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A Study of the Metro and Housing Value Interaction with Hedonic Price Model: Comparison of Ankara Batıkent and Koru Metro Stations

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Abstract

The effects of urban rail systems on the real estate market were studied by analysing housing prices around Ankara Koru and Batıkent Metro Stations using the Hedonic Price Model. Quantitative data on residential sales were used. The findings reveal that sale values of residences are more elastic in term of metro effect in Batıkent, where middle-lower income groups live, compared to Koru Metro Station, where middle-upper income groups live. As the distance to the metro station decreases in Batıkent, prices increase. These results suggest that subways can help reduce polarization between income groups in cities while increasing accessibility. Providing access to neighbourhoods with both low and high-income individuals by metro increases housing prices more in favour of low-income groups and reduces income polarization between income groups.

Keywords: *Metro stations, housing prices, hedonic price model, accessibility, transportation planning, urban planning.*

Metro ve Konut Değeri Etkileşiminin Hedonik Fiyat Modeli ile İncelenmesi: Ankara Batıkent ve Koru Metro İstasyonlarının Karşılaştırılması

Öz

Kentsel raylı sistemlerin emlak piyasası üzerindeki etkileri, Hedonik Fiyat Modeli kullanılarak Ankara Koru ve Batıkent Metro istasyonları çevresindeki konut fiyatları analiz edilerek incelenmiştir. Konut satış değerlerine ilişkin nicel veriler kullanılmıştır. Bulgular, orta-alt gelir grubunun yaşadığı Batıkent'teki konutların satış değerlerinin, orta-üst gelir grubunun yaşadığı Koru Metro İstasyonu'na kıyasla metro etkisi açısından daha esnek olduğunu ortaya koymaktadır. Batıkent'te, metro istasyonuna yaklaştıkça fiyatlar artmaktadır. Bu sonuçlar, metroların erişilebilirliği artırırken şehirlerdeki gelir grupları arasındaki kutuplaşmayı azaltmaya yardımcı olabileceğini göstermektedir. Hem düşük hem de yüksek gelirli bireylerin yaşadığı mahallelere metro ile erişim sağlanması, konut fiyatlarını düşük gelirli gruplar lehine artırmakta ve gelir grupları arasındaki kutuplaşmayı azaltmaktadır.

Anahtar kelimeler: *Metro istasyonları, konut fiyatları, hedonik fiyat modeli, erişilebilirlik, ulaşım planlaması.*

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1. Introduction

Transportation systems are constantly interacting with their surroundings. The distribution of economic development among regions and the spatial structure of the city are closely related to transportation systems (Rodrigue, Comtois & Slack, 2006). In the relevant literature, it is emphasized that transportation systems should be carried out as a whole with urban planning and environmental policies to be able to create meaningful changes in space, move away from dependence on private cars, and be effective in sustainable and balanced development (Alaylı, 2006; Banister, Anderton, Bonilla, Givoni & Schwanen, 2011; Blunden, 1973; Cervero & Kochelman, 1997; Cervero, 2003; Handy, 2005; Litman & Colman, 2001). The demographic and economic structures of the people, as well as their socio-cultural relationships, are emphasized in the capacity of vehicles and the integration of transportation modes (Çınar, 2003). In these relationships, rail system applications, which are one of the mass transportation systems, are preferred to provide the fastest, most efficient and effective solutions to urban transportation needs (Barış, 1994).

Although rail system investments are high-cost projects, they are being implemented in large cities in recent years due to their ability to increase density around stations, increase the rate of public transportation use, and contribute to spatial development, and they affect land use and urban form. Studies examining the role of rail systems in land use, the development and transformation of the built environment of cities, as well as the accessibility of stations, the values of accessible station locations regarding housing prices, and the impact of urban functions on site selection are increasingly important. To evaluate these effects, analyses are conducted in areas that have gained access to the rail system after completing their urban development, comparing the situation before and after the arrival of the rail system. Many studies have been accomplished on variables that especially affect real estate values. Among these variables, it is seen that not only the structural characteristics of the housing, such as the size of the housing, the number of rooms, and the relative elevation value of the housing compared to other houses, but also spatial variables such as location, transportation facilities, distance to public transportation stations, and distance to the city center are included (Açlar & Çağdaş, 2008; Alas, 2017; Büyükduman, 2014; Bourassa, Hoesli & Vincent, 2003; Wong, Chau, Yau & Cheuna, 2011). In addition, some studies have taken travel times to school, work, and shopping as variables (Keskin, 2008). Generally, larger, well-viewed, and high-rise houses are more expensive. The prices of houses close to public transportation stations are also high (Choy Lennon, Stephen & Winky, 2007). In addition, it is emphasized in the relevant literature that indicator variables based on social class also yield useful results (Douglas, Elizabeth & Geoffrey, 2013).

This study focuses on the impact of metro stations on housing values. The aim is to reveal how the accessibility to metro stations and the structure affect the area, and how the distance and residential values change accordingly. Quantitative data were obtained to determine their effects on the sale prices of housing. As part of the fieldwork, the Batıkent Station on the Kızılay-Batıkent (M1) Metro Line, which is located on the west and southwest corridor created within the framework of a controlled decentralization policy adopted in Ankara's planning studies, aiming to intensify urban development, and the Koru Station, which has a high user profile with a higher living standard than Batıkent and intensive residential use on the Kızılay-Çayyolu (M2) Metro Line, were selected. The residential values near metro stations were analysed with the Hedonic Price Model. Thus, it was revealed how these effects were shaped in areas with different socio-economic structures. In addition to contributing to the literature, this study aims to obtain findings that will contribute to urban planning and urban policy-making around the stations. In this framework, answers to the following research questions were discussed.

- The proximity of housing to metro stations positively affects sales values.
- Increased accessibility through public transportation positively affects the mobility of lower and lower-middle-income groups in ensuring socio-economic justice.
- Providing metro access to neighbourhoods with low-income and/or high-income individuals increases housing prices more in favour of low-income groups and contributes to reducing income polarization with high-income groups.

In parallel to the research questions, the study will focus on the interaction of metros with their surrounding areas and their effects on the sale values of housing. These values will be evaluated within the framework of the structural and spatial characteristics of housing using the Hedonic Price Model.

Firstly, the theoretical discussions on the effects of rail system stations on the housing market, land use affecting the use of rail systems, accessibility-walkability-distance, and demographic structures, as well as the effects of rail system stations on the housing market were discussed. In the next section, the methodology used in the study (Hedonic Price Model) was explained. Then, the sale values of housing around the Batıkent and Koru metro stations in Ankara were evaluated using the Hedonic Price Model. The study was finalized with the conclusion section, which includes evaluations and recommendations.

2. Literature Review: Dynamics Affecting the Use of Rail Systems and Their Impact on the Housing Market

In the relevant literature, transportation-related problems are presented as traffic congestion, air and noise pollution, and many environmental problems such as global warming and climate change (Batur, 2017). Many countries focus on public transportation systems to achieve integrated and sustainable urban development, energy efficiency, and efficiency in time and budget. Especially in developed countries, population growth and irregular rapid urbanization caused by demographic growth lead to the development of a public transportation system that can meet the needs of the population rather than improving the quality of public transportation services (Abd Aziz, Kasim & Masirin, 2019). Rail systems have a positive impact on people's welfare, accessibility and the environment in urban planning and development, as they are an effective transportation mode on development and growth along their routes (Abd Aziz, Kasim & Masirin, 2019). The literature highlights three key components with which urban rail system facilities/stations interact. These are;

- Land use
- Accessibility, walkability and distance
- Socio-economic and demographic structure

In this study, the impact of urban rail system stations on housing prices will be deliberated. Within this scope, the effects of urban rail systems are evaluated in theoretical discussions interactively with these components.

2.1. Dynamics Affecting the Use of Rail Systems

In this section, rail systems are deliberated within the framework of theoretical discussions in interaction with the above components.

2.1.1. Land use

Cities are constantly changing due to natural and human-induced effects. Urban transportation constitutes the basic backbone of this structure. The form of the city is shaped by topography, natural features, economy, historical development process, and transportation network (Vuchic, 2007). The function of land use is important to overcome urban transportation problems, as transportation is a derived demand. In this context, optimum land use is always an important objective of land use planning. Optimum land use means using the land most effectively to achieve a specific goal or creating the most favorable activity on the land to achieve a positive outcome (Abd Aziz, Kasim & Masirin, 2019). Land use shows the spatial accumulation areas of many human actions such as nature, economic, social, cultural, production, consumption, and distribution. Case studies indicate that investments made to improve public transportation, rail system investments without complementary factors cannot promote spatial change, development, and urban growth along the corridor where they are built, and they cannot create the expected density in land use. According to Babalık Sutcliffe (2002), pedestrianization and local policies are complementary to the development of urban rail systems, while according to Pan & Zhang (2008), urban rail systems can contribute to land use and development with the implementation of correct policies.

2.1.2. Accessibility, walkability and distance

The main factors affecting accessibility are expressed as mobility, land use, transportation, and transportation system integration (Victoria Transport Policy Institute, 2016). Easy and comfortable access to business activities, education, employment, and recreational facilities and planning and design solutions that support walkability and neighbourhood scale constitute the essence of urban planning and transportation infrastructure (Murray, Davis, Stimson & Ferreira, 1998; Erdoğanaras, Cihangir-Çamur, Görer-Tamer & Mercan, 2020).

Accessibility is recognized as one of the indicators of development in modern societies, as stated by Avcı (2005). Walkability is also one of the important research topics because creating walkable urban spaces supports pedestrian accessibility (Cihangir-Çamur, Erdoğanaras, Görer-Tamer & Satoğlu, 2021).

The distance to bus stops, accessibility to the destination, pedestrian-oriented designs, density and diversity in land use are factors that affect walkability (Cervero & Kockelman, 1997; Ewing & Cervero, 2010). Good connections are also one of the factors that positively affect walkability (Agampatian, 2014).

Jach (2001) defines urban space as the place where the common sub-consciousness of users is the gift of feelings, rituals, and beliefs that belong to the city. It is the street, the square, the café, the coffeehouse, the neighbourhood market, the bus stop, the car, and the metro. In this context, walkability contributes to urban space. In the research conducted, walkability, mixed land use, and effective use of the area have developed the concept of "Transit-Oriented Development" (TOD) defined by American architect Calthorpe (1994) as "mixed-use communities within a 10-minute walk along regional transportation systems." Vale (2015) has also added the definition of 800 m. distance. This approach, which reduces private car use and supports traditional neighbourhood design by encouraging walking (Belzer & Autler, 2002), has become a serious research topic in recent years, and influenced by both transportation and socio-demographic factors. It is also seen as an important tool for creating sustainable urban areas (Kütük & Yalçıner, 2019; Siddiqui & Eren, 2022).

Cervero (2003) stated that because the intersections of different uses and transportation modes defined as TOD are high-density and pedestrian-friendly environments, an area within a quarter to half a mile of a station has the potential for development; Vuchic (2007) stated that an area where transit will be performed should be about 500m or a 5-minute walk from the stations. According to the Time Savings Standards, the maximum walking distance is generally accepted to be between 400m and 800m (5 to 10 minutes).

Voith (1991) stated that people working in central business districts preferred the rail system line for their housing choices, and Al-Mosaind, Dueker & Strathman (1993) stated that the rail system stop should be a maximum of 500m from the residence. Southworth (2005) suggests that the walking distance to transportation stations should be between 400m and 800m (a walking distance of 10-20 minutes); Dube, Theriault & Rosiers (2013) found that the station should be accessible by walking or short car journeys.

In their research, Yang, Yan, Xiong & Liu (2013) surveyed the factors that affect people's preference for "walking as a mode of transportation" when going to a rail system station and determined that the most important criterion is the "distance to the station" (Figure 1).

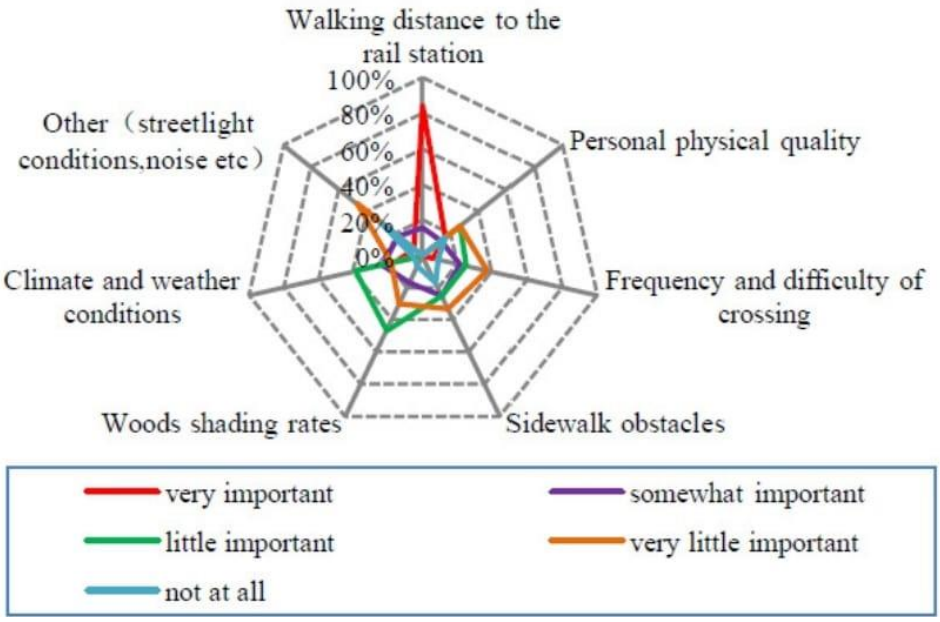

Figure 1. Factors influencing the preference for walking in accessing rail system stations (Yang, Yan, Xiong & Liu, 2013)

According to these studies, socio-economic factors that vary among individuals affect individual preferences in choosing transportation modes between work and home. Therefore, the relationship between rail systems and socio-economic and demographic characteristics is one of the current research topics.

2.1.3. Socio-economic and demographic structure

People's mobility levels vary depending on factors such as age, gender, and occupation. When considering all people, including those with and without disabilities, travel time and cost are decisive factors in meeting travel needs. When people choose a mode of transportation from the transportation systems available to them, they consider the highest benefit for themselves (Dong, Ben-Akiva, Bowman & Walker, 2006). From the perspective of travel mode choice, benefit is related to travel cost and travel time (Manski, 2005). In the relevant literature, two reasons are considered the main determinants: cost and time (Black, 1995; Davidov, 2003). In this respect, when a person chooses between different modes of transportation, they compare them in terms of cost and time (Institute of Transportation Engineers, 1992). Asensio (2002) highlighted that low-income people are more sensitive to travel costs, while high-income people are more sensitive to travel or waiting times. Similarly, Davidov (2003) noted that due to the speed of this mode, high-income people use private cars more than public transport. Therefore, it can be said that the value of time is more affordable for high-income people than low-income people. According to a study conducted in Toronto, Canada, young people walk longer distances than children, elderly people, and families, and women walk shorter distances than men (Alshalalfah & Shalaby, 2007). Bollinger & Ihlanfeldt (1997) found no significant relationship between rail transit systems and demographics and job opportunities, but they did observe an increase in public structures in areas with dense commercial functions. Cervero & Kockelman (1997), Shen (1998), and Geurs & Van Eck (2001) noted that data such as age, income, education, and physical condition affect people's accessibility levels via car or public transportation. They also observed that the ability of people to travel to work in their own residential areas significantly affects overall accessibility. Geurs &Van Wee (2004) argued that factors such as income, status, and education must be taken into account to define accessibility in terms of transportation, and that the socio-economic structure affects walking and car preferences. They also found that age is negatively proportional to many types of physical activity and that other socio-demographic characteristics vary depending on the purpose of the activity and also affect transportation expenses. Banister et al., (2011) found that as family income and education levels increase, the distance between home and work also increases.

2.2. The Impact of Rail Systems on Housing Prices

The literature generally acknowledges that housing values tend to increase in proximity to public transport stations, as they improve users' access to activity areas. Similarly, the connections between the socio-economic and demographic characteristics of the region and the rail system stations and rail lines are discussed, and it is emphasized that rail systems affect property prices. Due to the increase in technological and web resources related to real estate prices and the increase in public access to information, especially the relationship between housing values and the urban rail systems has become an important research topic.

Residential values are mostly evaluated based on the distance factor between houses and the station location (Abd Aziz et al., 2019). It is also noted that with the improvement of service quality, real estate values may increase in the areas on the outskirts of the city, as they become better connected to the rest of the city (Harjunan, 2018; Gallo, 2018). In the Buffalo real estate market, the average value of housing units located close to the train station has been found to increase compared to those located further away from the line (Hess & Almeida, 2016). In another study, proximity to commuter rail stations has a positive impact on land values compared to light and heavy rail (Debrezion et al., 2007). In low- and high-income neighbourhoods close to the railway station, it was found that low-income neighbourhoods were more affected (Bohman & Nilsson, 2016).

In contrast to this result, some researchers show that housing values increase in high-priced neighbourhoods, such as Salon & Shewmake’s 2011 study states that a 10% change in the distance leads to a 1% change in house price. Many studies on this subject indicate that there is an increase in the value of housing around the rail system, that there is a negative relationship between the number of users and the distance to the station, and that ease of access is taken into account when buying or renting housing around the station (Dube et al., 2013; Pan, Pan, Zhang & Zhong, 2014; Ransom, 2018; Yen, Mulley, Shaerer & Burke, 2018; Zhang & Wang, 2013).

Medda & Modelewska (2011) found that housing prices within 1 km of a metro station in Warsaw were 6.7% higher than those further away. Hiironen et al., (2015) found an 11-15% increase in housing values in the 400-meter buffer zone with the construction of a new railway station in the city of Helsinki. Sharma & Newman (2018) found a 4.5% increase in land values within the 500-meter buffer zone with the arrival of the railway in Bangalore.

The literature review reveals that there are limited studies on the effects of rail systems, especially the metro transportation mode, on housing market. Therefore, examining the spatial relationship between metro stations and housing market will provide data to guide urban planning and planning decisions, as well as contribute to the existing literature on the effects of metro stations on housing market in high- and low-income neighbourhoods, as each area has unique conditions.

3. Case Study Area and Method

In Ankara, the metro and Ankaray systems were established starting in the 1990s. These systems continue to be developed due to the increasing population and traffic density and the spread of urbanization. The concentration of urban services in Ankara mainly in the city center has led to traffic problems to increase in this area. Bus-based public transportation systems have been inadequate in the face of increasing needs. The compact structure of the city has increased traffic congestion and air pollution problems. In planning studies conducted in Ankara after the 1970s, a controlled decentralization policy was adopted. With this policy, a development strategy was put forward along certain corridors without spreading in space. Within this framework, urban development was proposed along two main corridors, the West Corridor consisting of Sincan and Batıkent routes and the Southwest Corridor where Çayyolu developments took place. While the West Corridor was planned for the decentralization of industry, the Southwest Corridor was thought to include public institutions and university campus areas (Cihangir-Çamur, Erdoğanaras & Demirbilek-Çardak, 2022). While industrial developments in the West Corridor were supported by government incentives, developments in the Southwest Corridor were left to market forces (Kütük & Yalçıner, 2019; Eren, 2021). Two metro lines were proposed to establish the relationship of these corridors with the city center. The Batıkent Metro Station's planning allowed for high-density development with mixed land use for living and working areas. The balance between living and working areas could not be established at the Koru Metro Station, and this area was realized as a lower density and scattered settlement. In addition, while the station in the West Corridor was opened in 1997, the Koru station was opened in 2014. In this study, these two stations were selected as sample areas due to the differences in physical structuring as well as the different socio-economic groups that have chosen to settle in these areas.

Fieldwork was conducted in Kent-Koop Neighbourhood (Figure 3 and 4) where the Batıkent Station of Kızılay-Batıkent (M1) Metro Line, and Koru Neighbourhood (Figure 5 and 6) where Koru Station of Kızılay-Çayyolu (M2) Metro Line, two of the four metro routes in the city, are located. Kent-Koop Neighbourhood is an area where mixed-use (trade+residential) buildings are dense, and low-income groups are prevalent. It is a neighbourhood that has a high proportion of middle-aged (50-54 years) and elderly (55-65+ years) in the population structure and has a household size of 3, with families with three members being dense. Koru Neighbourhood is a region where mainly residential structures are located, and upper and middle-income groups live with low density. The proportion of middle-aged (45-54 years) and elderly (55-65+ years) is denser in the population distribution. The average household size is 2.7, and the number of families with three members is higher. In order to reveal the effects of metro stations on the housing market, Batıkent Station neighbourhood, which is inhabited by lower income groups, and Koru Station neighbourhood, which has a higher income user profile, provide a comparison opportunity in terms of monitoring these effects and provide the opportunity to examine the effects of metro stations on housing markets.

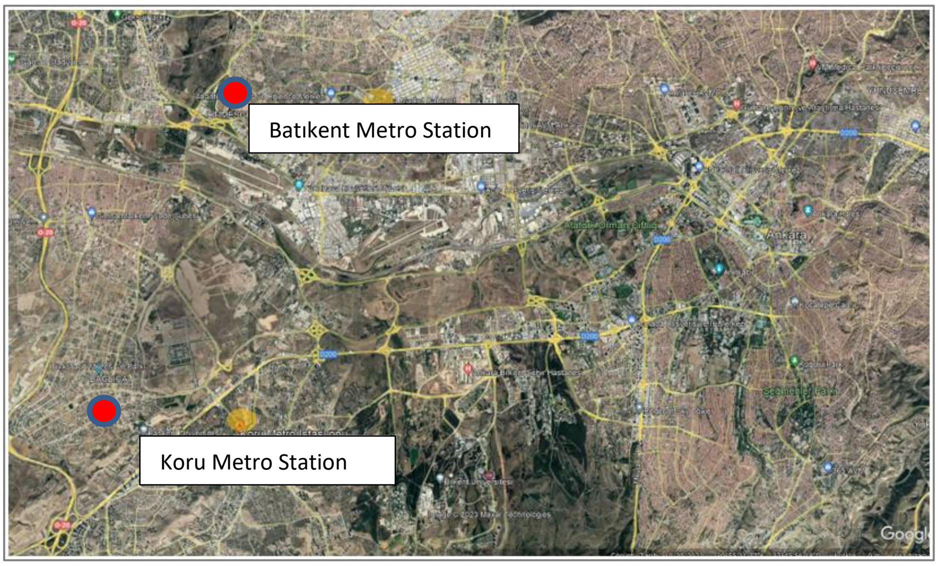

Figure 2. Location of Batıkent Metro Station in the western corridor and Koru Metro Station in the southwestern corridor of Ankara

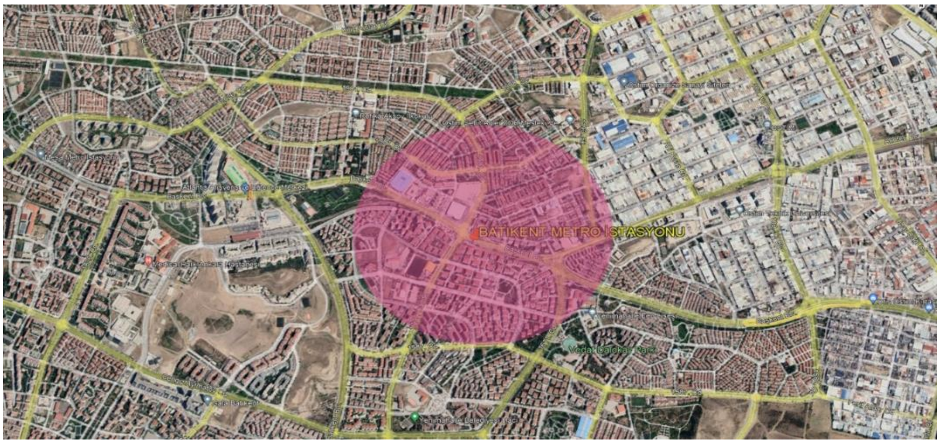

Figure 3. Batıkent Metro Station and surroundings

Figure 4. Comparison of construction around Batıkent Metro Station between 2002 and 2022

Figure 5. Koru Metro Station and surroundings

Figure 6. Comparison of construction around Koru Metro Station between 2002 and 2022

In this framework, the areas where the study will be carried out were selected within the 1500-meter radius, which is considered as a walkable distance to the metro stations. Web site (Sahibinden.com) data were used to reveal the house prices and the components affecting the prices were evaluated by using the Hedonic Price Method.

Hedonic Price Method (HPM)

The HPM establishes a link between the features of a house and its price. Here, the effect of each feature to be added or removed from the house on the price of the house is decomposed. The added features aim to differentiate the goods (Özkan & Yalpır, 2005). As a result, HFM is a method that evaluates the price of a particular good as the sum of the values of its attributes and estimates the value of each attribute using regression analysis. Today, the United Kingdom, Ireland, Finland, France, France and the United States prepare house price indices using the HFM method. Within the scope of the article, it will be examined whether there is an acceptable connection between accessibility and the prices of houses for sale and rent in the area within a radius of 1500 meters around Batıkent and Koru Stations. The model used in this regression is the Logarithmic Linear model.

According to the Logarithmic Linear Model, the dependent variable, i.e. the price, is the logarithm of the price, and the independent variables (whether it is a site complex/apartment, square meter, the floor it is located or owned, the age of the house, the number of rooms and living rooms, distance to the metro station, distance to the school, distance to the bus stop) are in linear form. The logarithmic linear model is interpreted as "a one-unit change in the independent variable $X1$ will lead to a change in the dependent variable P by $\beta1$ percent" (Özçalık, 2018).

$$lnP = \alpha + \beta1X1 + \beta2X2 + \beta3X3 + \dots \dots \dots \dots + \beta nXn + \varepsilon i$$

Below are the nine variables that will be used to test whether there is a significant relationship between the price of the house and the distance of the house to the metro station.

Table 1. Variables used in the Hedonic Method

	Index	Variables	Unit	Description
Building Variables	$\beta1$	Structure Type	Villa, Apartment	Use and Type of Building
	$\beta2$	Price (Dependent variable)	Turkish Lira	House price
	$\beta3$	Area	Square Meters	Total residential area
	$\beta4$	Floor Level	Integer	The Floor Level of the apartment
	$\beta5$	Building Age	Years	Total time since construction
	$\beta6$	Number of Rooms or Independent Sections	Integer	Number of bedrooms, living rooms
Location Variables	$\beta7$	Distance to Metro Station	Meter	Walking distance
	$\beta8$	Distance to School	Meter	Walking distance to educational amenities
	$\beta9$	Distance to Bus Stop	Meter	Walking distance to bus stop

By obtaining data from Sahibinden.com real estate sales websites, a set consisting of a total of 55 data including houses for sale and rent within a radius of 1500 meters centered on the station was prepared. Evaluation was performed based on 24 properties for sale in Batıkent and 18 properties for sale in Korukent. All data were collected on the same day (23.10.2022) at the stations to ensure the same economic conditions were met.

4. Findings and Discussion

Section 4 presents the results and evaluations of the hedonic price method for properties for sale around Batıkent and Koru stations, which are categorized into four subheadings.

4.1. Effect of Batıkent Metro Station on Housing Sale Prices

This section focuses on the evaluation of sale prices for properties in Batıkent using the hedonic price method. In this method, the dependent variable is the property price, while the independent variables are site/apartment status, square meters, floor level, and age of the property, number of rooms, distance to the metro station, distance to educational amenities, and distance to bus stops. As the values of positive factors increase, the sale price of the property increases, and as the values of negative factors increase, the sale price decreases.

Distance to the Batıkent metro station is the sixth independent variable that affects the property sale price. As the distance between the property and the metro station increases, the sale price of the property decreases due to the negative relationship between distance and price.

Table 2. Correlation relationships of Batıkent Metro Station for housing sale prices

	Distance to Metro Station (m)	Site /Apartment	Price (TL)	Square Meter (m²)	Number of Rooms	Floor Level	Building Age (year)	Distance to Bus Stop (m)	Distance to School (m)
Distance to Metro Station (m)	1	.142	-.162	-.161	-.330	.020	.133	.532**	-.160
Site/Apartment	.142	1	.296	-.108	-.046	.226	.274	.156	.041
Price (TL)	**-.162**	**.296**	**1**	**.609****	**.421***	**.007**	**-.345**	**.173**	**-.103**
Square meter(m²)	-.161	-.108	.609**	1	.689**	-.307	-.582**	-.111	-.274
Number of Rooms	-.330	-.046	.421*	.689**	1	-.067	-.188	-.260	-.080
Floor Level	.020	.226	.007	-.307	-.067	1	.363	-.233	.251
Building Age (year)	.133	.274	-.345	-.582**	-.188	.363	1	.134	-.194
Distance to Bus Stop (m)	.532**	.156	.173	-.111	-.260	-.233	.134	1	-.239
Distance to School (m)	-.160	.041	-.103	-.274	-.080	.251	-.194	-.239	1

According to correlation matrix (Table 2) there is a very strong positive relation between the variables price and square meter (0.609), a strong positive relation between price and the number of rooms/sections (0.421), positive relation between price and whether it is located in a site or an apartment building (0.296), price and the distance to the bus stop (0.173) and a negative relation between the variables price and the age of the building (0.345), price and the distance to the metro station (0.162), price and the distance to the school (0.103). According to the results of the Hedonic Regression Model, the variables of distance to the school, floor level, and square meter size, location in a site or apartment building, distance to the metro stop, distance to the bus stop, age, and number of rooms explain 53.5% of the variation in the housing price. For the One-Way Analysis of Variance (ANOVA) to determine whether multiple independent variables are significant or not in the created model, the significant value of the F-test is 0.005, which is less than 0.05. Therefore, a statistically significant relationship between the variables in the regression model has been determined.

The significant value (B) of the T-test is greater than 0.05 for variables such as location in a site/apartment building, housing size, number of rooms, floor level, and housing age, indicating that there is no statistically significant relationship between these variables and the housing price. However, the significant value (B) of the T-test is less than 0.05 for the variables of distance to the metro station and distance to the bus stop, indicating that there is a statistically significant relationship between these variables and the housing price.

The table shows the correlation coefficients between the price and different variables of residential properties located near the Batıkent Metro Station. The variables include square meter size, number of rooms, building age, distance to the bus stop, distance to the metro station, distance to the school, floor level, and whether the property is located in a site or apartment building.

The correlation coefficients range from -1 to 1, where a value of -1 indicates a perfect negative correlation, 0 indicates no correlation, and 1 indicates a perfect positive correlation. The table shows that the variables with the strongest positive correlation to price are the square meter size (0.609), number of rooms (0.421), and whether the property is located in a site or apartment building (0.296). The variables with the strongest negative correlation to price are age (-0.345) and distance to the metro station (-0.162).

Table 3. Independent variable relationships of Batıkent Metro Station for housing sale prices

Coefficients								
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	13.205	.394		33.482	.000		
	Distance to Metro Station (m)	.000	.000	-.379	-2.152	.047	**.651**	**1.537**
	Site/ Apartment	.140	.072	.297	1.945	.070	**.867**	**1.153**
	Square Meter (m2)	.008	.004	.556	2.099	.052	**.288**	**3.467**
	Number of Rooms	.018	.099	.042	.184	.856	**.389**	**2.571**
	Floor	.021	.010	.338	2.015	.061	**.720**	**1.390**
	Building Age (years)	-.050	.043	-.232	-1.153	.266	**.501**	**1.996**
	Distance to Bus Stop (m)	.002	.001	.520	2.854	.011	**.609**	**1.643**

4.2. The Effect of Koru Metro Station on Housing Sale Prices

The distance of the house for sale to the metro station is an independent variable that affects the housing price in fourth place. As the distance increases, there is an increase in the sale price of the house, so the relationship between distance and price is proportional.

Table 4. Correlation relationship for Koru Station for housing sale prices

Correlations									
Pearson Correlation Coefficient	DISTANCE to METRO STATION(m)	SITE/ APARTMENT	PRICE (TL)	SQUARE METER (m²)	NUMBER of ROOMS	FLOOR	BUILDING AGE (yıl)	DISTANCE to BUS STOP (m)	DISTANCE to SCHOOL(m)
Distance to Metro Station (m)	1	.274	.351	.298	.146	.263	-.368	.284	-.077
Site/ Apartment	.274	1	-.037	.023	.258	.066	.000	-.218	-.281
Price (Tl)	.351	-.037	1	.937**	.695**	-.027	-.563*	.242	-.143
Square Meter	.298	.023	.937**	1	.684**	-.077	-.536*	.381	-.140
Number of Rooms	.146	.258	.695**	.684**	1	-.280	-.409	-.072	-.165
Floor	.263	.066	-.027	-.077	-.280	1	-.440	.168	.046
Building Age (Years)	-.368	.000	-.563*	-.536*	-.409	-.440	1	-.319	.268
Distance to Bus Stop (M)	.284	-.218	.242	.381	-.072	.168	-.319	1	-.174
Distance to School (m)	-.077	-.281	-.143	-.140	-.165	.046	.268	-.174	1

According to correlation matrix (Table 4) there is a very strong positive relation between the variables price and square meter (0.937), price and the number of rooms/sections (0.695), positive relation between price and distance to metro stop (0.351) and distance to bus stop (0.242) and a negative relation between price and building age (0.563), whether it is located in a site or an apartment building (0.037) and the floor (0.027).

According to the summary of the Hedonic Regression Model, variables such as distance from the school, the floor it is located on, square meter size, whether it is located in a site/apartment, distance to the metro station, distance to the bus stop, age, and number of rooms explain 93.2% of the price variable of the houses for sale in Korukent. For one-way analysis of variance (ANOVA) to determine whether a model with multiple independent variables is significant or not, the null (H0) and alternative (H1) hypotheses are tested. Since the F-test's significant value is less than 0.05, it has been determined that the regression model is significant and there is a statistically significant relationship between the variables. The significant value (B) of the t-test is greater than 0.05, indicating that there is no statistically significant relationship between the distance of the house to the metro, whether it is located in a site/apartment, the age of the house, the distance to the bus stop or school, and the price of the house. However, since the significant value (B) of the t-test is less than 0.05, there is a statistically significant relationship between the square meter, the number of rooms, and the floor number of the house and the price of the house. When the square meter value of the house increases by one unit, the price of the house increases by 0.004 units, when the number of rooms increases by one unit, the price of the house increases by 0.344 units, and when the floor number of the house increases by one unit, there is a change of 0.028 units in the price. The Table 5 shows the correlation coefficients between the price and different variables of residential properties located near the Koru Metro Station. The variables include square meter size, number of rooms, building age, distance to the bus stop, distance to the metro station, distance to the school, floor level, and whether the property is located in a site or apartment building. The correlation coefficients of the model range from -1 to 1, where a value of -1 indicates a perfect negative correlation, 0 indicates no correlation, and 1 indicates a perfect positive correlation. The table shows that the variables with the strongest positive correlation to price are the square meter size (0.677), number of rooms (0.414), and the floor (0,291). The variable distance school has a negative correlation (-0.120).

Table 5. Independent variable relationships of Koru Metro Station for housing sale prices

Coefficients						
	Unstandardized Coefficients		**Standardized Coefficients**	**T**	**Sig.**	
	B	**Std. Error**	**Beta**			**VIF**
Constant	**13.629**	.380		35.882	**.000**	
Distance to Metro Station(M)	**-1.345E-5**	.000	-.007	-.090	**.930**	**1.439**
Site/ Apartment	**-.168**	.164	-.084	-1.027	**.331**	**1.646**
Square Meter (M2)	**.004**	.001	.677	6.015	**.000**	**3.155**
Number of Rooms	**.344**	.099	.414	3.484	**.007**	**3.508**
Floor	**.028**	.009	.291	3.105	**.013**	**2.179**
Building Age (Years)	**.029**	.055	.057	.526	**.612**	**2.963**
Distance to Bus Stop (M)	**.000**	.000	.027	.319	**.757**	**1.777**
Distance to School(M)	**-.001**	.000	-.120	-1.613	**.141**	**1.374**

4.3 Evaluation of the Housing Sale Prices around the Batıkent and Koru Metro Stations Compared to the Cases

The residential areas around the Batıkent Metro Station hosts both developing and established housing areas subject to planning implementations related to middle and low-income households. On the other hand, the residential areas around the Koru Metro Station is characterized by low-rise housing units as well as high-rise apartments for upper-middle and high-income households. The hedonic regression analysis of the housing sale prices presents the differences and similarities of the both locations, Batıkent and Koru, in terms of variables affecting the housing sale prices. The most important variables affecting the housing sale prices in Batıkent case are the size of the house, the distance to bus stop, the number of the rooms, the age of the building, whether it is located in a site or an apartment building and distance to metro station. On the other hand it is seen for the Koru case that only the variables related to housing characteristics are affecting the housing sale prices are; the size of the house, the number of the rooms, the floor number and distance to school. Some of the findings of the two cases investigated in this article are parallel to the cases found in the literature. In a middle-low-income residential area (Batıkent), the distance to the bus stop and metro station affects the housing sale prices, whereas in a high-income residential area (Koru), there is no such effect. Studies in the literature indicate that rail system investments affect housing prices, and the accessibility to metro stations also contributes positively to the increase in housing prices, just as the proximity to the city center does (Bajic, 1983; Cervero, 2003; Pan & Zhang, 2008).

Research conducted in Istanbul shows that being close to a metro line has a positive effect on the surrounding housing prices (Şahin, 2019). Similarly, another study examining the effect of Istanbul metro stations on housing prices found that the closer the distance to the station, the higher the housing prices (Cengiz, 2020).

In a thesis study that examined the effects of metro stations and metro lines on the housing sub-market, it was found that there is no significant difference in the prices of the housing around the station areas and metro lines within 250 meters. However, it was determined that the values of the for-sale and rental housing around the station areas were higher than those in areas with similar proximity to the metro line (Alas, 2021). Another study found that proximity to transportation points such as public transportation stations positively affect housing prices, in addition to variables such as size, age, floor number, garden view, sea view, etc. In this study, it was found that housing prices are high around public transportation stations (Choy et al., 2007). Another study conducted in Istanbul states that the housing prices around the station areas increase in areas where housing prices are already high and similar results were obtained for rental values (Alkay, 2011). However, there are also studies that demonstrate the opposite of this general trend, such as the effect of metro stations decreasing housing prices in areas where high-income groups live (Nelson, 1999).

5. Conclusion and Suggestions

In the relevant literature, it is emphasized that metro stations within walking distance cause an increase in housing prices and accessibility is an important criterion in people's transportation mode choices. The results of the Hedonic Price Model applied in this study reveal that the impact of Batıkent and Koru Metro Stations, with different socio-economic characteristics, on housing sales prices varies depending on accessibility within the 1500-meter radius defined as a walkable distance. Batıkent with a mixed-use land pattern and is inhabited by the middle-lower income group, as the distance of the housing to the station decreases, the sale prices of the houses increase. In this case, it can be said that users' lower income levels make them more sensitive to travel costs and less expected to own a car. On the other hand, in Koru, where high-income group lives, the increase in housing sales prices within the 1500-meter radius of the Koru Metro Station as one moves away from the station indicates that housing-related features such as the size, number of rooms, and number of floors are more important in determining housing prices. This situation is also supported by the fact that high-income individuals use private cars more when compared to public transportation and their time is more valuable.

In other words, the relationship between accessibility and housing sales values is lower near Koru Metro Station, where users with a high socio-economic level, while it is higher near Batıkent Metro Station, where users with a low socio-economic level. This situation shows that metro transportation systems are effective in reducing polarization between different socio-economic groups in the city. In the future, conducting similar studies in high and lower socio-economic housing areas using the same method and applying this model at regular intervals will contribute to monitoring socio-economic problems such as polarization in the city and overcoming these problems with transportation policies. Additionally, this study can be expanded to include rental housing prices around metro stations and compare sales and rental values. Similarly, sales and rental values in areas located along the metro line and those far away from it can be compared, taking into account socio-economic differences, to obtain more general results.

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