DistShop (m)	-1.84	0	-1.16	0.01	-2.36	-1.21	-0.5	-2.22	-2.19	-2.18	85	0.046
DistHosp (m)	0.21	0.43	0.13	0.604	0	0.11	0.31	0.21	0.24	0.25	85	0.048
DistSchool (m)	0.58	0.37	0.39	0.513	-0.2	-0.06	1.49	0.44	0.52	0.58	85	0.045
DistCBD (m)	-0.21	0.726	-0.21	0.698	-0.02	0.13	0.28	0.16	0.21	0.24	85	0.047
DistSea (m)	0.67	0.068	0.43	0.194	-0.09	0.28	0.72	0.49	0.5	0.5	85	0.049
DistMetro (m)	0.66	0.316	0.2	0.729	-0.04	0.31	0.76	0.91	0.92	0.95	85	0.045
$\mathbf{R^2}$	0.696		0.709		0.804							
RSS	56,193,612		55,823,961		36,355,293			48,900,287				
AIC	1421.06		1420.00		1398.00			1413.50				
			Rho: 0.287									
			p-value: 0.05		Bandwidth=80.0							
			Moran's' I: 0.900		Adj. Alpha(95%)= 0.031 < 0.05							

Descriptive statistics of the medium-sized real estates in the secondary catchment area of the Metro line is presented in Table 4.94.

Table 4.94. Descriptive statistics the medium-sized real estates in the secondary catchment area (850m - 1900m) of the Metro line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	187	941.2	4427.1	2168.9	574.1	329567.2
Area (TL/m^2)	187	81.0	110.0	97.1	8.3	69.1
Age	187	0.0	24.0	5.1	4.1	22.6
Floor	187	0.0	26.0	4.1	4.4	19.0
Facility	187	0.0	1.0	1.1	0.3	0.1
CreditVia	187	0.0	1.0	1.5	0.5	0.3
DistShop (m)	187	134.0	1794.9	938.1	445.1	198151.0
DistHosp (m)	187	160.7	3945.9	1296.4	970.2	941278.6
DistSchool (m)	187	112.3	3365.4	1067.0	781.5	610764.6
DistCBD (m)	187	203.7	3268.1	2081.4	612.2	374748.1
DistSea (m)	187	2936.7	6953.7	5250.6	1061.2	1126219.9
DistMetro (m)	187	874.6	1891.6	1475.1	246.4	60689.0
Valid N	187					

The analysis results of the medium-sized real estates group in the secondary catchment area (850m - 1900m) of the Metro line are presented in Table 4.95. GWR has the best performance in prediction based on the RSS and AIC values. The coefficient of the Metro distance variable is negative (-0.140) which means that the prices of the medium-sized real estates in the secondary catchment area increase as the distance to the Metro line decreases.

Table 4.95. The analysis results of the medium-sized real estates in the secondary catchment area (850m - 1900m) of the Metro line.

Medium-sized real estates in the secondary catchment area (850m - 1900m) of the Metro line													
	OLS		**SAR**		**GWR**			**MGWR**					
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**
Constant	3818.9	0.000	10665.5	0.000	3751.1	4343.5	5943.2	4357.6	4379.8	4382.7	185.0	0.049
Area (m^2)	-17.7	0.000	4.4	0.742	-28.4	-15.6	-10.7	-16.4	-16.1	-16.1	185.0	0.048
Age	6.1	0.653	16.9	0.665	-42.5	-25.9	44.6	-49.5	-21.9	28.1	123.0	0.018
Floor	35.2	0.000	5.4	0.814	26.6	30.3	49.5	27.9	29.4	47.4	168.0	0.029
Facility	-15.0	0.885	830.5	0.004	-186.3	15.3	62.9	2.5	22.1	25.1	185.0	0.044
CreditVia	277.4	0.003	-797.5	0.014	-3.3	152.9	273.6	114.4	123.0	130.4	185.0	0.045
DistShop (m)	-0.310	0.019	0.320	0.455	-0.960	-0.210	0.020	-0.450	-0.250	-0.050	106.0	0.022
DistHosp (m)	0.170	0.026	0.440	0.286	0.010	0.220	0.650	0.180	0.190	0.200	185.0	0.045
DistSchool (m)	0.230	0.011	-0.720	0.093	-0.170	0.140	0.440	0.040	0.050	0.080	185.0	0.043
DistCBD (m)	0.280	0.002	-0.380	0.570	0.180	0.330	0.730	0.190	0.200	0.200	185.0	0.048
DistSea (m)	-0.190	0.000	-1,210	0.000	-0.520	-0.250	-0.110	-0.280	-0.280	-0.280	185.0	0.049
DistMetro (m)	-0.190	0.236	-0.690	0.005	-0.580	-0.140	0.090	0.020	0.040	0.040	185.0	0.048
R^2	0.512		0.514		0.638							
RSS	29,939,337		31,026,356		22,194,570			24,628,167				
AIC	2795.61		2798.60		2770.55			2773.92				
			Rho: 0.212									
			p-value: 0.50		Bandwidth=170.0							
			Moran's' I: 0.325		Adj. Alpha(95%)= 0.026 < 0.05							

Descriptive statistics of the small-sized real estates in the primary catchment area (0 - 850m) of the Metro line is presented in Table 4.96.

Table 4.96. Descriptive statistics of the small-sized real estates in the primary catchment area (0 - 850m) of the Metro line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	32	1142.9	9466.7	4038.3	2216.1	4911002.1
Area (TL/m^2)	32	45.0	79.0	69.1	7.3	53.8
Age	32	0.0	14.0	4.1	3.6	13.0
Floor	32	0.0	24.0	9.5	6.2	38.6
Facility	32	0.0	1.0	1.1	0.4	0.2
CreditVia	32	0.0	1.0	1.4	0.5	0.2
DistShop (m)	32	189.9	823.6	420.1	178.1	31707.7
DistHosp (m)	32	546.3	3565.2	1843.5	1220.9	1490630.9
DistSchool (m)	32	565.9	2984.7	1713.7	891.4	794625.8
DistCBD (m)	32	359.0	2918.6	1713.5	901.3	812300.1
DistSea (m)	32	4233.6	7010.1	5451.8	1090.1	1188364.2
DistMetro (m)	32	9.0	801.1	506.2	216.7	46938.7
Valid N	32					

The analysis results of the small-sized real estates in the primary catchment area (0 - 850m) of the Metro line are presented in Table 4.97. GWR has the best performance in prediction based on the RSS and AIC values. The coefficient of the Metro distance variable is negative (-2.131) which means that the prices of the small-sized real estates in the primary catchment area, have a high premium due to the proximity to the Metro line.

Table 4.97. The analysis results of the small-sized real estates in the primary catchment area (0 - 850m) of the Metro line.

Small-sized Real Estates in the Primary Catchment Area (0 - 850m) of the Metro line												
	OLS		**SAR**		**GWR**			**MGWR**				
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Bandwidth**	**P>t value**
Constant	5710.5	0.511	8198.3	0.256	-12224.8	-11700.9	18917.4	-11631.0	-11558.0	-11521.1	31.0	0.050
Area (m^2)	-44.7	0.236	-45.9	0.122	-62.0	-40.7	-32.3	-45.2	-36.1	-35.3	21.0	0.046
Age	33.3	0.796	39.3	0.701	58.1	77.4	84.0	88.3	112.0	119.1	30.0	0.041
Floor	42.3	0.289	37.9	0.237	49.1	59.1	199.1	12.6	15.3	61.2	31.0	0.033
Facility	510.9	0.347	553.8	0.198	-90.4	35.1	837.7	-39.1	48.9	291.3	28.0	0.050
CreditVia	503.6	0.560	463.4	0.496	567.3	1456.1	1716.4	611.4	1481.9	1501.3	21.0	0.031
DistShop (m)	-5,443	0.011	-5,836	0.001	-6,490	-3,795	-2,493	-9,400	-7,405	-7,360	28.0	0.037
DistHosp (m)	0.808	0.405	0.854	0.273	0.652	0.905	2,493	1,916	2,161	2,166	28.0	0.050
DistSchool (m)	1,383	0.759	1,862	0.605	-2,921	-2,268	1,880	-1,715	-1,348	-1,323	28.0	0.050
DistCBD (m)	0.309	0.897	0.322	0.864	0.892	0.946	1,899	2,582	2,796	2,802	28.0	0.049
DistSea (m)	-0.394	0.865	-0.660	0.727	-3,916	3,164	3,317	2,395	2,573	2,585	21.0	0.051
DistMetro (m)	-1,388	0.274	-1,774	0.148	-3,108	-2,131	2,744	-1,293	2,026	2,126	21.0	0.035
R^2	0.842		0.765		0.901							
RSS	24,118,565		15,012,573		8,311,257			11,042,322				
AIC	573.08		572.06		545.06			549.87				
			Rho: 0.118									
			p-value: 0.689		Bandwidth=31.0							
			Morans' I: 0.684		Adj. Alpha(95%)= 0.035 < 0.05							

Descriptive statistics of the small-sized real estates in the secondary catchment area (850m - 1900m) of the Metro line is presented in Table 4.98.

Table 4.98. Descriptive statistics of the small-sized real estates in the secondary catchment area (850m - 1900m) of the Metro line.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	25	1800.0	4036.4	2709.9	567.8	322429.1
Area (m^2)	25	50.0	78.0	67.1	9.0	80.9
Age	25	0.0	9.0	4.6	3.3	10.6
Floor	25	0.0	20.0	5.1	6.2	38.9
Facility	25	0.0	1.0	1.4	0.5	0.3
CreditVia	25	0.0	1.0	1.5	0.5	0.3
DistShop (m)	25	266.3	1818.4	881.4	585.4	342732.8
DistHosp (m)	25	218.2	3986.7	1254.4	1351.6	1826915.0
DistSchool (m)	25	359.3	3406.2	1504.4	915.3	837738.1
DistCBD (m)	25	1250.5	3309.0	2335.4	544.2	296197.8
DistSea (m)	25	3570.4	6528.6	5505.7	794.9	631787.3
DistMetro (m)	25	882.3	1886.2	1406.5	246.6	60799.7
Valid N	25					

The analysis results of the small-sized real estates in the secondary catchment area (850m - 1900m) of the Metro line are presented in Table 4.99. Due to the small number of observations in the dataset the SAR, GWR and MGWR analysis results cannot be obtained and presented. The coefficient of the Metro distance variable is negative (-0.099) which means that the prices of the small-sized real estates in the secondary catchment area decrease as the distance to the Metro line increase.

Table 4.99. The analysis results of the small-sized real estates in the secondary catchment area (850m - 1900m) of the Metro line.

Small-Sized Real Estates in the Secondary Catchment Area (850m -1900m) of the Metro line		
	OLS	
Variables	**Coefficient**	**P>t value**
Constant	1441.6	0.582
Area (m^2)	15	0.464
Age	-47.9	0.742
Floor	30.4	0.393
Facility	-259.8	0.415
CreditVia	417.3	0.622
DistShop (m)	0.334	0.624
DistHosp (m)	-0.438	0.304
DistSchool (m)	0.553	0.342
DistCBD (m)	-0.079	0.917
DistSea (m)	-0.039	0.844
DistMetro (m)	-0.099	0.930
R^2	0.470	
RSS	4,101,759	
AIC	395.15	

5. A PROPOSED METHOD FOR THE ANALYSIS OF THE EFFECTS OF TRANSPORTATION INVESTMENTS ON REAL ESTATE PRICES IN OVERLAPPING ZONES (OVERLAPPING ZONE)

The effect of one transportation system on property prices is mostly investigated in the previous studies. However, there are also cases where more than one transportation alternatives for some locations. When there are two systems available for a region, real estates located in both catchment areas of the transportation systems seem to favor this opportunity compared to the ones inside one catchment area or none. Therefore, there exist geographical locations in which the real estates can gather the benefits of proximity to two transportation systems. Although some of the studies have two transportation systems in their study area, the combined effects of these transportation systems are not evaluated in any of them [1], [2], [7], [18], [21], [26], [30]. Generally, the effects of transportation systems on residential property prices are investigated in terms of the price changes and its dependency on proximity to the transportation system. Therefore, there is a gap in the literature for the analysis of the prices of the residential properties within these geographical locations. In this study, this geographical location in which two transportation systems have an effect on the real estate prices is named the "overlapping zone". It is hypothesized that the real estates located in the overlapping zone of the transportation systems have higher price values. In order to analyze the condition of these real estates in the market, a new model, namely "overlapping zone model (OZM)", is proposed:

$$y_i = \alpha + \beta_i X_i + \tau_i \delta_i, \tag{5.1}$$

where y_i is the price of the house, α is the standard coefficient, β_i is the coefficient of explanatory variables, X_i indicates the explanatory variables, δ_i is the zone parameter explaining the location of the house, τ_i is the coefficient of zone parameter where (i= 1, 2, 3,...,n).

The real estates within the overlapping zone are weighted according to their relative distances to both of the transportation systems. The distances can be adjusted based on the distance between the transportation modes. Since, the overlapping zone model aims to provide a better prediction for the real estates within the overlapping zone, the analysis techniques with overlapping zone model should perform better compared to regular hedonic price model.

The selected study area within this dissertation includes an overlapping zone which is in Esenyurt County, between the BRT line and planned Esenyurt Metro line. The real estates that are defined in the overlapping zone are not inside the primary and secondary catchment areas, yet the habitants living in these real estates have to reach to the BRT line or the Metro line in order to reach city center. Therefore, a third catchment area is defined that is up to 3,700 meters from each transportation mode. The intersection zone is called the overlapping zone. It is hypothesized that the real estates within the overlapping zone should be analyzed with a different approach. The regular hedonic price model is considered as insufficient at explaining this condition. Therefore, a new model, namely overlapping zone model, is proposed for the analysis of the effects of two transportation systems on the residential property prices. Same dataset is first analyzed by utilizing the regular hedonic price model, and then it is analyzed by using the proposed overlapping zone model.

The regular model used for the selected study area is:

$$\begin{aligned} y_i &= \alpha + \beta_1\,(size) + \beta_2\,(age) + \beta_3\,(creditvia) + \beta_4\,(floorlev) \\ &+\beta_5\,(facility) + \beta_6\,(rooms) + \beta_7\,(distHosp) + \beta_8\,(distMall) + \\ &\beta_9\,(distBRT) + \beta_{10}\,(distMetro) + \beta_{11}\,(distSchool) + \beta_{12}\,(distCBD) + \\ &\beta_{13}\,(distSea) \end{aligned} \tag{5.2}$$

The overlapping zone model used for the selected study area is:

$$
\begin{aligned}
y_i = \alpha + \beta_1 (size) + \beta_2 (age) + \beta_3 (creditvia) + \\
\beta_4 (floorlev) + \beta_5 (facility) + \beta_6 (rooms) + \\
\beta_7 (distHosp) + \beta_8 (distMall) + \beta_9 (distBRT) + \\
\beta_{10} (distMetro) + \beta_{11} (distSchool) + \beta_{12} (distCBD) + \\
\beta_{13} (distSea) + \tau_i \delta_i
\end{aligned}
\tag{5.3}
$$

The term $\tau_i \delta_i$, in Equation 5.3 is called the overlapping zone parameter, which is adjusted based on the geographical condition of the study area. Within this study, the overlapping zone is divided into 4 subzones; those are from 2,300m to 2,650m as the first subzone, from 2,650m to 3,000m as the second subzone, from 3,000 to 3,350 as the third subzone and from 3,350 to 3,700 as the fourth subzone. These distances are defined based on the geography of the selected study area. Then the explanatory variable is defined as presented in Table 5.1.

Table 5.1. Overlapping zone parameter for the selected study area.

Overlapping Zone Parameter (δ)		
Subzones	Distance Interval	δ
#1	2300m - 2650m	4
#2	2650m - 3000m	3
#3	3000m - 3350m	2
#4	3350m - 3700m	1

The descriptive statistics of the overlapping zone is presented in Table 5.2. There are 1,318 observation points inside the overlapping zone. The table consists of minimum, maximum, mean, standard deviation and variances of the variables.

Table 5.2. The descriptive statistics of the overlapping zone.

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Price (TL/m^2)	1318	766.7	10060.0	2510.8	901.4	812532.4
Area (m^2)	1318	40.0	300.0	108.9	32.1	1032.1
Age	1318	0.0	26.0	4.2	3.10	14.10
Floor	1318	0.0	35.0	4.2	5.1	26.0
Facility	1318	0.0	1.0	1.3	0.4	0.2
CreditVia	1318	0.0	1.0	1.6	0.5	0.2
DistShop (m)	1318	14.4	1913.4	786.6	407.1	165762.7
DistHosp (m)	1318	1.4	2657.1	809.0	516.5	266816.6
DistSchool (m)	1318	6.7	2231.2	919.2	411.5	169319.1
DistCBD (m)	1318	1818.4	4746.4	3108.5	711.2	505749.9
DistSea (m)	1318	2072.4	7185.6	5235.6	1407.0	1979553.4
DistMetro (m)	1318	1015.2	3698.7	2813.2	689.8	475885.2
Overlapping ZP	1318	1.0	4.0	2.0	1.0	1.0
Valid N	1318					

The comparison of the analysis results of OLS and SAR methods for hedonic price model (HPM) and the overlapping zone model (OZM) is presented in Table 5.3. According to the results, the overlapping zone model performed better for OLS technique, the AIC value of HPM is 21,128.65 and AIC value of OZM is 21,002.55; also the RSS value of HPM is 693,386,651 and RSS value of OZM is 629,172,950. Based on these values the performance of proposed overlapping zone model is better than the performance of hedonic price model at prediction of the estimates. The overlapping zone model also performed better at SAR analysis, the AIC value of HPM is 20,973.12 and AIC value of OZM is 20,916.40. RSS value of the HPM (512,456,875) is higher than the RSS value of OZM (498,265,984). Additionally, Moran's' I index of OZM (0.419) is lower than the one for HPM (0.448). Lower Moran's I index means better spatial autocorrelation within the model. These results indicate that the overlapping zone model is more successful at prediction of the estimates.

Table 5.3. Comparison of the Hedonic Price Model (HPM) and Overlapping Zone Model (OZM) for OLS and SAR analyses.

Overlapping Zone Analysis Hedonic Price Model (HPM) and Overlapping Zone Model (OZM)								
	OLS (HPM)		**OLS (OZM)**		**SAR (HPM)**		**SAR (OZM)**	
Variables	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**	**Coefficient**	**P>t value**
Constant	1693.4	0.000	**2486.5**	**0.000**	1862.3	0.000	**2386.9**	**0.000**
Area (m^2)	-5.4	0.000	**-5.3**	**0.000**	-5.9	0.000	**-5.8**	**0.000**
Age	8.3	0.333	**7.8**	**0.340**	9.4	0.233	**9.6**	**0.243**
Floor	9.6	0.057	**7.6**	**0.095**	11.6	0.009	**9.7**	**0.025**
Facility	735.0	0.000	**628.7**	**0.000**	533.6	0.000	**498.4**	**0.000**
CreditVia	388.8	0.000	**417.1**	**0.000**	381.6	0.000	**404.0**	**0.000**
DistShop (m)	0.355	0.000	**0.102**	**0.138**	0.180	0.005	**0.023**	**0.724**
DistHosp (m)	0.178	0.000	**0.280**	**0.000**	0.106	0.019	**0.180**	**0.000**
DistSchool (m)	-0.137	0.041	**-0.137**	**0.031**	-0.157	0.011	**-0.142**	**0.019**
DistCBD (m)	-0.143	0.001	**-0.424**	**0.000**	-0.075	0.055	**-0.259**	**0.000**
DistSea (m)	-0.043	0.048	**-0.204**	**0.000**	-0.025	0.216	**-0.128**	**0.000**
DistMetro (m)	0.093	0.014	**0.252**	**0.000**	0.034	0.327	**0.152**	**0.000**
OverlapZP			**307,527**	**0.000**			**198,324**	**0.000**
R^2	0.352		**0.412**		0.426		**0.451**	
RSS	693,386,651		**629,172,950**		512,456,875		**498,265,984**	
AIC	21128.65		**21002.55**		20973.12		**20916.40**	
					Rho: 0.381 p-val: 0.000		**Rho: 0.342 p-val: 0.000**	
					Moran's I: 0.448		**Moran's I: 0.419**	

The comparison of the analysis results of GWR and MGWR methods for hedonic price model (HPM) and the overlapping zone model (OZM) is presented in Table 5.4. According to the results, the overlapping zone model performed better for GWR technique, the AIC value of HPM is 20,684.00 and AIC value of OZM is 20,658.17; also the RSS value of HPM is 392,566,028 and RSS value of OZM is 360,035,541. Based on these values the performance of proposed overlapping zone model is better than the performance of hedonic price model at prediction of the estimates.

The overlapping zone model also performed better at MGWR analysis, the AIC value of HPM is 20,845.70 and AIC value of OZM is 20,705.43. RSS value of the HPM (460,559,079) is higher than the RSS value of OZM (417,326,003). These results indicate that the overlapping zone model is more successful at prediction of the estimates also for GWR and MGWR analysis methods.

Since overlapping zone model is superior to the regular hedonic price model in all analysis types, the results are interpreted according to overlapping zone model. The best performance belongs to the GWR method in prediction of the estimates in the overlapping zone model. The coefficient of the overlapping zone parameter is positive (174.44) which means that the increase in the zone parameter result in an increase in the prices of the real estates. To give an example, a 100 m2 residential property in the first overlapping zone (2300m-2650m) is 17,400 TL more expensive than a 100 m2 residential property in the second overlapping zone (2650m-3000m).

Table 5.4. The analysis results of the small-sized real estates in the primary catchment area (0 - 850m) of the Metro line.

Overlapping Zone Analysis Hedonic Price Model (HPM) and Overlapping Zone Model (OZM)																
	GWR (HPM)			GWR (OZM)			MGWR (HPM)					MGWR (OZM)				
Variables	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Band.	P>t value	Min	Mean	Max	Band.	P>t value
Constant	-15421.3	1918.9	33614.0	-15228.7	1553.5	14353.1	-2274.5	1114.5	25289.0	43.0	0.001	-2492.3	-859.1	10575.2	43.0	0.001
Area (m^2)	-15.7	-7.2	3.9	-13.8	-6.7	1.8	-7.1	-7.0	-7.0	1316.0	0.048	-7.1	-7.0	-7.0	1316.0	0.048
Age	-51.3	8.7	88.8	-52.7	10.0	63.7	-17.7	11.4	74.3	266.0	0.007	-66.0	4.4	159.2	149.0	0.003
Floor	-43.2	42.9	160.2	-26.8	46.9	148.3	5.1	48.3	88.2	322.0	0.008	0.0	40.5	88.3	294.0	0.007
Facility	-204.3	437.9	1393.1	-102.8	457.5	1342.1	509.9	515.0	518.1	1316.0	0.049	483.8	486.4	489.0	1316.0	0.049
CreditVia	-339.7	380.0	1454.8	-243.6	376.6	1311.3	487.7	495.0	498.0	1316.0	0.049	466.8	469.6	471.1	1316.0	0.049
DistShop (m)	-6,600	-0.130	3,300	-3,420	-0.350	3,520	-2,670	-2,670	-2,670	1,316,000	0.050	0.750	0.750	0.760	1,316,000	0.049
DistHosp (m)	-1,930	0.580	5,580	-2,620	0.300	3,240	2,350	2,360	2,360	1,316,000	0.049	-0.040	-0.030	-0.030	1,316,000	0.049
DistSchool (m)	-3,960	-0.200	8,720	-2,020	-0.120	3,510	-0.540	-0.530	-0.530	1,316,000	0.050	-0.280	-0.280	-0.270	1,316,000	0.050
DistCBD (m)	-7,930	0.030	3,670	-3,040	0.070	2,040	-2,290	0.040	0.390	58,000	0.002	-0.140	-0.140	-0.140	1,316,000	0.050
DistSea (m)	-4,670	0.050	2,400	-1,670	-0.020	1,250	-2,980	0.140	0.850	41,000	0.001	-1,900	0.110	1,060	47,000	0.001
DistMetro (m)	-2,490	-0.410	2,310	-2,000	-0.230	2,720	-0.010	0.140	0.150	536,000	0.042	0.100	0.370	0.390	502,000	0.039
Overlapping ZP				-146.9	174.4	1,043.7						-58.6	271.6	379.2	305	0.022
R^2	0.633			0.636												
RSS	392,566,028			360,035,541			460,559,079					417,326,003				
AIC	20684.00			20658.17			20845.70					20705.43				
	Bandwidth=212.0			Bandwidth=262.0												
	Adj. Alpha(95%)= 0.004 < 0.05			Adj. Alpha(95%)= 0.005 < 0.05												

6. CONCLUSIONS AND RECOMMENDATIONS

In this chapter, the conclusions, limitations of the models, the contributions of the dissertation and the recommendations for future studies are presented.

6.1. Conclusions

This dissertation examines the effect of transportation systems on the prices of residential properties by determining the parameters affecting the real estate prices in the selected study area and measuring the amount of the effects of these parameters. Initially, the literature is comprehensively reviewed in order to determine the parameters affecting the real estate prices within different study areas. Then, the possible parameters that might be effective on real estate prices in the study area are selected. Later on, in order to measure the effect of the selected parameters, the real estate experts whose work zones are in the selected study area of this dissertation are surveyed through a questionnaire. The survey is analyzed through ANOVA analysis and the outcomes showed that some parameters such as, age, floor level, credit viability of the real estate and the proximity of the BRT line have higher correlations with the experience level of the real estate experts. In other words, the opinions of the real estate experts regarding the effect of these parameters on real estate prices revealed that these parameters have high effects on real estate prices. Thereafter, based on the selected parameters, the data is collected by convenient sampling technique from the study area, Esenyurt and Beylikduzu Counties. The datasets are divided into subgroups and they are analyzed using ordinary least squares (OLS), spatial auto regression (SAR), geographically weighted regression (GWR) and multiscale geographically weighted regression (MGWR).

The summary of the effects of the proximity to the BRT line on the real estate prices is presented in Table 6.1. According to the results, proximity to the BRT line has a positive effect in the primary catchment area, low and middle income neighborhoods of the primary catchment area, medium and small size real estates in the primary catchment area whereas the effect of proximity to BRT line is negative for high income neighborhood of the primary catchment area and large size real estates in the primary catchment area. Also, the prices of all types of real estates and all income groups in the secondary catchment area are negatively affected by the proximity to the BRT line. The prices in the secondary catchment area decrease. The reason behind that might be due to the effect of other factors such as accessibility to sea in Beylikduzu County and proximity to TEM Highway and planned Metro line in Esenyurt County outweigh the benefits of the proximity to the BRT line. Also, the negative effect on the high income neighborhood and large size houses in the primary catchment area might be due to low dependence of the habitants to the public transportation mode, namely the BRT line.

Table 6.1. Summary of the effects of proximity to the BRT line.

	Effects of proximity to the BRT line on real estate prices					
	Primary (Positive)			Secondary (Negative)		
Income Levels	High (Negative)	Middle (Positive)	Low (Positive)	High (Negative)	Middle (Negative)	Low (Negative)
Size	Large (Negative)	Medium (Positive)	Small (Positive)	Large (Negative)	Medium (Negative)	Small (Negative)

The summary of the effects of the proximity to the Metro line on the real estate prices are presented in Table 6.2. According to the results, proximity to the Metro line has a positive effect for all types of houses and neighborhoods in primary and secondary catchment areas whereas the only negative affect is observed for the medium size real estates in the primary catchment area. The Metro line is not providing service currently. However, the planned operation time is very close and it is expected that it will highly contribute to the accessibility of the county. Therefore, the proximity to the metro line provides a premium to the real estates in the vicinity.

Table 6.2. Summary of the effects of proximity to the Metro line.

	Effects of proximity to the Metro line on real estate prices					
	Primary (Positive)			Secondary (Positive)		
Income Levels	Upper-Middle (Positive)		Lower-Middle (Positive)	Upper-Middle (Positive)		Lower-Middle (Positive)
Size	Large (Positive)	Medium (Negative)	Small (Positive)	Large (Positive)	Medium (Positive)	Small (Positive)

Thereafter, it is hypothesized that the regular hedonic price models are insufficient in predicting the estimates in the overlapping zones, in which two transportation systems might affect the prices. This was satisfied by the newly proposed model, namely overlapping zone model (OZM). The analysis results indicated that the proposed model improved the regular hedonic price model at prediction of the estimates. The proposed model is transferrable to the analysis of the effect of two transportation systems on the residential property prices in other locations.

The transferability of findings in other areas is possible. The expectations of how the parameters and the proximity to the transportation infrastructure would affect the prices of residential properties in different study areas are determined as the outputs of this research.

6.2. Limitations of the study

In this dissertation, the general limitation is the validity of the results for larger areas; that is, the generalization of the outcomes since the parameters affecting the price and the coefficients of these parameters in economic models change across the space. In other words, the factors affecting the real estate prices might not be the same for different locations. Therefore, the transferability of the outcomes is possible only through providing an intuition for carefully deciding the possible affecting parameters for various study areas.

6.3. Contributions

Contributions of the dissertation are listed below:

- The parameters affecting the real estate prices for a region in the study area are described by performing a comprehensive literature review, a survey with the real estate experts and the analysis of the established model based on the data set sampled from the study area of Beylikduzu and Esenyurt Counties.
- The multiscale geographically weighted regression (MGWR) is a new method. The first implementation of this analysis technique with an actual data set on a study area is performed.
- A new analysis model, overlapping zone model, is proposed for investigation of the effects of two transportation systems on residential property prices.

6.4. Recommendations

For further studies, the impact of the transportation systems on other types of properties such as commercial and industrial properties can be determined. The findings could be used as an indicator for the economic improvement of the vicinity due to the proximity to transportation infrastructure. The opportunity of the use of value capture mechanism for financing at new transportation project and how much of this premium should be captured is the subject of a future study.

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APPENDIX A: SURVEY QUESTIONS FOR EXPERTS

Table A.1. Survey Questions for Experts.

SURVEY QUESTIONS FOR EXPERTS						
P1	***How old are you?***					
P2	***What is your gender?***					
P3	***What is your level of education?***					
	No education	Primary School	High School	University	Graduate	Post Graduate
D1	***How long have you been in real estate sector?***					
	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	20+
D2	***How many people have you been interacting for selling or*** **renting of a residential property? (The process might not be successful interaction is enough).**					
	0 - 200	201 - 400	401 - 600	601 - 800	801 -1000	1001+
Q1	***What is the effect of residential property's age on prices?***					
	None	Very Low	Low	Medium	High	Very High
	0	1% - 5%	6%-10%	11%-15%	16%-20%	%21 +
Q2	***What is the effect of that whether the residential property has parking and other facilities or not, on prices?***					
	None	Very Low	Low	Medium	High	Very High
	0	1% - 5%	6%-10%	11%-15%	16%-20%	%21 +
Q3	***What is the effect of residential property' floor level on prices?***					
	None	Very Low	Low	Medium	High	Very High
	0	1% - 5%	6%-10%	11%-15%	16%-20%	%21 +
Q4	***What is the effect of residential property's credit viability on prices?***					
	None	Very Low	Low	Medium	High	Very High
	0	1% - 8%	9%-16%	17%-24%	25%-32%	%33+

Table A.1. Survey Questions for Experts (Cont.).

SURVEY QUESTIONS FOR EXPERTS						
Q5	***What is the effect of residential property's proximity to hospitals on prices?***					
	None	Very Low	Low	Medium	High	Very High
	0	1% - 3%	4%-6%	7%-9%	10%-12%	%13 +
Q6	***What is the effect of residential property's proximity to shopping malls on prices?***					
	None	Very Low	Low	Medium	High	Very High
	0	1% - 5%	6%-10%	11%-15%	16%-20%	%21 +
Q7	***What is the effect of residential property's proximity to CBDs on prices?***					
	None	Very Low	Low	Medium	High	Very High
	0	1% - 8%	9%-16%	17%-24%	25%-32%	%33+
Q8	***What is the effect of residential property's proximity to high schools on prices? (Please answer that question considering the obligatory law for highs cool registrations in Turkey)***					
	None	Very Low	Low	Medium	High	Very High
	0	1% - 3%	4%-6%	7%-9%	10%-12%	%13 +
Q9	***What is the effect of residential property's proximity to seaside on prices? (Please answer that question considering geographical condition of Beylikduzu Esenyurt Counties)***					
	None	Very Low	Low	Medium	High	Very High
	0	1% - 3%	4%-6%	7%-9%	10%-12%	%13 +
Q10	***What is the effect of residential property's proximity to public transportation systems on prices? (Please answer that question considering BRT line for Beylikduzu Region)***					
	None	Very Low	Low	Medium	High	Very High
	0	1% - 8%	9%-16%	17%-24%	25%-32%	%33+
Q11	***Is there any other factor affecting the real estate prices that you may consider? What is the effect in your opinion?***					
	None	Very Low	Low	Medium	High	Very High