DOKUZ EYLÜL UNIVERSITY

GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

THE USE OF URBAN QUALITIES IN REAL ESTATE ASSESSMENT: A MODEL BASED ON GIS

by

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June, 2022

İZMİR

THE USE OF URBAN QUALITIES IN REAL ESTATE ASSESSMENT: A MODEL BASED ON GIS

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We have read the thesis entitled "**THE USE OF URBAN QUALITIES IN REAL ESTATE ASSESSMENT: A MODEL BASED ON GIS**" completed by **RIZA ENDER UMUR** under supervision of **PROF.DR. EBRU ÇUBUKÇU** and we certify that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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ABSTRACT

Thanks to technological developments in the field of GIS, it is possible to measure the quality of street networks. Given that, this study aims to create a model which examines the influence of urban qualities within the neighbourhood unit on housing prices. Since this study is limited to housing values, potential factors that affect housing value is discussed under two main headings: neighbourhood and building characteristics. The dataset was obtained by filtering the data from 151 valuation reports prepared by licensed appraisers. These are the reports of the residences for which an appraisal report has been prepared in the city of Izmir, Buca, in 2020.

With the data obtained, a series of regression models were run via SPSS software. First, the influence of the building characteristics were tested, and the results showed that type (residence or not), size, presence of elevator, building quality, presence of parking lot, number of rooms were the significant factors on house values. Next, a reduced model is formed by eliminating the insignificant building characteristics and adding the neighbourhood characteristics to this reduced model to test the influence of neighbourhood characteristics on house values; after accounting for the important building characteristics. Results revealed that distances to the hospitals, green areas, global restaurants, shopping centers, university, and density of the groceries within the 400-meter buffer zone of housing were significant on estimating the value of housing. This study provides empirical evidence that data on neighbourhood characteristics leads better predictions of house values when it is not possible to collect a detailed data on building characteristics. The most important result of the study is that the housing value will be predictable with less detailed data.

Keywords: Geographic information systems, housing valuation, hedonic price modelling

KENTSEL MEKANSAL ÖZELLİKLERİN TAŞINMAZ DEĞERLEMEDE KULLANIMI: CBS TEMELLİ BİR MODEL GELİŞTİRME ÖNERİSİ

ÖZ

CBS alanındaki teknolojik gelişmeler sayesinde, mekânsal özellikleri sayısal olarak ölçmek mümkündür. Bu çalışma, mekânsal özelliklerin konut fiyatları üzerindeki etkisini inceleyen bir model oluşturmayı amaçlamaktadır. Bu çalışma konut değerleriyle sınırlı olduğundan, değeri etkileyen potansiyel faktörler çevresel ve yapı özellikleri olmak üzere iki ana başlık altında ele alınacaktır. Lisanslı değerleme uzmanları tarafından hazırlanan 151 değerleme raporundan bu veriler filtrelenerek veri seti oluşturulmuştur. Söz konusu raporlar, İzmir ili Buca ilçesinde 2020 yılında hazırlanmış olan değerleme raporu düzenlenen konutlara aittir.

Elde edilen veriler ile SPSS yazılımı yardımıyla regresyon modelleri oluşturulmuştur. Öncelikle bina özellikleri değişkenleri test edilmiş ve site içinde olmak, konut büyüklüğü, asansör ve otopark varlığı, yapı kalitesi ve oda sayısı faktörlerinin konutun değerini anlamlı bir şekilde etkilediği görülmüştür. Daha sonra, konut değeri üzerinde sadece etkisi istatistiksel olarak anlamlı bulunan değişkenleri kullanarak sınırlandırılmış regresyon modeli oluşturulmuş ve bu indirgenmiş modele komşuluk birimine ilişkin özellikler eklenerek ve bu çevresel özelliklerin etkileri test edilmiştir. Sonuç olarak hastanelere, yeşil alanlara, restoranlara, alışveriş merkezlerine, üniversiteye ve marketlere uzaklık dışındaki özelliklerin konut değeri tahmininde anlamlı olmadığı görülmüştür. Bu çalışma, kentsel ve mekânsal özelliklerin konut değerleri üzerindeki etkisini göstermesi açısından oldukça önemlidir. Bina özellikleri hakkında ayrıntılı veri toplamanın mümkün olmadığı durumlarda, konut değerinin tahmininde harita üzerinden kolaylıkla elde edilebilecek çevresel özellikler ile konut değerinin yeterince doğru tahmin edilebileceği gösterilmiştir.

Anahtar kelimeler: Coğrafi bilgi sistemleri, konut değerleme, hedonik fiyatlama modeli

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ABBREVIATIONS

GIS   : Geographical Information Systems

IVS   : International Valuation Standards

IVSC   : International Valuation Standards Council

CMB   : Capital Markets Board of Turkey

TSI   : Turkish Statistical Institute

OSM   : Open Street Maps

CHAPTER 1
INTRODUCTION

Real estate is quite different from other types of assets as it is immovable. This difference makes real estate unique in all directions compared with other assets. Therefore, its location has a direct influence on the value of the asset. The share of real estate in the economic hierarchy is quite large and there are many types of real estate. Given that each type of real estate has a different purpose, the advantages offered are different. All of this requires a different determination of its value. However, this study only focuses on housing type of real estate.

Maslow's (1943) hierarchy of needs includes physiological and safety needs as the most basic needs. Housing is very important because it fulfills many physiological and safety needs, such as security, safety, sleep, warmth. (McDonald & McMillen, 2007) stated that housing is the most important need of people after their physical needs. Therefore, it is the oldest and most primary type of real estate and people are constantly buying houses and it provides the formation of a market consisting of housing sales. It is also preferred as an investment tool, therefore some of the sales are purchased for investment purposes rather than necessity. In brief, the housing market is one of the important variables in an economy. The housing market is an economic indicator for nearly all countries since it benefits other economic instruments and has a high value.

In Turkey, 1,348,729 houses were sold in 2019, 1,499,316 in 2020, and 1,491,856 houses were sold in 2021 (Turkish Statistical Institute, 2021). Nearly half of these sales are made using mortgage, and banks are required to have a valuation report prepared for each mortgage. These reports are prepared by licensed appraisers. Appraisers examine the real estate physically on site and identify positive or negative factors that can affect the value in their reports. These reports are prepared according to the International Valuation Standards (IVS). In the concluding part of the report, it estimates the market value of the house.

Previous studies have shown that the impact of neighborhood characterization on the value of dwellings is frequently ignored. This study tests this issue with the locational data obtained from the Geographical Information Systems (GIS) analysis. Therefore, the valuation reports are preferred as dataset. Because in these reports, besides the building characteristics of the house, neighbourhood characteristics are also taken into consideration. In the study, 151 appraisal reports prepared for the houses in the Buca district in Izmir were provided from the appraisal company. The building characteristics data were filtered into these reports and their location was derived from the coordinates specified in the reports.

GIS have increased its prevalence in all areas due to advances in technology in recent years. The Parcel Inquiry application developed by the General Directorate of Land Registry and Cadastre in Turkey is a web-based GIS where people can easily learn the location and information of their properties. As well, many municipalities have provided web-based GIS platforms for real property in their population. Such developments increase the investments in GIS technologies.

In this study, data on neighbourhood characteristics in the study area were obtained through network analysis using ArcGIS Pro 2.5 software, one of the most commonly used GIS software. Thus, it was possible to statistically check whether the neighbourhood characteristics are effective in the value of the house. With Network Analysis, firstly, the distances of the houses to the important facilities determined. Subsequently, the density of the important facilities in the buffer zones was measured and added to the dataset.

It is important to create a model that can mathematically predict housing value. The model that is based on neighborhood and building characteristics minimizes the subjective evaluations and reduces the labor and provides objectivity for the valuation process.

The data obtained allowed us to analyze the effect of the building characteristics on the value of the dwelling. The same process was applied for neighbourhood

characteristics, and general and reduced regression models were created with SPSS-25 software. Thus, it was tested whether the neighbourhood characteristics have an effect on the value of the house. After that, the factors that are effective in determining the value of the dwelling were statistically analyzed. Last, whether the neighborhood characteristics are useful in estimating the value is interpreted in the end of the study.

CHAPTER 2
HOUSE TYPE PROPERTY AND VALUATION

2.1 Definition of the House and Market Data in Turkey

Real estate is defined as "property in the form of land or buildings" in the dictionary (Oxford Learner Dictionaries, 2021). As defined, it is immovable because its existence depends upon the earth. At the same time, the Cambridge Dictionary defines housing as "that people live in". For this reason, it is important for human life. People spend most of their time in their homes and they always want to own their homes. Those who cannot own a house will rent one to meet their need for shelter. Also, some sources describe the real asset as; "Physical assets that have an intrinsic worth due to their substance and properties. Real assets include precious metals, commodities, real estate, land, equipment, and natural resources." (https://www.investopedia.com). Similarly, Pagourtzi (2003) defined the real property as the full range of interests, benefits, rights, and charges inherent in the ownership of real estate.

Real estate is a global asset that people all around world aim to own one. In parallel for every income group, owning a real estate has been one of the most important goals in life (either to use as a shelter or to invest). In fact, Zang et al. (2018) empirically proved that homeownership is a significant factor that determines overall happiness.

In US, investments on housing are more than capital investments for other initiatives (Greenwood & Hercowitz, 1991). Yet, investment on a house is not simple. As all other investments, investors' decision on buying a house is influenced by the market prices. However, market prices or economical issues are not the only factor that influence an investors' decision to buy or not to buy a house. Expectancy about life satisfaction and social life also influence an investor's decision. For example, Painter & Redfearn (2002) investigate the factors that determine the willingness to own a house in United States and concluded that interest rates have

little impact on the issue. In fact, they said this had no effect on long-term demand for housing.

In Turkey, the situation is different. The main trigger of investing in housing in Turkey is the market price and low mortgage rates in comparison to the inflation rate. Çetin, (2021), stated that in Turkey the housing supply is above the demand. He believes that this disequilibrium is trying to be resolved by reducing the mortgage rates. Low mortgage rates encourage the use of mortgages and increases the demand to purchase housing. He also concluded that a systematic decrease in the mortgage rates would cause housing prices to rise.

2.1.1 House Sales Statistics in Turkey

Data for the purchase and sale of dwellings in Turkey are published by the Turkish Statistical Institute (TSI). Table 2.1 shows the number of housing sales in the last five years and the proportion mortgaged sales. (Turkish Statistical Institute, 2021)

Table 2.1 House Sales Statistics

Year	Mortgaged Sales	Other House Sales	Total House Sales	Percentage of Mortgaged Sales (%)
2017	473,099	936,215	1,409,314	33,6
2018	276,820	1,098,578	1,375,398	20,1
2019	332,508	1,016,221	1,348,729	24,7
2020	573,337	925,979	1,499,316	38,2
2021	249,530	1,197,326	1,491,856	19,7

As can be seen from Table 2.1, the number of mortgaged sales in Turkey between 2017 and 2020 ranged from 20% to 40% of the total sales. This rate down to under %20 in 2021. For each mortgage sales a valuation reports have been prepared to determine the market value of the dwelling based on a given standard. The valuation reports are prepared according to **International Valuation Standards (**IVS). These standards are determined and published by the **International Valuation Standards Council** (IVSC) which is the most respectful international authority on that matter.

2.2 International Valuation Standards and Valuation Approaches

According to IVS, there are three valuation approaches:

(a) Market Approach,

(b) Income Approach,

(c) Cost Approach.

2.2.1 Market Approach

According to IVS, the Market Value is defined as:

"The estimated amount for which an asset or liability should exchange on the valuation date between a willing buyer and a willing seller in an arm's length transaction, after proper marketing and where the parties had each acted knowledgeably, prudently and without compulsion." (IVS, 2021, p:18)

This method allows to determine the asset by comparing its value with the value of other assets having similar properties. According to IVS, this approach should be implemented in the following cases:

(a) asset to be valued have recently been sold at an appropriate value,

(b) the subject assets or similar assets to be valued are actively on sale, and/or

(c) there are often or recent observable processes in substantially similar assets.

The market approach can also be implemented under the following additional circumstances:

(a) transactions related to subject asset or similar assets are not quite recent, given the levels of volatility and market activity.

(b) subject asset or similar assets are purchased and sold in public but are not actively traded.

(c) information is available on market transactions, but similar assets have differences that need subjective correction.

(d) information about final trade is unreliable.

(e) the key factor that affects the value of the asset is the price it gets in the market instead of the cost of production or the ability to income-producing.

According to IVS, appraisers gather comparable market information and apply it if corrections are required for real property. The reasons for the corrections made and the way they are measured should be recorded. If information about subject asset exists, it's referred as "the prior transaction method". The comparable trading method determines the price per square meter and the rent per square meter. With this value, the value of the real estate is calculated by multiplying this value with the size of the real estate.

The data set used in the thesis was provided from such valuation reports as in Turkey this type of valuation is the most common way for private appraisal companies.

2.2.2 Income Approach

This approach is based on the valuation of income-producing real estate. It forecasts the future cash flows as a single value. In other words; according to this approach the value of an asset is based on the value of the income, cash flows or cost

savings data. In the thesis; this approach was not considered because this study is restricted to housing type real estates.

2.2.3 Cost Approach

This approach provides an estimate of value for an asset based on the economic principle that a buyer will not pay more than its cost. The estimated housing price with this approach will not reflect the real market. Therefore, this approach was not considered in the study.

2.3 Valuation Sector in Turkey

The real estate appraisal is applied differently in each country because of varying legal processes and buying preferences in each country. Therefore, different approaches are used in valuation. Considering the valuation studies in Turkey, it is generally tried to estimate market values. Such studies attempt to imitate buyers purchasing preferences (E. Pagourtzi, 2003).

In Turkey, part of the valuation reports, prepared for mortgages. These reports are produced by valuation companies authorized by Capital Markets Board of Turkey (CMB). Appraisers examine and report on the legal and technical features of houses. In addition to determining a house's value based on legal and technical issues companies use the house value of similar houses which are on sale during the valuation process. When there are houses that have been sold recently, the valuation will yield more precise results. In this way, they determine the market value of the house defined in the International Valuation Standards (IVS).

Figure 2.1 states the number of licensed real estate valuation companies by years (MKK Real Estate Information Center):
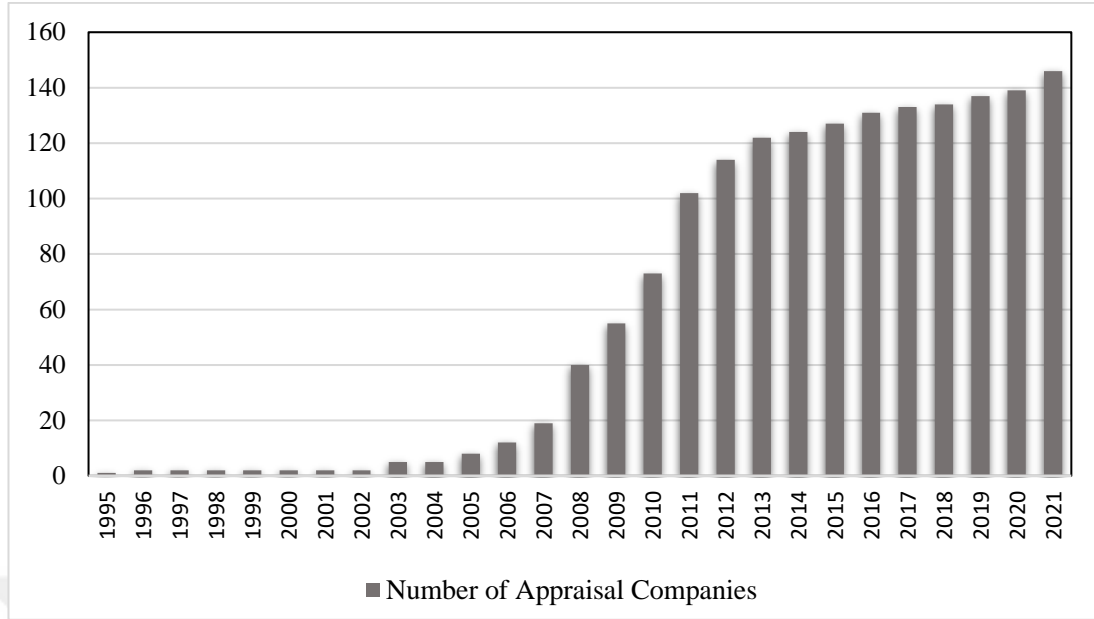
Figure 2.1 Change of the number of appraisal companies by year

The number of real estate valuation companies has increased rapidly every year since 2003. There are currently 146 valuation companies in Turkey. The total number of reports they have prepared over the past three years is presented in Figure 2.2 (MKK Real Estate Information Center). Data for the last quarter of 2021 have not yet been completed and therefore not included in the table. The figure shows that due to the discounts on mortgage loan rates in 2020, more valuation reports were needed than other years.
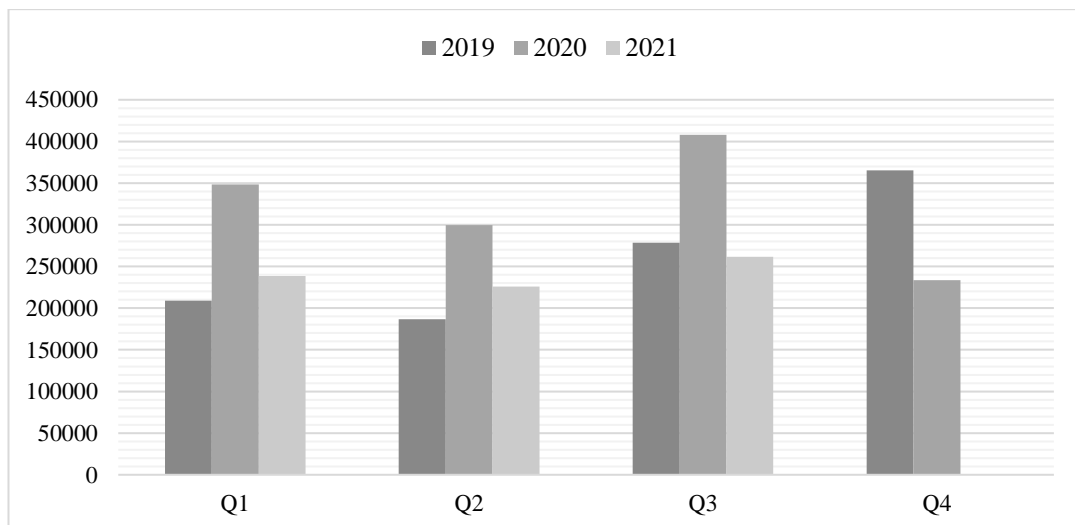
Figure 2.2 Total number of appraisal reports in Turkey

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Appraisal reports are prepared for all types of real properties. 73 percent of valuation reports prepared throughout 2020 were prepared for housing. The housing market appears to have a serious impact on the valuation sector. For 2021, 63 percent of the reports prepared over the nine-month period were prepared for housing. Figure 2.3 shows the share of other types of real estate until October 2021. (MKK Real Estate Information Center):
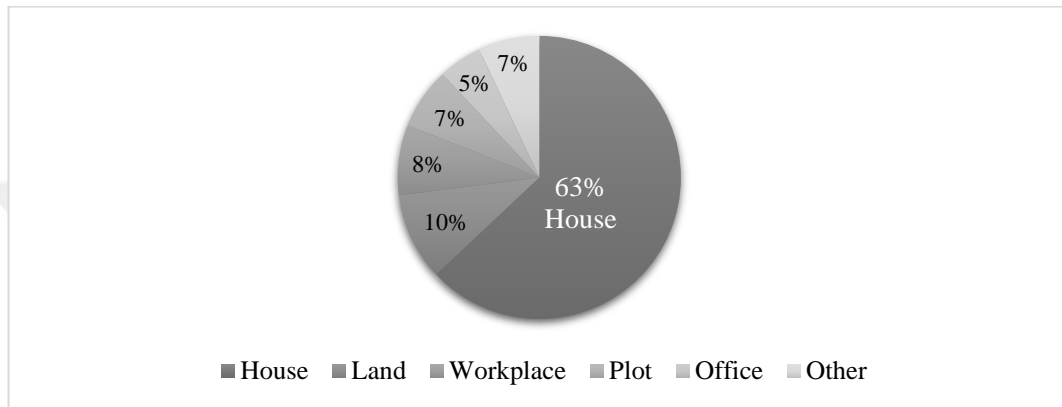
Figure 2.3 Distribution of real estate types of appraisal reports until October 2021

This thesis used the data set provided in 2020 for Buca District. 10% of appraisal reports prepared in all districts in Izmir were prepared for Buca. Also, among all types of real properties about %70 was prepared for houses. The number of reports and percentages of dwellings prepared in the Buca district of Izmir in 2020 are given in Figure 2.4 (MKK Real Estate Information Center).
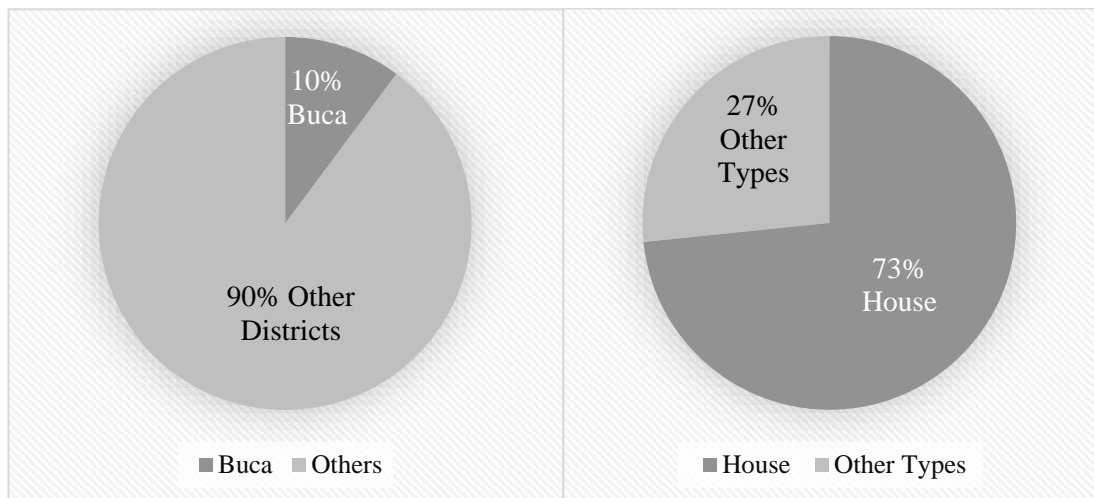
Figure 2.4 Distribution of the number of appraisal reports prepared in Izmir in 2020 by district and by real estate type

2.4 Use of Locational Factors in Appraisal Process

In housing appraisals, market value is generally determined. With this approach, the selling prices of similar houses are obtained from the market. These examples must be chosen from dwellings as close as possible to house and should have similar properties. Locational factors are based on an appraiser's personal interpretation. An example of a comparison table used by appraisers is shown in Table 2.2.

Table 2.2 Example of comparison table used in the appraisal process

Attribute	Comparable house for sale	Comparable house for sale	Comparable house for sale	Subject house
Location	Similar	Better	Worse	-
Size (m²)	100,00	110,00	90,00	100,00
Number of Rooms	3	3	2	3
Building age	10	5	15	5
Other Attributes	. . .	. . .	. . .	. . .
Price (TL)	250,000	330,000	180,000	*Estimated*

Table 2.2. shows that information from three similar dwellings has been used to determine the value of the subject house. The location advantage is similar in the first, better in the second and worse in the last. The appraiser determines a unit value by considering all other attributes for the dwelling. The value of the dwelling is estimated by multiplying the size of the dwelling by the unit value.

CHAPTER 3
COMPONENTS OF THE HOUSING VALUES

According to the literature various factors influence property value. Yet, these factors differ by the type of the property. Given that, type of the property should be determined first. Since this study is limited to housing values, potential factors that affect housing value will be discussed under two main headings: (1) neighborhood and (2) building characteristics. These two main headings have been determined according to the factors considered in the valuation reports examined in the thesis and used as data.
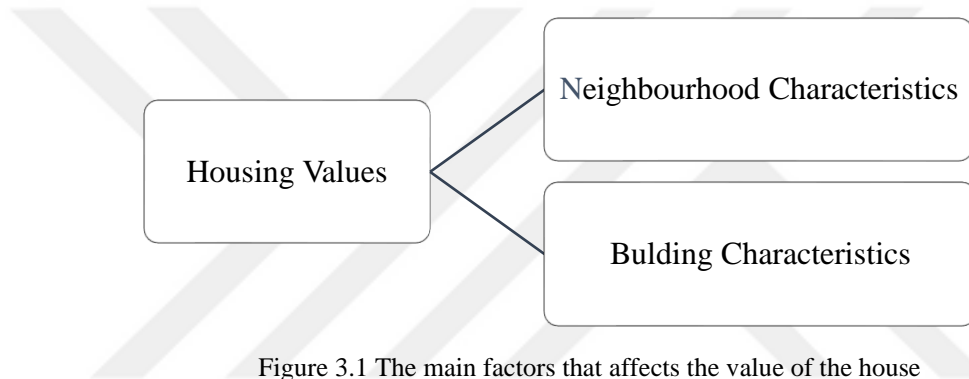
Figure 3.1 The main factors that affects the value of the house

3.1 Neighbourhood Characteristics

Every house has a land share and the most important factor affecting its value is its location. Due to the immobility of houses, the importance of the location on house prices becomes even more prominent. Kiel & Zabel (2008) stated that there was a common opinion that the only factor to determine the price of a house is its location.

Torres et al. (2013) focused on characteristics of the neighbourhood via 5 variables. These are; accessibility, cultural services, commercial services, and green areas. They stated that, neighbourhood characteristics were more efficient on the house value than building characteristics.

Archer et al. (1996) stated that housing prices change depending on site-related factors. In their study in Florida, they monitored the changes in a site for 21 years

and investigated the changes in housing prices and variations in the area. Distance to important places in the region, changes in population and housing stock are considered as important variables that influence house price. However, they found that these factors had a small impact on the value of the dwellings.

In brief, various parameters related to neighbourhood characteristics have been discussed in the relevant literature as determinants of house prices; some of which were found to be more important and some other were found to be less important. Among all these parameters the three most discussed features in these studies will be discussed in more detail in the next section; Accessibility to Various Destinations, Distance to the City Center, Distance to the Social Infrastructure, Walkability in the Neighborhood, and Environmental Noise, Pollution.

3.1.1 Accessibility to Various Destinations

This characteristic is related to the street network around the house. It is also related to the presence and density of various destinations (Gatheru & Nyika, 2015). Hayrullahoğlu (2017) investigated the value of the houses in relation to its proximity to main transportation roads. In their study, only the distance to two main roads was considered as a key neighborhood factor. In that study; as various confounding variables are ignored, non-locational factors were found to be much more effective than spatial properties of the neighborhood street network.

Yalpir, et al. (2014) in their study, they examined the impact of locational factors that on the housing values. Those factors are; distance to transportation network, social infrastructure, green areas, trade centers, university. Also Bulut (2011) has taken into account factors such as distance from police stations, parks, and hospitals. In each of the studies, different characteristics have been found to be important in different study areas.

3.1.2 Distance to The City Center

Distance to the city center; in some studies, the location advantage of the house has been considered only as the distance to the city center. Research showed that as distance to city center decreases the value increases. For example, Garcia et al. (2008) identified the city center as the oldest historical square in the city. However, that study is criticized for ignoring other related variables.

Yalpir et al. (2014) have established trade centers as a city center. Also, Yayar & Karaca (2014) considered health centrals as a central point in their study. They concluded that there were significant relationships between the proximity of the housing to the health center. In this thesis, no point selected for the city center. Instead, the important facilities are categorized and digitized in GIS software.

3.1.3 Distance to The Social Infrastructure

In literature, health centers, education facilities, parks, shopping malls, police stations, bus stations, marketplaces, public institutions, transportation networks, etc. thought to be effective in determining housing values. As demand for housing affects price, it is argued that houses close to such amenities tend to be more expensive. (Özen & Şişman, 2019; Yalpir et al. 2014; Gatheru & Nyika, 2015)

3.1.4 Walkability in the Neighborhood

According to (Yates & Miller, 2011) walkability affects the livability of the neighborhood. If residents to be able to go to work, school, hospital, etc. without using a motor vehicle, this prevents air pollution and decrease vehicle expenses. As a result, the neighborhood becomes preferable. Studies also show that as the neighborhood becomes more walkable, housing prices increase accordingly. (Li, et al., 2015)

3.1.5 Environmental Noise, Pollution, etc.;

Wilhelmsson (2000) argued that housing prices are lower in neighborhoods with noise pollution, such as heavy traffic. In parallel, Saptutyningsih (2013) states that substances that cause air pollution, such as carbon monoxide, negatively affect housing prices.

In brief, the effect of these above neighbourhood characteristics on housing values will be studied in this thesis.

Walkability, environmental noise, pollution, distance to the city center factors is not considered in the study. Because these parameters did not bring any major change to the study area and showed a homogeneous distribution. The distribution of important points throughout the area is heterogeneous, and in some areas, they are densely populated, and in some other areas they are less densely located. In other words, important facilities are social and commercial areas that are considered to be effective for the value of housing in the study area. Shopping centers, groceries, restaurants, railway stations, hospitals, universities, and green areas are considered as important areas. Given that; in this study, the distances between the important facilities and the dwellings and the densities of the important areas within the 400-meter buffer zone of the resident is measured.

The specified distance and density data were obtained via Geographical Information Systems (GIS). By using the ArcGIS Pro Network Analysis module, the distance and density data for the important facilities mentioned above were obtained. In the Figure 3.2, the distances of some houses to their nearest shopping centers were shown with ArcGIS Pro software. It is expected that the distance to shopping centers will have a negative effect on the value.
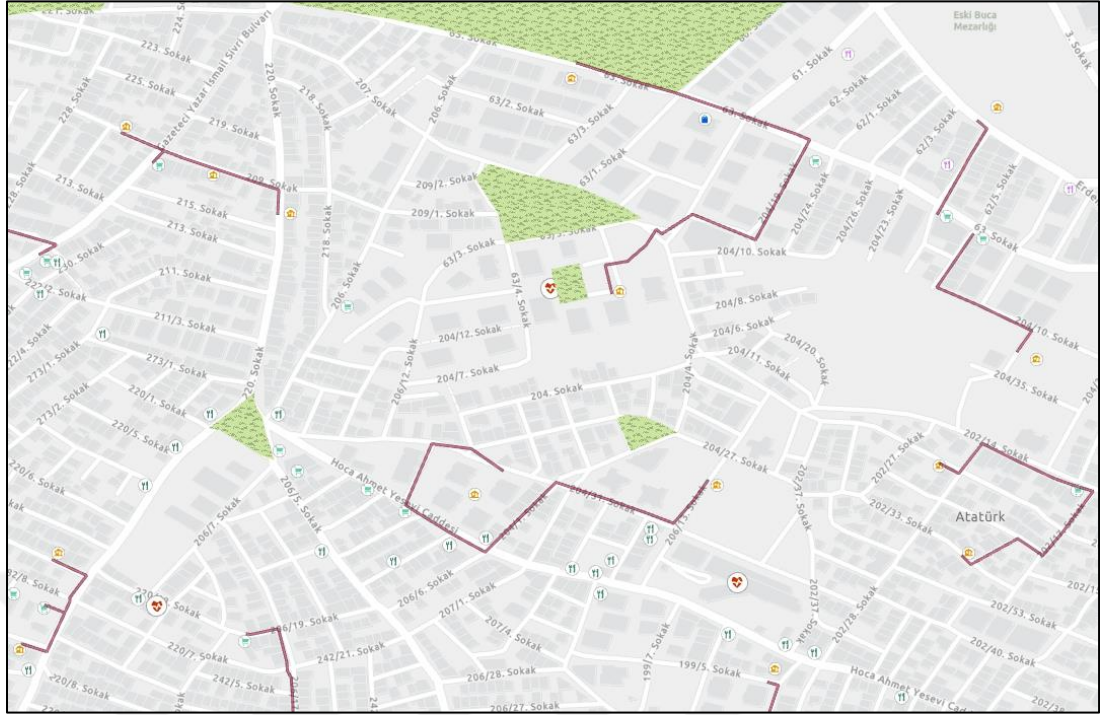
Figure 3.2 Analysis of the distances of houses to the closest shopping centers

In brief, location is considered to be the main factor that affects the value of a property. However, location is measured via various variables. Such as being in one district or another or being close to a specific destination. Although voluminous number of studies investigate the influence of various factors related to location on house price; common and generally accepted results could not be obtained. As the measures and the combination of parameters of interest change from one study to another voluminous number of studies produced conflicting findings.

This study aims to review the literature with that perspective and will develop a methodology that uses the most appropriate parameters and their measures. As the factors identified by previous studies were very diverse and open to interpretation; in this study 15 neighbourhood characteristics were specified and measured as below shown in the Table 3.1.

Table 3.1 Neighbourhood characteristics for the Buca District

LOCATIONAL ATTRIBUTES / NEIGHBOURHOOD CHARACTERISTICS	ID	IMPORTANT FACILITES / DESTINATIONS
Distance to the closest *(meter)*	1	Shopping Center
	2	Grocery
	3	Global Restaurant
	4	Local Restaurant
	5	Railway Station
	6	Hospital
	7	University
	8	Green Area
Density within 400-meter buffer area *(meter, square meter for green areas)*	9	Shopping Centers
	10	Groceries
	11	Global Restaurants
	12	Local Restaurants
	13	Railway Stations
	14	Hospitals
	15	Green Areas

3.2 Building Characteristics

The building characteristics of the dwelling directly affect its demand, which can have a positive or negative affect on the price of the dwelling. The characteristics related to the building characteristics in the related literature are described below.

3.2.1 Size of The House

The size of the dwelling determines the number of persons that can live in it. For this reason, the house size is very important, especially for families. The value of the housing is expected to increase as its size increases. In almost every study, the size of the dwelling has been considered as one of the main factors that determines its value

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(Bohari et al. 2015; Saraç, 2012; Gatheru & Nyika, 2015; Tabar & Şişman, 2020; Hayrullahoğlu et al. 2017; Brondino & Silva, 1999; Garcia et al. 2008; Yalpir et al. 2014; Demirel et al. 2016).

Turnbull et al. (2006) found that neighbourhood characteristics were effective in selecting the size of the dwelling. In neighbourhoods where families prefer the most, there is a demand for large-scale housing. On the other hand, single people prefer small houses for various reasons. He also mentioned that property taxes are more costly for larger dwellings than for smaller ones.

In the valuation process, the appraiser must detect the unit price of the housing in the neighbourhood. With this value, the value is calculated by multiplying this value with the size of the housing. Since this study uses a dataset of valuation reports, the size of the dwellings is very important.

In previous studies, the datasets were usually provided by real estate agents or surveys. This reduces the reliability of the data. In this study, housing size is calculated from architectural projects. This provides more accurate results.

3.2.2 Building Age

In previous studies, the age of the building negatively affects the value of the dwelling (Demirel et al. 2016; Tabar & Şişman, 2020; Saraç, 2012; Hayrullahoğlu et al. 2017; Garcia et al. 2008; Selim & Demirbilek, 2009; Amca, 2016). A dwelling's physical aging decreases the demand for it. Because of lower demand, the value of the asset is expected to decrease.

Garcia et al. (2008) argued that the value has decreased as the age increases for large dwellings. However, they also stated that as long as the size of the dwelling decreases, the value decreases to a certain point along with the age. This showed an interesting result, such as age showing non-linear behavior to housing value.

Güler et al. (2019) conducted their study in Rize province with the aim to determine the factors that affect the housing price. The housing value is determined as a dependent variable, and as independent variables, building age, the size of the house, elevator, view, number of rooms, build quality and heating system were used. 100 surveys were performed in the household to create the dataset. The results showed that only the housing age negatively influences the value of the dwelling.

3.2.3 Number of Rooms

Besides the size of the housing, the number of rooms in a house is also important to people. It's usually important to have a room for each person. Hence, the increase in the number of rooms does not only increase the size of the housing, it also adds the functionality of it. Therefore, increases in the number of rooms affects the house price positively (Hayrullahoğlu et al. 2017; Güler et al. 2019; Nas, 2011; Tabar & Şişman, 2020; Demirel et al. 2016; Yalpir et al. 2014; Garcia et al. 2008).

Nas (2021) stated that there is a reciprocal relationship between the number of rooms and the housing area. The growth in the size of the house often increases the number of rooms. Therefore, one of these two variables was used in the study. Of the houses with an equal number of rooms, the largest indicated a greater value. Therefore, the number of rooms variable has been removed from the models. When valuation reports are reviewed, similar houses for sale are chosen from those with the same number of rooms as the dwelling.

3.2.4 Number of Balconies

As the number of rooms increases the functionality of the dwelling, the presence of the balcony is a factor of the demand for it. The balcony also provides the advantage of the view, especially in high-rise buildings. (Tabar & Şişman, 2020; Garcia et al. 2008). Garcia et al. (2008) found that the presence of the balcony had a positive effect on the value of the dwelling. When valuation reports are reviewed, similar houses for sale are chosen from those with the similar use of balcony as the dwelling.

3.2.5 Number of Bathrooms

Number of bathrooms an effective factor in housing preference. Each person wants to have their own bathroom. Therefore, the number of bathrooms is expected to increase the value of the dwelling (Nguyen & Cripps, 2001; Garcia et al. 2008; Demirel et al. 2016; Tabar & Şişman, 2020; Daşkıran, 2015). When valuation reports are reviewed, similar houses for sale are chosen from those with the similar use of bathrooms as the dwelling.

3.2.6 Total Number of Floors in the Apartment

Building quality is an important factor in the demand for housing purchase. These buildings offer advantages like view, better quality, safety etc. (Demirel et al. 2016; Amca, 2016). Because of these features, high-rise buildings are more preferred. However, it was seen that there was no high-rise building in the study area. When valuation reports are reviewed, similar houses for sale are chosen from those with the buildings of similar heights as the dwelling.

3.2.7 The Floor the House is Located on

It has been observed that the ground and top floors are less preferred than the other floors. Therefore, houses located on the middle floors are more valuable (Amca, 2016; Demirel et al. 2016; Daşkıran, 2015). Demirel et al. (2016) shown that this factor has a significant effect on the housing values. When valuation reports are reviewed, similar houses for sale are chosen from those with the apartments of similar heights as the dwelling.

3.2.8 Type (Gated Community or Not)

The security of a neighbourhood is very important for people. It is expected that houses in secure neighbourhoods would have higher values. Likewise, this security can also be physically provided; when the house is located in an environment which is surrounded by walls or when the house involves a security system. Such physical

features increase the housing value. Eksioglu (2010) investigated the perceived neighbourhood security and found that dwelling in secure neighbourhoods are preferred more by people. In other words, amenities related to security increase the people's desire to own such type of housing.

The valuation reports show that appraisers compare such dwellings to the same ones. So, it's been seen that gated communities are not compared to other types of housing. Also, some of these dwelling include amenities such as swimming pools, playgrounds, gymnasium are considered factors that increase value. If the housing is gated communities, it allows such benefits (Yayar & Karaca, 2014).

3.2.9 Presence of Elevator

Elevator is a factor that increases the value of the houses in high-rise buildings (Garcia et al. 2008; Saraç, 2012; Selim & Demirbilek, 2009; Daşkıran, 2015; Güler et al. 2019). Güler et al. (2019) concluded that there was a significant relationship between the presence of the elevator and the increase in the housing value. When valuation reports are reviewed, similar houses for sale are chosen from those with same usage of elevator as the dwelling.

3.2.10 Presence of Parking Lot

Some central neighbourhoods may not have enough parking spaces. In these neighborhoods, the demand for housing is reduced (Daşkıran, 2015; Nas, 2011; Afşar et al. 2017). Afşar et al. (2017) showed that the presence of parking lot is important for the housing value. Also, Daşkıran (2015) in his research in the Denizli province pointed out that housing prices are higher in neighbourhoods that have sufficient parking space. When valuation reports are reviewed, similar houses for sale are chosen from those with the same usage of parking lot as the dwelling.

3.2.11 Presence of Heating System

It has been observed that houses with heating systems are of higher value. If the dwelling has a heating system, the type of fuel used is also important for the potential buyers. Demirel et al. (2016) & Daşkıran (2015) concluded that housing with heating systems has higher prices. It has been observed that the common fuel usage in the study area is natural gas. Therefore, it is expected that housing with this type of fuel is more expensive. When valuation reports are reviewed, similar houses for sale are chosen from with the same heating system as the dwelling.

3.2.12 Building Quality

The construction quality of the building affects the selling price of the house positively. Saraç (2012) pointed out that the quality of the building is related to the material and the labor. These factors have an impact on the cost of the property and the selling price. Güler et al. (2019) found that there is a statistically significant and positive relationship between material quality and housing price. When valuation reports are reviewed, similar houses for sale are chosen from those with the saimilar build quality as the dwelling.

Among the parameters considered in previous studies regarding building characteristics, 12 parameters were used in this thesis. The content and measurement types are listed below (Table 3.2).

Table 3.2 Building characteristics for the study area

ID	ATTRIBUTE TYPE	MEASUREMENT
1	Size of the house	Square meter
2	Building age	Years
3	Number of rooms	Digit
4	Number of balconies	Digit
5	Number of bathrooms	Digit
6	Total number of floors in the apartment	Digit

Table 3.2 Continues

7	The floor the house is located on	Digit
8	Type (gated community or not)	1: Yes 0: No
9	Presence of elevator	1: Yes 0: No
10	Presence of parking lot	1: Yes 0: No
11	Presence of heating system	1: Yes 0: No
12	Building quality	Quality level from 1 to 5

The parameters related to building characteristics differs between studies. Although some studies show a holistic approach and involve many of the parameters mentioned above, some focuses only on one or two of these parameters. Although studies vary on the consideration of independent variables about building characteristic; results were generally parallel.

The above-mentioned building characteristics were usually measured by surveys or real estate agent's subjective evaluations. Yet these data sources are not reliable. On the other hand; the valuation reports of the appraisers have better potential to give more accurate and objective information. Given that that data set is used in this thesis.

In addition, when multiple variables are used in a study; the influence of some variables surpass the influence of other variables. For example, the number of rooms is insignificant when the house area variable exists. Moreover, studies rank the influence of various variables. For example, heating system is not effective as the other variables.

3.3 Statistical methods to study House Prices

The literature review showed that many statistical methods such as Hedonic Pricing Method, Artificial Neural Networks, Fuzzy Logic, Ordinary Least Square and Support Vector Machines were used to study House Prices. The literature review

showed us there are models which suitable for collective valuation and GIS-based value map production have been tried to be determined.

Yalpır (2007) examined the valuation methods/models under three main headings: Traditional Methods, Statistical Methods, and Modern Appraisal Methods. In this study, studies were reviewed, and it is seen that studies tend to use one of the two models: "Artificial Neural Networks" & "Hedonic Pricing Model". The first model can also be called Modern Valuation Methods and the last one is referred to as Statistical Valuation Methods. As this thesis focused on the hedonic pricing model, previous studies related to this subject were reviewed in the literature.

3.3.1 Hedonic Pricing Model

The price of an asset can be expressed as the sum of the prices of the variables that forming it. This value may be defined as the hedonic price for the assets. Therefore, the hedonic pricing model is used to measure the effect of characteristics owned by a property on its price (Rosen, 1974).

The price of the dwelling can be reduced to its components. In parallel, prices may be determined for some of these components. The hedonic price model is the most common method for this issue. (Alkay & Ocakçı, 2003).

The main purpose of the hedonic pricing model is to create a predictive model. This model is also referred to as the regression model where each factor regarding the building and neighbourhood characteristics is introduced as coefficients in the model (Monson, 2009). Having various independent variables (building and neighbourhood characteristics) various models could be run and the best fit must be chosen (McLeod, 1984). The model chosen shows the major and significant factors that influence house price. For example, O'Sullivan (2002) showed that a house buyer considers the housing structure, location, neighbourhood, environmental characteristics etc. as significant factors that influence house price.

3.3.2 Previous Studies on the Hedonic Pricing Model

Güler et al. (2019) in their study, used variables such as area of the house, housing material quality, heating system, socio-economic level of the district, sea view and building age as independent variables in the regression model. The data set was formed by 100 surveys held with households. The results showed that, 11.1% difference was found between the actual housing prices and estimated housing prices. According to the results, the quality of housing material is the most important variable affecting the price of the house. The model was based on one-year data set. This was referred as one of the limitations of the study and future work is encouraged to replicate the study with several years of data.

Selim & Demirbilek's (2009) study also relied on surveys. They used the Household Budget Survey Data which was published by Turkish Statistical Institute. The dataset included 7514 house rental value. Hedonic method and Artificial Neural Network method were employed and compared in the study. The independent variables included; type of house, building age, flooring type of rooms and bathrooms, heating system, number of rooms, size of the house etc. Variables related to neighbourhood characteristics were not used in this study. According to the result of the study, the most important variables affecting the house rent were found to be house type, the number of rooms, and the size of the house. In addition, the rental values obtained from the Artificial Neural Network model were found closer to the actual rental values.

Gatheru & Nyika (2015) aim to combine the Geographical Information Systems (GIS) data with the hedonic pricing model. Since the subject of the study are land type properties, locational factors have been considered. Among the neighbourhood characteristics they considered, they found that easy access to the main road and primary schools had an impact on the dwelling value. In hedonic pricing model, he stated that a more precise result would be obtained by eliminating variables that do not have a significant impact on value.

Eksioglu (2010) tested the effect of environmental aesthetics on the value of houses using a hedonic pricing model. For the dataset, 100 dwellings were surveyed by real estate agencies. In addition, surveys have been conducted on environmental esthetics. With the obtained data, the effect of the environmental esthetic on the housing value has been statistically tested. As a result, aesthetic variables, such as better urban qualities and aesthetically pleasing environments have a statistically significant positive effect on housing prices.

Daşkıran (2015), conducted 102 surveys with households in Denizli province. They employed logarithmic regression model the influence of various factors on house prices. At the end of the study, it has been revealed that there is a significant relationship between the floor on which the house is located, the number of elevators, the number of rooms, the number of bathrooms. He also stated that there is no significant relationship between the age of the house and its value.

Yayar & Karaca (2014) collected the housing characteristics data by filling out survey forms to real estate agencies in the study area. 21 of the 32 variables they used have a significant impact on the housing value. The most important variables that had a positive effect of the value of the house were found to be the number of bathrooms, the heating system, the presence of elevator.

Kördiş et al. (2014) has collected information such as size, distance to the coastline, heating system, view, type, building age, number of total floors in the apartment, the floor on which the house is located on, number of rooms, number of bathrooms, frontier, elevator, parking lot, swimming pool, gated community or not, and presence of the security system of the 2,067 dwellings in Antalya province. The study conducted across the province, then the neighborhoods were divided into three main groups, the lower, middle, and upper income group. After statistical analyses, the most effective value factor was determined to be the size of the dwelling. It is argued that the 1% increase in housing size raises its value by 0.77%. Moreover, the distance to the coastline and the building age has an adverse effect on the value.

CHAPTER 4
METHODOLOGY

4.1 Information About The Study Area

In this study, Izmir Province, Buca District was chosen as the study area. Buca has an area 180 square kilometers and it's located on the 9 kilometers southeast of Izmir. Buca is among the fastest growing counties in terms of population growth. According to the last census, it was the fastest growing district at the metropolitan level in 1990 with an increase rate of 97% compared to 1980. Migration to the district continues today. Migrations that started from east to west in the 1950s also affected Buca. In addition, the presence of Evka 1, Izkent, Ege-Koop, Buca Koop residences in the district and the establishment of many faculties have accelerated the migration to the district in recent years. The population, which was 203,383 in 1990 and 285,250 as of 1997, reached 314,638 (according to unofficial results) in 2001. According to the 2007 population of Turkey Statistics Institute releases 400 930, while in 2008 the population of 407 526. (Website of Buca Municipality, 2021). The borders of Buca district on the satellite image are shown in the Figure 4.1.
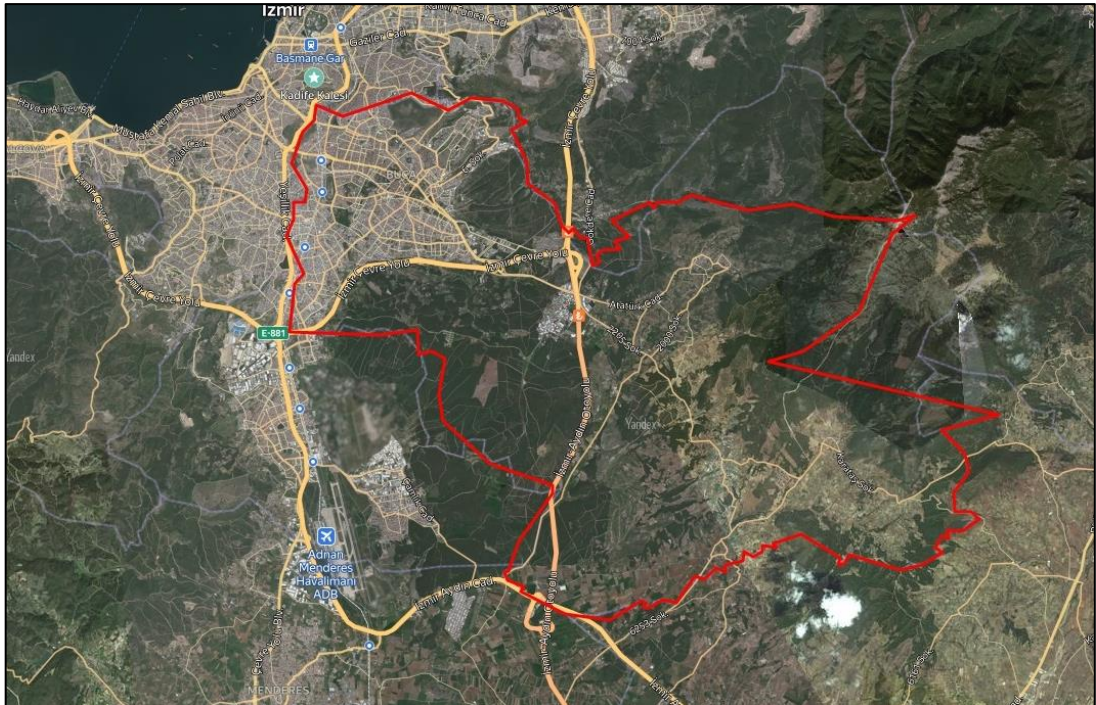
Figure 4.1 Location and borders of Buca district on satellite image

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4.2 Data Source and Integration with GIS

According to Yomralıoğlu (2000) GIS can store graphical and qualitative data in a linked database. It provides accurate results as long as it is kept up to date and saves time and money (Özen & Şişman, 2019).

Özen & Şişman (2019) in his study, produced raster layers belongs to the regions preferred on an urban basis. In this way a value map has been created. It is thought that some of these raster layers can also be used as vectors. The variables they use are schools, hospitals, parks, malls, trading centers, bus stations, public institutions, transportation network, highways, and university.

In this study, the locations of the houses for which the value data is known, and the building and neighborhood characteristics were transferred to ArcGIS software as vector layers. The data set was obtained from 151 valuation reports prepared by appraisers in Buca District in 2020. This data has been obtained from a provided the valuation company licensed by Capital Markets Board of Turkey (CMB). The point layer of 151 houses is shown in the Figure 4.2. As shown in the figure the data was homogenously distributed across the study area.
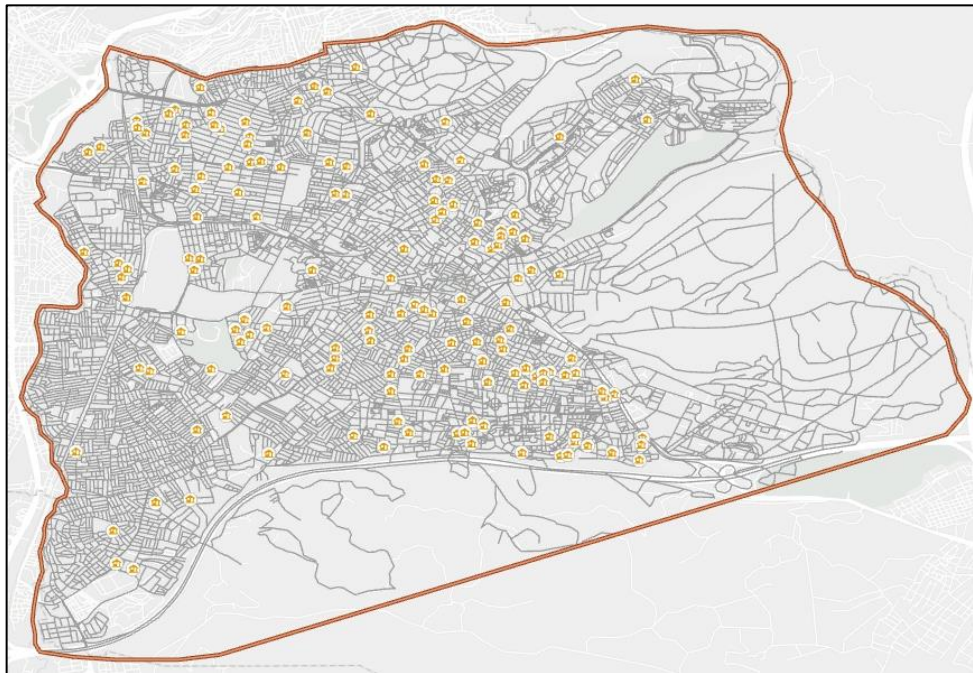

Figure 4.2 Houses and road network in the study area

From these reports information about the size, age, the number of rooms, balconies, bathrooms, the total number of floors in the apartment and the floor on which the house is located on, presence of an elevator, parking lot, and heating system, type of house (gated community or not) and building quality was obtained for each house. All data is imported into attribute tables for each house layer.

After specifying the exact location of 151 houses in ArcGIS Pro software as a point layer, a street network data has been added to the database as a line layer for the network analyses. Moreover, a point layer for important locations işn Buca district is produced. To do that; the location of 8 important type of destinations (shopping center, grocery, global restaurant, local restaurant, railway station, hospital, university, green area) were digitized and added to the geodatabase as a point layer. In addition, university area and green areas were added as a polygon layer. The information about these destinations were derived from OSM provided by Google and transferred to ArcGIS Pro software and updated by on site observations. After running the network analyses on street network data, it is possible to measure the closest distance to each amenity from each house.

4.3 Network Analysis in GIS

ArcGIS Pro software allows accessibility queries to be made with the Network Analysis module if there is a line layer representing road networks. Network Analysis modules included in the software are listed below.

a) Service Area
b) Route
c) Closest Facility
d) Location-Allocation
e) Origin Destination Cost Matrix

In the study, the "Closest Facility" module was used to measure the closest distances from 151 houses to 8 important facilities (shopping center, grocery, global

restaurants, local restaurants, railway station, hospital, green area, and university). The distances were calculated in meters. Figure 4.3 shows an example of that analysis.
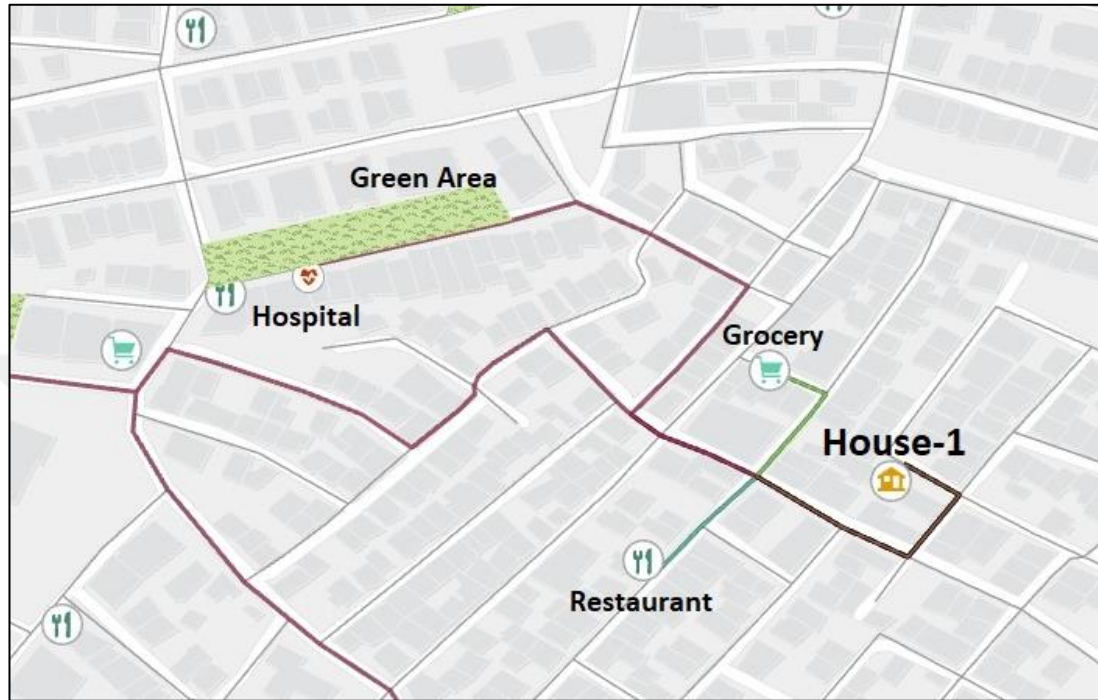
Figure 4.3 Measurement of the distance to the closest facility from the house

Next, the "Service Area" module was used. With the help of this module, buffer areas of 400-meters have been created for each house by using the existing street network data (Figure 4.4). In the study, the pedestrian and the vehicle roads were not held as separate. Because pedestrians may walk on any path. In the study area there was no road of detecting a vehicle that pedestrians couldn't walk. Given that, the buffer areas were determined based on the street network that treats pedestrian paths and vehicle roads as similar. Important points in these buffer areas were counted with the help of software and recorded in the attribute table. For green areas the number of areas in the buffer area was calculated in square meters. As the university area is a land use that serves the entire city, not the neighbourhood, only the closest distance was measured, its density within the buffer area was not calculated.

In brief, 8 closest distance measures and 7 density measures (within the buffer zones) were calculated via Network Analyses. These 15 data will provide a database of neighbourhood characteristics used in the study.
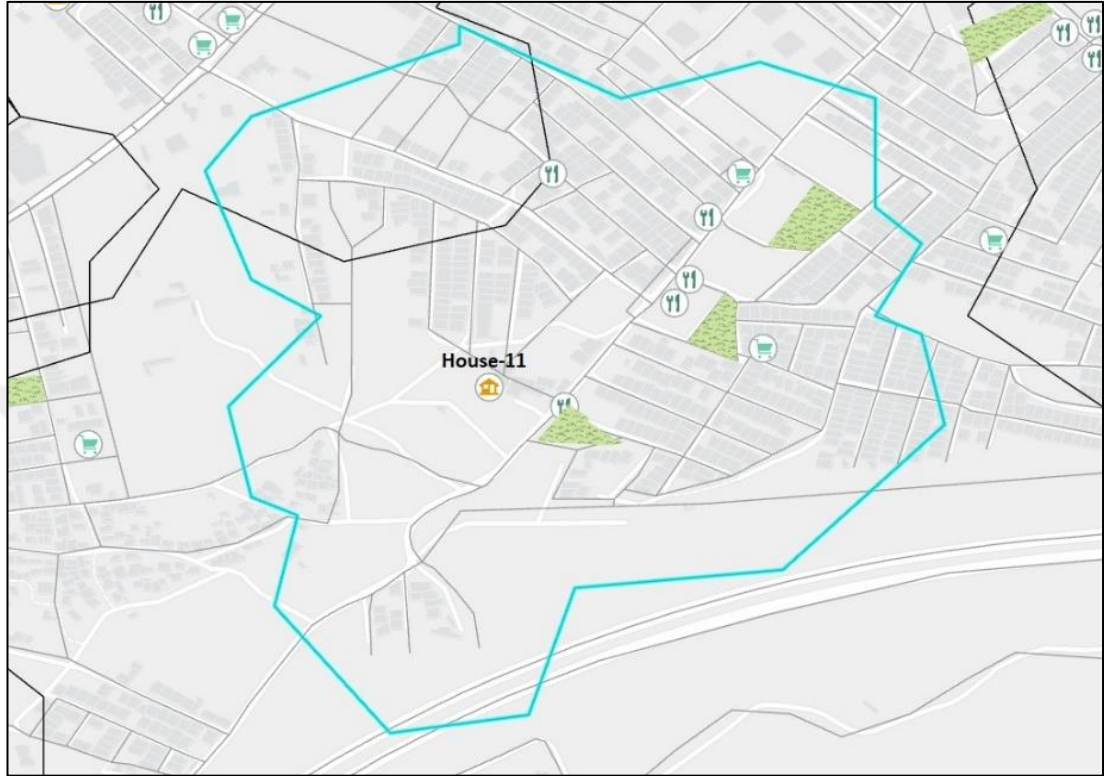
Figure 4.4 400-meter buffer zone of the house

CHAPTER 5
STATISTICAL INFERENCE

Linear Regression Models were run to identify the significant factors that influence house price. Firstly, the effect of building characteristics on housing value was analyzed. Housing values were chosen as the dependent variable, and 12 building characteristics were selected as independent variables (Table 5.1). After that, with the Backwards Method, variables that have a significant effect on the value have been determined (Table 5.2). According to the model; Size, Number of Rooms, Elevator, Parking lot, Type, and Build quality had a significant effect on the house value.

Table 5.1 Coefficients table of all building characteristics variables

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-125925.276	35607.532		-3.536	.001
	Size	2012.594	265.234	.556	7.588	.000
	Number of rooms	38695.957	9606.548	.275	4.028	.000
	Bathroom	5758.845	8539.799	.029	.674	.501
	Balcony	3846.896	6681.299	.028	.576	.566
	Building age	-644.913	494.177	-.067	-1.305	.194
	The floor the house is located on	-4232.347	2786.153	-.069	-1.519	.131
	Total number of floors in the apartment	-361.252	2780.798	-.008	-.130	.897
	Heating system	2314.736	12342.416	.007	.188	.852
	Elevator	19826.940	11790.621	.082	1.682	.095
	Parking lot	32322.997	10438.400	.137	3.097	.002
	Type	68267.284	17144.123	.211	3.982	.000
	Build quality	41862.708	9585.846	.214	4.367	.000
a. Dependent Variable: Value (TL)						

According to Table 5.1, building age, the floor the house is located on and total number of floors in the apartment variables have a negative effect on the value. The increase of all other factors increases the value of the housing.

After eliminating all insignificant variables, the Backwards method was rerun in the SPSS software as the Linear Regression Analysis. As shown in Table 5.2, the significant effect of all variables remained. In other words, variables that; size, number of rooms, elevator, parking lot, type, build quality have a statistically significant impact on the housing value.

Table 5.2 Coefficients table of building characteristics obtained by the backwards method

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
7	(Constant)	-152516.139	29281.369		-5.209	.000
	Size	2026.829	232.861	.560	8.704	.000
	Number of rooms	38896.640	9267.166	.276	4.197	.000
	Elevator	22241.532	9645.329	.092	2.306	.023
	Parking lot	31817.934	10193.772	.135	3.121	.002
	Type	54452.728	13512.852	.168	4.030	.000
	Build quality	49577.090	7721.705	.254	6.420	.000
a. Dependent Variable: Value (TL)						

According to the Table 5.2, the square meter increase in size increase provides a 2026.83-TL increase over the value. Also, the value increases by 38896.64-TL for each room. The presence of the elevator increases the value by 22241.53-TL, parking lot 31817.93-TL, type 54452.72-TL, and Build quality 49577.09-TL.

The same process was applied for neighbourhood characteristics, and results showed that distances to the closest, Shopping Center, Hospital, Global Restaurant, University, Green Area, and Density of the Groceries within the 400-meter buffer zone had a significant effect on the house value (Table 5.4).

Table 5.3 Coefficients table of all neighbourhood characteristics

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	169361.385	75952.924		2.230	.027
	Distance_shop	-140.452	30.274	-.630	-4.639	.000
	Distance_grocery	-80.295	111.757	-.072	-.718	.474
	Distance_globalrestaurant	55.800	20.737	.409	2.691	.008
	Distance_localrestaurant	-17.064	51.887	-.042	-.329	.743
	Distance_railway	2.181	8.021	.027	.272	.786
	Distance_hospital	93.011	32.953	.377	2.823	.005
	Distance_university	52.541	23.957	.385	2.193	.030
	Distance_greenarea	112.401	71.361	.119	1.575	.118
	Density_hospital	8879.157	20202.805	.049	.440	.661
	Density_railway	25002.390	47028.722	.042	.532	.596
	Density_globalrestaurant	1488.434	3640.128	.039	.409	.683
	Density_localrestaurant	-929.274	1895.744	-.051	-.490	.625
	Density_grocery	3767.579	3318.322	.115	1.135	.258
	Density_shop	-11518.240	17675.139	-.062	-.652	.516
	Amount_Greenarea	-.118	.292	-.038	-.403	.688
a. Dependent Variable: Value (TL)						

In the Table 5.2, all neighborhood characteristics variables have been used and their effects measured. After that, the Backwards method has been selected in the SPSS software as the Linear Regression Analysis. As shown in Table 5.4, variables that; distance to the shopping center, global restaurant, hospital, university, green area, and density of the groceries have a statistically significant impact on the housing value. All other factors are statistically insignificant on the housing value.

Table 5.4 Coefficients table of neighbourhood characteristics obtained by the backwards method

<table>
<tr><th colspan="8">Coefficients^a</th></tr>
<tr><td colspan="2" rowspan="2">Model</td><td colspan="2">Unstandardized Coefficients</td><td>Standardized Coefficients</td><td rowspan="2">t</td><td rowspan="2">Sig.</td></tr>
<tr><td>B</td><td>Std. Error</td><td>Beta</td></tr>
<tr><td rowspan="7">10</td><td>(Constant)</td><td>152816.747</td><td>40499.852</td><td></td><td>3.773</td><td>.000</td></tr>
<tr><td>Distance_shop</td><td>-127.322</td><td>20.070</td><td>-.571</td><td>-6.344</td><td>.000</td></tr>
<tr><td>Distance_globalrestaurant</td><td>52.063</td><td>16.304</td><td>.382</td><td>3.193</td><td>.002</td></tr>
<tr><td>Distance_hospital</td><td>76.760</td><td>17.627</td><td>.311</td><td>4.355</td><td>.000</td></tr>
<tr><td>Distance_university</td><td>47.804</td><td>15.850</td><td>.350</td><td>3.016</td><td>.003</td></tr>
<tr><td>Distance_greenarea</td><td>118.347</td><td>64.748</td><td>.126</td><td>1.828</td><td>.070</td></tr>
<tr><td>Density_grocery</td><td>4658.033</td><td>2378.562</td><td>.143</td><td>1.958</td><td>.052</td></tr>
<tr><td colspan="8">a. Dependent Variable: Value (TL)</td></tr>
</table>

Using these tables, full and reduced models were created, and An F-test has been applied to check if the variables extracted from the general model are significant to the model.

5.1 Full and Reduced Models

5.1.1 Model-1: All Building and Neighbourhood Characteristics

For the F Test, full and reduced models were created using coefficients tables from the SPSS software. The first model includes all the building characteristics in Table 5.1 and all the neighborhood characteristics in Table 5.3. In the reduced version of that model, variables containing all the neighbourhood characteristics were removed.

Table 5.5 Full and reduced model-1

ID	Full Model-1	ID	Reduced Model-1
1	Type	1	Type
2	Size	2	Size
3	Elevator	3	Elevator
4	Build quality	4	Build quality
5	Parking lot	5	Parking lot
6	The floor the house is located on	6	The floor the house is located on
7	Balcony	7	Balcony
8	Number of rooms	8	Number of rooms
9	Bathroom	9	Bathroom
10	Heating system	10	Heating system
11	Age	11	Age
12	Total number of floors in the apartment	12	Total number of floors in the apartment
13	*Distance to shop*		**R² Value = 0.836**
14	*Distance to grocery*		
15	*Distance to global restaurant*		
16	*Distance to local restaurant*		
17	*Distance to railway*		
18	*Distance to hospital*		
19	*Distance to university*		
20	*Distance to green area*		
21	*Density of shop*		
22	*Density of grocery*		
23	*Density of global restaurant*		
24	*Density of local restaurant*		
25	*Density of railway*		
26	*Density of hospital*		
27	*Density of green area*		
R² Value = 0.854		

5.1.2 Model-2: All Building Characteristics and Reduced Neighbourhood Characteristics

As a second model, the full model uses all the building characteristics in Table 5.1 and reduced neighbourhood characteristics in Table 5.4. In the reduced version of that model, the variables containing neighbourhood characteristics were removed.

Table 5.6 Full and reduced model-2

ID	Full Model-2	ID	Reduced Model-2
1	Type	1	Type
2	Size	2	Size
3	Elevator	3	Elevator
4	Build quality	4	Build quality
5	Parking lot	5	Parking lot
6	The floor the house is located on	6	The floor the house is located on
7	Balcony	7	Balcony
8	Number of rooms	8	Number of rooms
9	Bathroom	9	Bathroom
10	Heating system	10	Heating system
11	Age	11	Age
12	Total number of floors in the apartment	12	Total number of floors in the apartment
13	*Distance to hospital*	**R² Value = 0.836**	
14	*Distance to green area*		
15	*Distance to global restaurant*		
16	*Distance to shop*		
17	*Distance to university*		
18	*Density of grocery*		
R² Value = 0.850			

5.1.3 Model-3: Reduced Building Characteristics and All Neighbourhood Characteristics

As a third model, the full model uses the reduced building characteristics in Table 5.2 and all the neighborhood characteristics shown in Table 5.3. In the reduced version of that model, the variables containing all the neighbourhood characteristics were removed.

Table 5.7 Full and reduced model-3

ID	Full Model-3	ID	Reduced Model-3
1	Size	1	Size
2	Number of rooms	2	Number of rooms
3	Elevator	3	Elevator
4	Parking lot	4	Parking lot
5	Type	5	Type
6	Build quality	6	Build quality
7	*Distance to shop*		**R² Value = 0.810**
8	*Distance to grocery*		
9	*Distance to global restaurant*		
10	*Distance to local restaurant*		
11	*Distance to railway*		
12	*Distance to hospital*		
13	*Distance to university*		
14	*Distance to green area*		
15	*Density of shop*		
16	*Density of grocery*		
17	*Density of global restaurant*		
18	*Density of local restaurant*		
19	*Density of railway*		
20	*Density of hospital*		
21	*Density of green area*		
R² Value = 0.848			

5.1.4 Model-4: Reduced Building and Neighbourhood Characteristics

As the fourth model, the full model uses reduced building characteristics in Table 5.2 and reduced neighborhood characteristics shown in Table 5.3. In the reduced version of that model, the variables containing reduced neighbourhood characteristics were removed.

Table 5.8 Full and reduced model-4

ID	Full Model-4	ID	Reduced Model-4
1	Size	1	Size
2	Number of rooms	2	Number of rooms
3	Elevator	3	Elevator
4	Parking lot	4	Parking lot
5	Type	5	Type
6	Build quality	6	Build quality
7	*Distance to hospital*	**R² Value = 0.810**	
8	*Distance to green area*		
9	*Distance to global restaurant*		
10	*Distance to shop*		
11	*Distance to university*		
12	*Density of grocery*		
R² Value = 0.848			

5.2 Using Models with the F Test

Next for each model, full and reduced versions were compared via F tests to see whether introducing neighbourhood characteristics into the price estimation models improves the models significantly. F Test was calculated via the following formula. (Pindyck & Rubinfield, 1991)

$$F_{q,N-k} = \frac{(R^2{}_{full} - R^2{}_{reduced})/q}{\left(1 - R^2{}_{full}\right)/(N-k)}$$

R² general: R² value of full model

R² reduced: R² value of reduced model

q: number of variables removed from the full model

N: total number of data

k: number of variables used in the full model, including the constant variable

Table 5.9 Model-1 and Model-2 used in F test and results

	Full Model-1	Reduced Model-1	Full Model-2	Reduced Model-2
R²	0.854	0.836	0.850	0.836
Significance Level	0.05		0.05	
q	15		6	
N-k	123		132	
Critical Value	1.011		2.053	
F Value	1.748		2.168	
Significance	Not significant		Not significant	

Results showed that in Table 4.8, when all measures of building characteristics were used (Model-1 and Model-2); F values were below the critical value, indicating that collecting data on neighbourhood characteristics in addition to all building characteristics did not improve the models significantly.

On the other hand, when only some of building characteristics were used (Model 3 and Model 4); F values were above the critical value indicating that collecting data on neighbourhood characteristics in addition to reduced building characteristics improved the models significantly.

Table 5.10 Model-3 and Model-4 used in F test and results

	Full Model-3	Reduced Model-3	Full Model-4	Reduced Model-4
R²	0.848	0.810	0.845	0.810
Significance Level	0.05		0.05	
q	15		6	
N-k	129		138	
Critical Value	1.745		2.165	
F Value	2.150		5.194	
Significance	Significant		Significant	

In brief, this study provides empirical evidence that data on neighbourhood characteristics leads better predictions of house values when it is not possible to collect a detailed data on building characteristics.

CHAPTER 6
CONCLUSIONS

Housing, one of the essential human needs, is very important for social life. Numerous needs, such as warming, security, privacy, depend on it. Over time, housing has become not only a need but an investment tool. Because of this feature, it also has an important place in the economy. So many sectors have been formed for housing operations. The valuation sector is one of them. The appraisers are responsible for assessing value by analyzing both the building and neighbourhood characteristics of the dwellings.

There is no doubt that urban qualities have an effect on buying preferences of dwellings. Many studies have focused to identify factors that affect housing value. It has been shown that the most common method used for these studies was the hedonic pricing method. Using this model, it was found that the variables that affect the dwelling could be examined into two main categories as building and neighborhood characteristics.

Most studies have found that building characteristics have been examined in detail and different results have been obtained. However, it has been observed that neighbourhood characteristics are often analyzed superficially. For example, the advantage of location is measured only as a distance from the city center (or another central point), and all the other factors have been overlooked. Therefore, this study is focused on testing the effect of neighbourhood characteristics in detail on housing value.

In the study, two different data sources were used. The first one is the valuation reports. 151 valuation reports prepared in Buca district of Izmir province have been provided. The building characteristics of the dwellings are filtered from these reports. The most discussed variables in the literature, provided by these reports which are considered the most compatible with the study area. These factors are; size of the house, building age, number of rooms, number of balconies, number of bathrooms,

total number of floors in the apartment, the floor the house is located on, type (gated community or not), presence of elevator, presence of parking lot, presence of heating system, and building quality. Statistical results showed that; type, size, presence of elevator, building quality, presence of parking lot, number of rooms have a statistically significant impact on the housing value.

Consistent with the literature, housing size was found to be statistically efficient in value of the house. Besides, previous studies have different results on the building age. In this study, the building age was found to be statistically insignificant on the housing value. Moreover, type, presence of elevator, building quality, presence of parking lot, and number of rooms was found to be statistically significant.

GIS analysis was used as the secondary data source. Firstly, the study area is digitized with ArcGIS Pro software. Streets in Buca district have been defined to create network analysis. The important facilities obtained from Open Street Maps (OSM) were transferred to the database as point and polygon layers. For the first method of network analysis, the closest facility module is used. It measures the distance from the dwelling to the closest facility. The second method of network analysis measured the density of facilities within the 400-metre buffer zone of the housing. From these two network analyses, 15 neighbourhood characteristics data were obtained. These are; distance to the closest; shopping center, grocery, global restaurant, local restaurant, railway station, hospital, university, green area, and density of the shopping centers, groceries, global restaurants, local restaurants, railway stations, hospitals, green areas within 400-meter buffer area. Statistical results showed that; distance to the shopping center, global restaurant, hospital, university, green area, and density of the groceries have a statistically significant effect on the housing value. Based on these statistical results, full and reduced models were created. The purpose is to measure the impact of neighbourhood features on housing values. Four models were created for this purpose;

For the first model; full model involves all the measures of building and neighbourhood characteristics, and reduced model involves only the all the measures

of building characteristics. After the regression analysis and the F-test, F values were below the critical value, indicating that collecting data on neighbourhood characteristics in addition to all building characteristics did not improve the model-1 significantly.

For the second model; full model involves all measures of building characteristics and significant measures of neighbourhood characteristics, and reduced model involves all measures of building characteristics. After the regression analysis and the F-test, F values were below the critical value, indicating that collecting data on neighbourhood characteristics in addition to all building characteristics did not improve the model-2 significantly.

For the third model; full model involves the significant building characteristics and all measures of neighbourhood characteristics, and reduced model involves only the significant building characteristics. After the regression analysis and the F-test, F values were above the critical value indicating that collecting data on neighbourhood characteristics in addition to all building characteristics improved the model-3 significantly.

For the fourth model; full model involves the significant building and neighbourhood characteristics, and reduced model involves only the significant building characteristics. After the regression analysis and the F-test, F values were above the critical value indicating that collecting data on neighbourhood characteristics in addition to all building characteristics improved the model-4 significantly.

These results indicate that, when the data on the building characteristics obtained in detail, the additional data on neighbourhood characteristics have no significant impact on the accurate prediction of housing value. However, when the data on the building characteristics is limited to important ones, the additional data on neighbourhood characteristics has become statistically significant on predicting housing value.

In the study area, it was found that the housing values are close to one another in each neighborhood. This minimizes the impact of neighbourhood characteristics on the value of the dwelling. Study on a provincial basis is thought to yield more precise results. Finally, it was found that neighbourhood characteristics leads better predictions of house values when it is not possible to collect a detailed data on building characteristics.

The most important result of the study is that the housing value will be predictable with less detailed data. While building data is difficult to obtain, neighborhood data can be obtained faster and more consistently with the help of Geographic Information Systems (GIS). Once the neighborhood data is obtained, it is sufficient and can be updated. Better projection of the street network will make the results more consistent.

In this research, the study area is restricted by a single county and limited dataset. More consistent results can be obtained in a wider workspace and larger database. In addition, limited data resources were used in the GIS analysis. Better results can be achieved through fieldwork and more reliable data sources. Thus, the impact of neighbourhood characteristics on housing value can be more accurately measured.

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APPENDICES

Table A.1 Building Characteristics Dataset

ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Lat.	38,388	38,3973	38,3653	38,3727	38,3812	38,3805	38,3782	38,3611	38,3977	38,3683	38,3659	38,3741	38,3944	38,3977	38,3934	38,3614	38,3763	38,368
Long.	27,1833	27,1584	27,197	27,1856	27,1794	27,1621	27,157	27,1491	27,1641	27,1532	27,1603	27,1485	27,168	27,1481	27,1536	27,1525	27,1835	27,1742
Value (TL)	185.000	435.000	130.000	340.000	180.000	385.000	520.000	360.000	290.000	275.000	300.000	385.000	400.000	200.000	290.000	300.000	170.000	650.000
Size of the house (m²)	41	151	35	154	61	124	130	100	108	118	76	143	103	47	122	102	39	137
Number of rooms	3	4	2	4	3	4	4	3	4	4	3	4	4	3	4	4	2	4
Number of bathrooms	1	1	1	2	1	2	2	2	2	2	1	2	3	2	2	2	1	2
Number of balconies	0	2	1	2	1	2	2	1	3	2	1	5	1	2	2	2	0	2
Building age	6	24	2	9	23	15	9	3	25	27	4	14	5	4	19	5	4	7
The floor the house is Located on	0	2	2	4	4	4	6	7	3	4	3	2	1	1	4	4	1	8
Total number of floors in the apartment	6	4	4	5	4	4	7	15	8	5	7	4	3	4	4	4	5	10
Presence of heating system	1	0	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1
Presence of elevator	1	0	0	0	0	0	1	1	1	0	1	0	0	0	0	1	0	1
Presence of parking lot	0	0	1	0	0	0	1	1	0	0	1	0	1	0	0	0	0	1
Type (gated community or not)	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	1
Build quality	2	2	3	2	2	2	3	3	2	2	4	3	3	3	2	3	3	4

19	38,4018	27,1661	280.000	72	4	2	1	3	1	5	1	1	0	0	2
20	38,3777	27,1584	490.000	128	4	2	2	13	7	10	1	1	0	1	3
21	38,3872	27,1857	300.000	97	4	1	2	10	2	4	1	1	0	0	2
22	38,403	27,1966	300.000	85	4	2	1	35	1	2	1	0	0	0	2
23	38,3948	27,1585	320.000	126	4	2	2	38	4	4	0	0	0	0	2
24	38,3721	27,1724	190.000	55	3	1	0	4	2	2	1	0	0	0	3
25	38,3985	27,1521	270.000	64	3	1	0	1	1	4	1	1	0	0	3
26	38,3545	27,1469	260.000	70	3	2	1	3	3	4	1	0	0	0	3
27	38,3692	27,1805	320.000	65	3	1	0	2	9	10	1	1	1	1	4
28	38,3852	27,1535	265.000	76	4	1	1	16	2	5	0	0	0	0	2
29	38,378	27,1516	480.000	138	4	3	2	5	7	10	1	1	1	1	3
30	38,377	27,1575	575.000	108	4	2	2	5	4	12	1	1	1	1	4
31	38,3989	27,1472	425.000	100	4	1	1	4	4	4	1	0	1	0	3
32	38,3943	27,1615	390.000	118	4	2	2	25	2	6	1	0	1	0	3
33	38,3833	27,185	310.000	80	4	2	1	12	1	6	1	0	0	0	3
34	38,3891	27,1768	200.000	46	2	1	1	5	4	5	1	1	1	0	3
35	38,3792	27,1579	575.000	110	4	2	2	5	3	7	1	1	1	0	3
36	38,393	27,1781	120.000	38	2	1	0	4	0	4	1	0	0	0	3
37	38,366	27,1854	500.000	118	4	3	2	11	3	11	1	1	1	0	3
38	38,3809	27,1838	290.000	101	4	2	1	18	4	5	1	0	0	0	2
39	38,3718	27,1945	300.000	65	3	1	1	5	3	6	0	0	0	0	3
40	38,3583	27,1449	315.000	114	3	2	2	4	2	4	1	0	0	0	3
41	38,3997	27,1546	280.000	74	3	1	1	4	5	5	1	1	0	0	3

42	38,3691	27,1731	500.000	108	4	1	1	10	4	11	1	1	1	1	3
43	38,399	27,1978	575.000	85	4	2	1	32	1	2	1	0	1	1	3
44	38,3677	27,1687	600.000	179	5	3	2	4	1	2	1	0	1	0	3
45	38,3853	27,1524	210.000	93	3	2	2	47	1	4	1	0	0	0	2
46	38,3669	27,1804	750.000	117	4	2	1	2	2	7	1	1	1	1	4
47	38,3671	27,1906	380.000	99	4	1	2	13	4	5	1	0	1	0	3
48	38,3931	27,1769	330.000	82	3	1	0	2	0	8	1	1	0	0	3
49	38,3841	27,1529	250.000	82	3	2	1	34	1	5	1	0	0	0	3
50	38,379	27,1799	255.000	50	2	2	1	8	9	11	1	1	1	1	3
51	38,374	27,1881	190.000	41	2	1	1	10	3	7	1	1	1	0	3
52	38,3896	27,1847	165.000	34	2	1	0	1	1	3	1	0	1	0	3
53	38,3783	27,1842	210.000	42	2	1	0	7	1	10	0	1	1	1	3
54	38,3797	27,1703	250.000	71	3	2	2	6	1	6	1	1	0	0	3
55	38,3657	27,1892	150.000	30	2	1	0	3	0	4	1	1	1	0	3
56	38,3739	27,1907	165.000	38	3	1	0	6	1	3	1	0	0	0	3
57	38,3661	27,1412	300.000	107	3	2	1	8	3	5	1	0	1	0	3
58	38,3679	27,179	635.000	115	4	3	2	4	2	7	1	1	1	1	3
59	38,3697	27,1561	350.000	120	4	1	1	7	3	4	1	0	1	0	3
60	38,3918	27,1573	280.000	103	4	2	3	41	4	4	1	0	0	0	2
61	38,3862	27,1824	170.000	36	2	1	1	8	3	4	1	0	1	0	3
62	38,3963	27,1436	260.000	65	3	1	0	3	4	4	1	0	1	0	3
63	38,3744	27,1664	250.000	68	3	2	1	4	1	3	0	0	0	0	3
64	38,3916	27,1679	300.000	55	2	1	0	1	3	5	1	1	1	0	3

Nr	(38,...)	(27,...)	(.000)	(.000)												
65	38,3781	27,1702	300.000	170.000	36	2	1	0	3	4	4	1	0	0	0	3
66	38,3769	27,1784	300.000		110	4	1	1	26	6	8	1	1	0	0	2
67	38,3743	27,1546	525.000		99	3	2	2	4	7	13	1	1	0	1	4
68	38,3949	27,1595	210.000		73	3	2	1	42	1	3	1	0	0	0	2
69	38,3866	27,183	250.000		75	3	2	1	13	1	7	1	0	0	0	2
70	38,373	27,182	260.000		93	4	2	2	29	2	5	1	0	0	0	2
71	38,3834	27,1457	580.000		132	4	3	2	5	6	7	1	1	1	1	4
72	38,3667	27,1919	250.000		40	2	1	1	2	2	11	1	1	1	1	3
73	38,4042	27,1689	365.000		114	4	1	2	3	2	4	1	1	0	0	3
74	38,3807	27,1748	215.000		63	3	1	0	5	1	4	1	0	0	0	3
75	38,3848	27,1454	190.000		38	2	1	0	3	3	4	1	1	0	0	3
76	38,3658	27,1899	145.000		40	1	1	0	2	0	5	0	1	0	1	3
77	38,4	27,151	280.000		77	4	2	0	7	1	5	1	0	0	0	3
78	38,3948	27,1663	275.000		85	3	1	2	20	3	4	1	0	0	0	2
79	38,3988	27,158	310.000		107	4	1	1	28	1	4	1	0	0	0	2
80	38,3899	27,1775	200.000		33	2	1	0	1	0	6	1	1	1	0	3
81	38,3676	27,1881	350.000		104	4	2	2	20	6	8	1	1	1	1	2
82	38,391	27,1767	300.000		83	3	1	1	9	2	5	1	1	1	0	3
83	38,3753	27,1737	230.000		61	3	1	1	1	1	2	1	0	0	0	2
84	38,3917	27,1669	250.000		78	3	2	1	40	1	4	1	0	1	0	2
85	38,3833	27,1724	335.000		98	3	1	2	14	4	4	1	0	0	0	2
86	38,3763	27,1741	350.000		92	4	1	1	9	3	4	1	0	0	0	3
87	38,3678	27,1907	200.000		50	2	2	0	8	1	2	0	0	1	0	3

ID															
88	38,3996	27,1704	185.000	63	3	2	2	40	5	5	0	0	0	1	1
89	38,3941	27,151	365.000	137	4	2	2	34	4	4	1	0	0	0	2
90	38,366	27,1943	165.000	39	2	1	1	5	2	3	1	0	0	0	3
91	38,3744	27,1858	130.000	35	1	1	0	4	0	3	0	0	0	0	3
92	38,3966	27,1582	200.000	57	3	1	1	27	1	5	1	0	0	0	2
93	38,3754	27,1669	330.000	97	2	1	2	3	1	3	1	0	1	0	3
94	38,3764	27,1669	330.000	97	3	1	2	6	4	4	1	0	1	0	3
95	38,3981	27,1555	230.000	72	3	1	2	33	4	4	1	0	0	0	2
96	38,3988	27,1778	240.000	64	3	1	0	3	2	3	1	0	0	0	3
97	38,4023	27,1648	265.000	78	3	1	1	1	4	4	1	0	1	0	3
98	38,3739	27,1847	350.000	94	3	2	1	3	2	4	1	1	1	0	3
99	38,3958	27,1424	225.000	36	2	1	0	1	2	4	1	1	1	0	3
100	38,3798	27,1765	290.000	68	3	1	1	2	2	4	1	0	0	0	3
101	38,3946	27,1757	250.000	80	3	2	1	26	0	4	1	0	1	0	3
102	38,395	27,1793	360.000	115	4	2	0	12	2	4	1	0	0	0	3
103	38,3738	27,1753	330.000	87	4	2	2	24	4	8	1	1	1	1	3
104	38,3973	27,1891	270.000	62	3	2	1	28	4	5	1	0	1	1	2
105	38,3736	27,1868	285.000	73	3	1	2	7	1	3	0	0	0	0	3
106	38,3837	27,1891	190.000	45	2	2	1	8	0	2	0	0	1	0	3
107	38,3772	27,1832	185.000	45	2	2	1	5	2	2	0	0	0	0	3
108	38,3739	27,1875	175.000	40	2	1	1	7	0	2	0	0	0	0	3
109	38,373	27,1875	190.000	49	3	2	1	3	1	3	1	0	0	0	2
110	38,3841	27,1863	200.000	49	3	1	0	4	0	2	1	0	0	0	3

55

111	38,3894	38,3666	27,1717	510.000	107	4	2	1	4	2	9	1	1	1	0	3
112	38,3894		27,1532	350.000	95	3	1	2	46	2	4	1	0	0	0	3
113	38,3751		27,1815	285.000	95	4	2	2	24	3	4	0	0	0	0	3
114	38,3687		27,1816	310.000	40	2	2	1	2	6	9	1	1	1	0	3
115	38,3737		27,1897	170.000	44	2	1	0	5	0	3	1	0	0	0	3
116	38,355		27,1451	325.000	75	3	1	1	2	3	4	1	1	1	0	2
117	38,377		27,1809	200.000	35	2	2	0	8	7	10	1	1	1	1	3
118	38,3814		27,1462	325.000	74	3	1	1	6	3	4	1	0	1	0	3
119	38,3715		27,1936	180.000	42	2	1	0	4	2	2	1	0	1	0	3
120	38,3859		27,142	410.000	110	4	2	1	2	2	4	1	1	1	0	3
121	38,3869		27,1807	190.000	35	2	1	0	3	2	5	1	1	1	0	3
122	38,3841		27,1646	225.000	43	2	1	1	0	2	2	1	0	1	0	3
123	38,3721		27,1933	230.000	37	2	1	0	2	2	4	1	1	1	0	4
124	38,4009		27,1632	260.000	60	3	1	1	1	4	4	1	1	0	0	3
125	38,3675		27,1973	215.000	41	2	1	0	3	2	5	1	0	0	0	3
126	38,3754		27,1903	190.000	35	2	1	1	8	2	3	0	0	0	0	3
127	38,3996		27,1504	200.000	82	3	2	2	21	3	4	1	0	0	0	1
128	38,3985		27,1549	270.000	92	4	2	3	33	4	5	0	0	0	0	2
129	38,3906		27,1786	255.000	60	3	1	1	3	4	5	1	0	0	0	3
130	38,3802		27,1757	325.000	94	4	1	0	6	1	4	1	0	0	0	3
131	38,3668		27,1972	195.000	45	2	1	1	9	2	3	1	0	1	0	3
132	38,3975		27,152	290.000	70	3	1	2	1	2	5	1	1	0	0	3
133	38,3771		27,1704	300.000	71	3	1	1	4	2	5	1	0	0	0	3

134	38,3879	27,1845	140.000	35	2	1	1	2	0	6	1	0	0	0	4
135	38,3842	27,1463	300.000	83	3	2	1	2	2	4	1	1	0	0	4
136	38,3784	27,1601	525.000	165	5	3	3	16	3	4	1	0	0	0	3
137	38,3921	27,153	315.000	77	4	2	2	34	4	5	1	0	0	0	2
138	38,3888	27,181	260.000	80	4	1	1	15	4	4	1	0	1	0	3
139	38,4022	27,1535	300.000	77	4	1	1	1	1	4	1	0	0	0	3
140	38,3875	27,1833	300.000	74	3	2	1	2	0	7	1	1	1	0	3
141	38,3862	27,1737	360.000	98	4	2	1	35	2	2	0	0	0	0	2
142	38,3738	27,1724	350.000	116	4	2	2	10	3	4	0	0	0	0	2
143	38,3982	27,1473	400.000	97	3	2	2	0	1	4	1	1	0	0	3
144	38,3744	27,1475	345.000	108	3	2	1	3	2	3	1	0	0	0	3
145	38,3738	27,1619	220.000	106	3	2	0	40	1	4	0	0	0	0	1
146	38,3943	27,1563	350.000	95	4	3	3	37	5	7	1	0	0	0	2
147	38,3929	27,1478	400.000	123	4	1	2	38	2	6	1	0	0	0	2
148	38,3743	27,1777	260.000	76	3	2	1	12	4	4	1	0	0	0	2
149	38,368	27,1797	500.000	109	4	2	2	11	2	10	1	1	1	1	3
150	38,3894	27,1591	210.000	76	4	2	1	28	1	4	1	0	0	0	2
151	38,3798	27,1734	360.000	98	4	2	1	14	1	5	1	1	0	0	3

Table A.2 Neighbourhood Characteristics Dataset

House ID	Distances to closest shopping center (m)	Distances to the closest grocery (m)	Distances to closest global restaurant (m)	Distances to closest local restaurant (m)	Distances to closest railway station (m)	Distances to closest hospital (m)	Distances to closest university (m)	Distances to closest green area (m)	Density of Hospitals	Density of Railway Stations	Density of global restaurants	Density of local restaurants	Density of groceries	Density of shopping centers	Amount of Greenareas (m²)
1	1.014,34	155,72	136,82	319,84	3.527,49	1.210,86	575,27	277,98	0	0	3	7	11	0	34628,8
2	688,15	135,81	763,25	195,94	1.380,71	866,89	1.905,14	242,03	0	0	0	9	11	0	10958,3
3	1.180,81	348,48	729,81	217,15	5.631,32	822,59	1.092,11	290,88	0	0	0	5	2	0	723,93
4	887,59	87,88	179,41	107,06	4.219,04	641,34	1.723,27	328,7	0	0	3	15	7	0	4729,93
5	130,57	248,25	271,34	452,04	3.255,99	372,92	584	189,56	1	0	9	1	7	1	154399,8
6	425,97	239,42	969,96	321,74	1.906,25	505,74	1.297,46	59,34	0	0	0	8	7	1	16980,4
7	664,6	78,8	1.481,72	250,51	1.471,53	835,07	1.809,22	487,69	0	0	0	4	6	0	6902,32
8	2.116,43	233,35	3.617,31	160,61	1.376,08	530,13	3.944,81	286,55	0	0	0	18	7	0	6866,18
9	976,07	59,79	927,92	355,51	2.045,87	228,26	1.572,74	254,9	1	0	0	1	13	0	24366,9
10	1.412,73	89,38	2.757,04	187,87	1.235,75	101,35	3.084,54	366,54	1	0	0	19	8	0	10186,4
11	1.242,70	289,91	2.672,95	63,14	2.243,38	1.012,95	3.000,45	98,87	0	0	0	5	2	0	6196,44
12	1.646,46	72,97	2.347,17	83,86	1.029,09	881,3	3.127,08	211,73	0	0	0	20	13	0	16067,5
13	773,21	120,38	617,47	135,47	2.174,13	482,95	1.161,04	137,56	0	0	0	5	14	0	56201,9
14	660	141,7	122,49	97,1	592,03	801,82	2.546,96	333,47	0	0	2	24	4	0	4906,66
15	275,19	168,41	369,79	93,81	769,14	727,32	1.798,68	310,01	0	0	1	15	8	3	26057,2
16	1.898,97	441,45	3.399,85	294,6	1.575,98	934,02	3.727,35	156,02	0	0	0	10	2	0	4745,14

17	735,13	193,07	384,51	221,04	3.983,87	268,94	1.254,43	335,31	1	0	3	11	5	0	2636,02
18	75,16	59,51	1.474,12	59,58	3.523,71	1.050,59	2.375,86	72,7	0	0	0	14	9	1	18730
19	1.340,18	59,1	1.514,31	113,5	2.338,55	343,09	2.138,39	240,13	1	0	0	10	14	0	9851,42
20	528,7	94,23	1.445,49	119,09	1.611,63	699,17	1.773,00	451,46	0	0	0	6	9	0	8675,79
21	1.156,11	171,01	434,63	601,13	3.813,35	1.419,76	745,88	62,9	0	0	1	0	7	0	21970,8
22	2.280,71	746,41	2.246,65	2.213,17	5.278,89	3.340,89	2.764,34	204,1	0	0	0	0	0	0	24407,2
23	557,96	72,56	551,03	253,81	1.250,53	836,09	1.618,62	343,86	0	0	0	11	14	0	10958,3
24	579,42	91,24	1.375,41	152,09	3.051,47	625,74	1.951,01	33,54	0	0	0	14	7	0	18276
25	835,1	198,98	411,91	100,82	1.029,22	1.251,47	2.394,42	182,59	0	0	1	20	6	0	6929,63
26	2.912,93	391,21	4.413,80	173,42	1.137,47	944,79	4.741,31	390,34	0	0	0	11	2	0	588,04
27	239,41	180	834	86,95	3.922,00	1.061,53	2.237,72	295,41	0	0	0	16	7	1	13679,4
28	1.075,80	12,99	984,68	235,2	1.269,91	160,98	1.748,42	270,67	1	0	0	9	8	0	85067,9
29	1.460,48	216,03	1.689,22	2,14	998,09	1.080,16	2.387,55	602,43	0	0	0	7	2	0	0
30	665,37	230,9	1.582,16	255,76	1.572,19	815,25	1.909,67	588,13	0	0	0	4	7	0	0
31	888,33	362,67	260,94	176,91	706,51	916,3	2.775,29	444,83	0	0	2	15	2	0	3678,08
32	737,58	100,97	541,56	52,33	1.496,05	736,46	1.343,16	259,28	0	0	0	6	8	0	10958,3
33	507,63	132	83,85	673,32	3.729,96	771,29	484,85	337,97	0	0	12	0	9	0	146260,5
34	1.063,83	170,39	284,96	12,55	2.771,96	1.076,30	625,38	394,41	0	0	7	14	10	0	30665,4
35	717,55	124,73	1.387,79	164,5	1.419,46	923,57	1.715,30	393,76	0	0	0	4	6	0	8675,79
36	489,57	156,03	608,77	236	3.115,17	1.515,12	1.135,94	206,54	0	0	0	7	8	0	41501,2

37	276,1	92,09	985,53	316,32	4.459,39	993,07	1.918,25	45,77	0	0	0	6	3	1	16003,2
38	306,78	118,59	63,79	597,73	3.693,33	537,75	627,15	306,83	0	0	15	0	8	1	149999,2
39	1.061,22	167,74	60,07	189,16	5.042,29	253,42	1.108,96	387,83	1	0	7	11	4	0	5210,39
40	2.679,60	192,1	4.180,47	183,78	874,79	417,85	4.507,98	197,59	1	0	0	24	9	0	1761,56
41	1.051,98	83,09	727,93	78,31	1.290,32	984,26	2.414,05	189,44	0	0	0	10	8	0	5810,42
42	274,24	6	1.508,36	25,59	3.370,24	882,32	2.207,59	182,84	0	0	0	12	10	1	21477,7
43	2.344,59	483,88	1.994,42	2.059,62	5.297,25	3.098,59	2.512,11	230,49	0	0	0	0	0	0	20833,6
44	646,45	140,63	2.045,42	103,51	3.018,96	1.058,84	2.580,85	89,68	0	0	0	12	6	0	12717,3
45	962,26	154,66	873,25	194,3	1.156,36	278,99	1.866,43	388,69	2	0	0	11	5	0	85067,9
46	448	53,17	1.065,17	138,43	4.022,23	1.270,12	2.411,16	429,53	0	0	0	9	3	0	10057,2
47	372,85	238,39	556,66	39,07	4.945,48	516,31	1.436,12	131,26	0	0	0	19	4	1	15298,8
48	440,81	149,37	650,82	412,64	2.984,87	1.392,65	1.295,77	299	0	0	0	4	7	1	35237,8
49	1.098,41	190,21	1.011,68	229,86	1.259,34	314,55	1.886,47	327,91	1	0	0	6	3	0	85067,9
50	299,72	308,27	378,07	382,71	3.489,76	59,53	898,4	67,83	2	0	2	8	8	1	132601
51	1.159,81	219,26	276,56	187,61	4.482,04	766,32	1.622,52	256,56	0	0	9	14	8	0	6829,96
52	1.219,71	46,08	291,67	428,09	3.719,72	1.440,06	809,36	273,53	0	0	2	4	8	0	25424,2
53	483,4	194,36	221,77	366,49	3.843,71	399,05	974,69	306,39	1	0	5	5	6	0	12803
54	630,58	200,74	972,94	186,97	2.772,10	443,45	1.300,44	422,32	2	0	0	13	8	0	11579,2
55	425,85	269,69	707,92	206,24	4.757,81	667,57	1.587,38	231,2	0	0	0	10	3	1	8877,82
56	1.037,61	134,76	174,84	224,76	4.715,10	562,62	1.535,10	157,97	0	0	9	7	7	0	3519,38

57	2.551,34	65,32	3.324,34	43,66	359,72	716,83	4.060,84	163,28	0	1	0	12	6	0	2690,3
58	305,37	158,4	1.050,58	11,04	3.926,64	1.127,49	2.303,68	243,99	0	0	0	12	7	2	13977,4
59	989,04	180,63	2.485,84	112,39	1.864,28	598,75	2.813,35	550,09	0	0	0	6	3	0	0
60	260,87	81,45	117,7	32,12	985,75	402,77	1.306,04	672,04	1	0	3	24	9	1	0
61	809,57	81,25	229,35	291,13	3.435,15	1.087,43	298,08	324,19	0	0	8	2	12	0	150698,9
62	857,46	242,36	609,36	224,1	545,26	502,63	2.728,27	194,81	1	0	0	14	4	0	6695,7
63	201,39	144,84	1.514,08	83,17	2.491,53	353,9	1.841,58	362,08	1	0	0	15	8	2	10038,7
64	538,29	192,75	240,82	216,22	2.012,67	789,26	822,84	0	0	0	11	8	8	0	23676,7
65	699,25	115,27	1.099,28	131,9	2.704,97	561,59	1.426,78	221,23	0	0	0	8	6	0	10052,9
66	603,23	151,98	681,58	140,14	3.550,00	250,5	1.160,97	198,86	2	0	0	19	6	0	13712,5
67	966,72	220,9	2.119,83	292,92	1.507,79	809,66	2.447,34	473,5	0	0	0	5	6	0	6501,94
68	631,26	147,8	611,81	247,69	1.323,82	850,06	1.568,34	255,85	0	0	0	10	11	0	10958,3
69	803,08	73,52	186,72	353,84	3.466,78	1.066,73	399,3	258	0	0	10	2	16	0	150698,9
70	599,6	183,66	407,3	229,84	3.936,51	450,73	1.615,22	384,85	1	0	2	12	6	0	4438,42
71	1.384,05	176,03	1.497,02	99,04	244,19	1.026,69	2.716,37	288,32	0	1	0	18	11	0	6428,91
72	681,41	176,3	521,69	195,76	5.065,80	490,14	1.374,03	399,32	0	0	0	16	3	0	5175,29
73	1.514,78	262,54	2.018,29	299,4	2.713,12	581,49	2.543,93	577,45	0	0	0	4	5	0	0
74	629,97	59,18	671,96	210,81	3.047,77	279,48	931,06	273,72	3	0	0	7	10	0	143732
75	1.247,82	20,94	1.360,79	3,67	274,32	890,45	2.580,14	360,38	0	1	0	23	8	0	6428,91
76	542,74	350,82	696,22	232,05	4.827,83	659,39	1.548,55	324,23	0	0	0	8	2	0	8877,82

77	1.040,31	175,84	409,11	57,91	998,99	1.208,77	2.661,80	340,96	0	0	1	18	3	0	1893,58
78	739,63	17,96	620,62	75,6	1.963,05	386,93	1.164,19	276,73	1	0	0	5	14	0	56201,9
79	784,23	132,06	1.016,89	128,84	1.476,79	688,61	2.129,13	483,1	0	0	0	13	9	0	9411,58
80	953,49	249,2	363,78	112,67	2.866,61	1.174,69	707,34	290,58	0	0	2	17	13	0	24414,3
81	179,6	163,99	793,66	87,12	4.756,88	730,8	1.705,35	198,89	0	0	0	13	4	1	19313,7
82	783,47	310,24	427,58	260,53	2.934,92	1.411,68	946,77	114,05	0	0	1	13	7	0	27259,1
83	874,99	90,27	1.115,90	48,5	3.007,60	195,2	1.520,46	213,5	1	0	0	16	11	0	13808,6
84	457,18	114,21	218,71	187,88	1.931,57	741,34	800,73	85,39	0	0	12	7	9	1	23676,7
85	820,11	130,65	409,14	236,86	2.620,08	251,76	750,24	246	2	0	1	12	9	0	136861
86	933,78	101,98	1.077,62	92,89	3.063,43	111,67	1.436,93	94,95	1	0	0	16	11	0	5351,62
87	421,97	196,46	497,99	76,04	4.981,37	457,64	1.394,19	190,57	1	0	0	21	5	1	7761,93
88	824,99	92,74	1.330,23	378,05	2.707,92	631,95	1.855,88	511,81	0	0	0	1	8	0	23271,6
89	212,4	380,88	207,85	133,2	478,72	721,15	2.034,53	231,2	0	0	1	22	4	2	30709,8
90	865,28	120,28	547,63	146,86	5.280,53	516,08	1.200,54	217,42	0	0	0	12	4	0	3834,3
91	1.019,75	142,58	123,6	192,91	4.219,79	525,46	1.501,71	168,78	0	0	4	15	8	0	1419,36
92	645,21	108,01	694,84	176,75	1.337,77	878,75	1.836,73	249,84	0	0	0	9	13	0	10958,3
93	258,3	35,8	1.382,76	58,55	2.435,48	410,81	1.710,26	347,78	1	0	0	17	8	2	10316,5
94	424,24	158,75	1.221,90	126,55	2.328,71	576,75	1.549,41	198,74	0	0	0	19	6	2	8695,8
95	778,72	168,51	809,14	155,94	1.157,64	1.006,67	2.153,28	319,86	0	0	0	13	11	0	6929,63
96	426,85	265,78	1.401,33	738,73	3.317,19	1.202,80	1.883,04	213,84	0	0	0	0	3	1	22113

97	1.468,90	121,74	1.518,09	15,22	2.312,05	214,37	2.185,05	227,35	1	0	0	10	11	0	9851,42
98	888,85	53,59	7,3	160,78	4.130,80	460,29	1.542,22	259,68	0	0	3	18	8	0	1419,36
99	1.003,17	202,77	755,07	211,65	690,97	432,76	2.873,99	323,66	1	0	0	8	2	0	8086,45
100	501,25	156,22	647,98	252,75	3.215,64	360,62	933,91	245,9	2	0	0	11	11	0	143732
101	292,78	88,53	777,52	354,97	2.908,46	1.251,55	1.343,32	98,62	0	0	0	4	12	1	35237,8
102	301,04	224,52	880,75	406,15	3.335,72	1.447,49	1.348,19	222,7	0	0	0	2	7	1	32653,3
103	627,12	3,06	1.019,03	209,01	3.207,83	265,65	1.595,46	382,42	1	0	0	13	12	0	14991,9
104	1.377,37	329,14	1.291,76	1.149,66	4.322,41	2.437,55	1.809,45	166,69	0	0	0	0	2	0	120058
105	993,91	175,15	185,2	67,96	4.317,15	622,82	1.593,42	169,75	0	0	3	16	9	0	3519,38
106	994,56	169,94	572,25	1.110,52	4.231,07	1.258,22	985,96	396,33	0	0	0	0	1	0	9347,57
107	620,7	161,04	401,15	262,2	3.869,45	261,94	1.137,50	328,3	1	0	4	10	6	0	13142,5
108	1.058,31	149,57	175,06	95,51	4.410,12	679,74	1.601,70	178,02	0	0	3	12	8	0	6829,96
109	1.012,74	37,1	129,48	2,72	4.383,69	713,18	1.714,70	291,03	0	0	3	16	7	0	6829,96
110	800,63	240,87	268,97	817,23	3.952,65	1.064,28	685,77	293,56	0	0	2	0	5	0	9347,57
111	424,17	150,98	1.800,56	170,16	3.341,18	1.227,97	2.553,24	303,01	0	0	0	11	6	1	15618,9
112	498,47	219,06	237,63	218,96	891,49	215,5	1.483,74	453,1	2	0	1	21	6	0	21021,2
113	746,9	187,72	473,54	99,65	3.779,44	365,1	1.451,48	303,15	1	0	2	16	3	0	5655,08
114	387,42	131,11	770,03	50,74	4.070,01	1.128,44	2.208,05	293,66	0	0	0	13	3	1	10057,2
115	1.106,45	203,6	243,67	232,89	4.584,74	631,45	1.603,93	226,8	0	0	9	13	6	0	3519,38
116	2.844,47	302,35	4.345,35	118,12	977,18	813,24	4.672,85	381,93	0	0	0	13	2	0	2349,6

117	513,98	361,6	561,84	83,2	3.762,73	141,17	1.112,66	114,17	2	0	0	17	6	0	13712,5
118	1.531,00	167,68	1.523,55	242,5	270,3	1.053,22	2.742,90	121,56	0	1	0	13	10	0	11203,1
119	995,37	61,74	94,72	111,52	4.978,18	200,4	1.214,96	353,77	1	0	7	12	4	0	8520,96
120	1.497,65	140,66	1.612,41	197,91	658,13	1.071,18	2.831,76	264,91	0	0	0	13	5	0	5703,06
121	880,63	208,38	123,27	142,28	3.226,92	961,45	330,75	361,43	0	0	8	9	11	0	148572,4
122	569,59	198,19	654,71	310,99	2.359,02	387,37	882,01	550,7	1	0	0	9	2	0	0
123	1.000,06	88,07	95,51	100,14	4.942,72	246,69	1.240,78	252,79	1	0	8	11	4	0	8520,96
124	1.364,97	185,14	1.291,40	163,91	2.057,53	291,36	2.015,73	240,42	1	0	0	8	14	0	9851,42
125	1.102,19	139,62	448,67	147,86	5.536,87	596,05	810,97	230,08	0	0	1	8	3	0	723,93
126	1.152,35	130,37	86,49	53,64	4.538,90	785,79	1.548,19	381,14	0	0	7	6	5	0	3519,38
127	930,13	200,94	298,93	66,38	888,8	1.098,59	2.636,94	316,76	0	0	2	20	3	0	4517,5
128	872,88	139,9	750,79	57,48	1.235,35	1.054,55	2.247,44	198,32	0	0	0	13	8	0	8434,33
129	823,81	303,17	477,11	251,28	3.005,23	1.352,70	803,17	325,69	0	0	0	17	10	0	39316
130	534,93	68,16	680,94	219,8	3.142,81	374,52	940,05	296,46	2	0	0	9	10	0	143732
131	1.150,71	202,82	569,74	148,6	5.621,31	691,23	932,04	228,74	0	0	0	5	3	0	723,93
132	713,92	296,31	460,62	96,87	920,55	1.134,05	2.279,77	130,97	0	0	1	8	4	0	6929,63
133	623,19	74,78	1.193,82	111,96	2.667,50	513,64	1.452,92	104,68	0	0	0	11	9	0	7699,58
134	1.008,84	151,08	281,82	464,84	3.660,54	1.272,49	593,07	109,21	0	0	3	0	10	0	40053,3
135	1.242,03	55,78	1.354,99	15,59	189,35	884,66	2.574,34	427,51	0	1	0	19	9	0	6428,91
136	476,76	100,63	1.297,67	79,05	1.663,02	763,15	1.625,17	315,13	0	0	0	10	13	1	13727

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	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151
	211,69	968,95	1.559,08	937,33	1.052,83	806,26	754,76	1.734,24	324,32	274,69	223,45	480,96	307,06	467,27	805,05
	103,61	85,28	492,22	99,66	346,28	199,13	223,37	123,3	71,14	100,19	16,38	254,24	108,24	122,91	90,03
	229,11	230,05	1.090,45	212,22	252,08	1.296,28	200,67	2.343,28	1.658,02	490,59	350,79	750,73	1.000,42	238,29	847,04
	110,58	185,26	283,56	423,29	166,2	80,59	74,24	30,44	179,94	109,18	37,77	65,3	62,14	133,43	93,61
	625,74	3.306,38	1.680,33	3.544,62	2.651,50	3.013,41	587,05	975,67	2.235,08	976,02	124,42	3.414,93	3.989,65	1.252,93	3.072,60
	587,76	1.183,37	1.086,90	1.200,99	642,19	424,18	796,83	931,62	165,6	726,81	565,73	342,03	1.129,18	412,26	362,52
	1.688,29	584,31	2.801,15	477,15	726,52	1.749,45	2.641,72	3.185,37	1.985,52	1.703,73	2.094,27	1.518,22	2.305,37	978,91	1.106,15
	313,34	237,76	382,84	225,13	385,72	330,2	328,49	263,45	380,64	349,57	104,27	124,92	288,59	529,99	356,76
	0	0	0	0	0	1	0	0	1	0	0	2	0	1	2
	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	1	2	0	4	7	0	2	0	0	1	1	0	0	7	0
	25	12	3	6	11	12	23	24	8	14	28	21	13	22	11
	8	12	0	12	7	9	4	15	9	13	11	10	8	4	14
	3	0	0	0	0	0	0	0	2	1	2	0	2	1	0
	26857,3	39033,6	3916,83	28812,6	8112,71	12218,6	3678,08	16067,5	3383,16	2412,13	27064,5	8012,81	10057,2	23969,5	15260,5

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