ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL OF SCIENCE ENGINEERING AND TECHNOLOGY

FINANCING URBAN RAIL INVESTMENTS VIA URBAN DEVELOPMENT

Ph.D. THESIS

Elif Can CENGİZ

Department of Urban and Regional Planning

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APRIL 2020

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İSTANBUL TEKNİK ÜNİVERSİTESİ ★ FEN BİLİMLERİ ENSTİTÜSÜ

METRO YATIRIMLARININ ARAZİ GELİŞTİRME İLE FİNANSE EDİLMESİ

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NİSAN 2020

Elif Can CENGİZ, a Ph.D. student of İTU Graduate School of Science Engineering and Technology student ID 502142804, successfully defended the thesis/dissertation entitled "FINANCING URBAN RAIL INVESTMENTS VIA URBAN DEVELOPMENT", which she prepared after fulfilling the requirements specified in the associated legislations, before the jury whose signatures are below.

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Date of Submission : 13 March 2020
Date of Defense : 1 April 2020

To my beloved husband Çağın CENGİZ,

FOREWORD

In this study, I would like to investigate the impact of metro projects on surrounding housing market. This was a very complicated and difficult task. The biggest limitation for this study was the data collection. Since there is not a public office recording real estate data accuretely in Turkey, the only possible way to collect housing data was to conduct a questionnaire survey on site. However, due to time and budget constraints this survey was conducted with real estate agents working on this site. In this wise, only the data regarding to housing units could be obtained. The data regarding to social issues could not be collected, since agents are third party and cannot give information on behalf of owners. For such a study, the apropriate data for housing units are transaction data, but in this study only asked price is obtained. Despite those limitations and hardwork we could finalized this study with great effort. Thus, I would like to expess my deepest gratitute to my advisor Prof. Dr. Hüseyin Murat ÇELİK and my co-advisor Assoc. Prof. Pelin ALPKÖKİN for all their support, guidance and patience throughout this reaserch. I would also like to thank my jury members Prof. Dr. Ela BABALIK, Assoc. Prof. Mustafa GÜRSOY, Assoc Prof. Hüseyin Onur TEZCAN for their time and valuable suggestions. I would like to express my sincerely gratitute to Enver Cenan İNCE for his technical support.

Phd is very time consuming and requires full dedication in human's life, so I would like to thank all my, collegues, friends and my dearest family for being next to me in this long lasting period of time.

I would also like to thank my dearest husband Çağın CENGİZ for his endless support and patience during this hard process when ever I got stressed and close to quit he was there all the time. I am also deeply greatful to Nazlı VARLIER and Cihan ERDOĞAN for their support, whenever I need to work long hours in the office they let me in their home and comfort me. I am also very lucky to have my mom and dad, their positive attitute supported me a lot, when I needed they were there even if it is on the phone.

April 2020

Elif Can CENGİZ
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ABBREVIATIONS

ALS	: Areal Licensing System
BOO	: Build Own Operate
BOOT	: Build Own Operate Transfer
BOT	: Build Operate Transfer
BRT	: Bus Rapid Transit
CBD	: Central Business District
DBFM	: Design Build Finance Maintain
DOP	: Düzenleme Ortaklık Payı
ERP	: Electronic Road Pricing
GM	: Greater Municipality
GLA	: Greater London Authority
HOT	: High Ocupancy Tolls
İETT	: İstanbul Elektrik Tramvay ve Tünel İşletmeleri
İBB	: İstanbul Büyükşehir Belediyesi
LRT	: Light Rail Transit
LVT	: Land Value Taxation
MTR	: Mass Transit Railway
MTRC	: Mass Transit Railway Corporation
PPP	: Public Private Partnership
R+P	: Rail Plus Property
TfL	: Transport for London
TEM	: Transit European Motorway
TOD	: Transit Oriented Development
TÜİK	: Türkiye İstatistik Kurumu
UITP	: Union Internationale des Transports Publics (International Association of Public Transport)

SYMBOLS

A	: Arithmetic gradien
C	: Contract Conditions
H0	: null Hypthesis
HA	: Alternative Hypothesis
i	: interest rate
L	: Locational Attributes
N	: Neighbourhood Attributes
N	: number of years
P	: Property related attributes/structural attributes
R	: Rent or Selling Price of the property
T	: Time

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FINANCING URBAN RAIL INVESTMENTS VIA URBAN DEVELOPMENT

SUMMARY

The impact of railway stations on the housing prices in the surrounding area has been investigated by numerous studies. Literature suggests that railway stations have significant impact on the surrounding land values. However, there is no agreement amongst these studies as to whether this impact is positive or negative. Some scholars claim that due to increase in accessibility railway stations have a positive impact on the surrounding property prices. On the contrary some claim that due to the nuisance effect rail stations have a negative impact on the properties in close vicinity of the station. The common part of these studies is that the impact varies depending on the type of the transit system. The nuisance effect is generally experienced in LRT corridors, since their stations and routes are mostly on the surface. The nuisance effect such as noise, vibration and visual pollution created by these systems can be seen in many cities. However, elements of heavy rail systems are generally located underground, so the nuisance effect is only experienced during the construction stage of the system which can be tolerated for the sake of the service it will provide after completion. The studies conducted on the impact of metro systems on the housing market of the surrounding area concluded that the impact is positive even at very close locations to stations. In this study the selected rail corridor is a metro project, therefore the impact of stations is accepted as a positive one.

The case study area selected is Istanbul, because it has the largest rail network of all the cities in Turkey. Furthermore, Istanbul has not been studied in this context before. The city needs further rail investments and has projects lined up for future rail network extensions. However, it has no money to realize these projects.

In the first part of the study the monetary impact of stations on the housing market is calculated. In the second part a methodology is developed how this increase in property value can be retrieved from property owners for the financing of rail projects.

This study is designed as a comparative study with a 'before' and 'after' analysis of the same area. One survey should be collecting the selling prices of apartments in the surrounding area before the rail system is built and the other after the rail system is in place. However, with the data available it was not possible to carry out a before and after analysis. Thus two case study areas with similar characteristics were selected: the after case being a metro system in operation, the other a proposed metro project which is currently under construction. A similarity check was conducted in order to demonstrate that in terms of this analysis these two cases are identical. Lastly, the before and after analyses were conducted on the basis of the selected study areas.

In this study the hedonic price model is used. There are many studies which investigate the impact of railway stations on the surrounding housing market, and different models are used to conduct these calculations. However, the hedonic price model is one of the prominent models amongst them. The data available made the use of the hedonic price model more suitable for this study. Other studies use difference-in-differences for the

calculations, and the GWR model uses a public database. The public data on housing is unfortunately not reliable; therefore the necessary data for this study was obtained by conducting on-site questionnaire surveys. Due to budget and time constraints the questionnaires were conducted with real estate agents working in areas around the stations of the rail system instead of property owners who are selling their apartments.

The case study was selected on the basis of certain criteria. Firstly, rail system projects in Istanbul were listed. Out of these only the metro projects were chosen, the rest was eliminated, and only metro projects of 10 to 20 km lengths were selected as potential case studies. Metro projects with a length of less than 10 km were eliminated from the study since they would not provide sufficient data for the analysis. Similarly, metro projects longer than 20 km were also eliminated, since it would be very hard to handle them. Out of the remaining projects a project was selected on the basis of potential ridership figures per km, namely the Ataköy-İkitelli metro project which has a 13 km route length and 11 stations. In order to perform the before and after analysis, another rail system corridor, the Esenler-Kirazlı corridor was selected. This case study area was demonstrated to be similar with the Ataköy-İkitelli metro corridor in terms of housing and population characteristics.

The questionnaire contained questions on apartment selling prices and characteristics of the apartments. As the questionnaire was conducted with real-estate agents and not the owners themselves, the social data on the owners and their family structure, education level, socio-economic status and family characteristics was not collected. The data obtained was modeled using the hedonic price model, then the coefficient of distance was used to estimate the value increase around the Ataköy-İkitelli metro stations.

After calculating the estimated value increase around the Ataköy-İkitelli metro corridor, as the second part a methodology was developed to collect some part of this increased value from property owners in the form of a tax. This is not a new form of tax; it has long been used in the world under different names such as special assessment, betterment tax, LVT and value increment tax. The names are different but the aim is the same. If after a public investment a property owner has a financial gain on his/her property, he is expected to share the profit with the community by contributing to the capital cost of other projects.

One of the main reasons for collecting this tax from property owners is to create money for funding further rail investments in Turkey. Without such a tax, the property owners will profit from a public investment funded by all citizens' taxes. Taxation of such capital gains will also help limiting urban rent.

METRO YATIRIMLARININ ARAZİ GELİŞTİRME İLE FİNANSE EDİLMESİ

ÖZET

Günümüzde kentsel alandaki en önemli altyapı hizmeti ulaşım sistemleri olarak görülmektedir. Kentler içinde barındırdığı nüfusun hareketliliğini sağlamak için bir çok farklı ulaşım moduna ihtiyaç duymaktadır. Kentlerin büyüklüğü ve coğrafi konumlarına bağlı olarak bu sistemler farklılık göstermektedir.

Ulaşım sistemleri kentlerin sosyal, ekonomik ve fiziki yapısı üzerinde uzun vadeli etkilere sahiptir. Özellikle metro, hafif raylı, tramvay gibi raylı sistemler ile ülkemizde de 2007 yılında İstanbul'un trafik sıkışıklığını hafifletmek amacıyla İstanbul'un ulaşım sistemine dahil edilen hızlı otobüs taşımacılığı (metrobüs) gibi sistemler kalıcı alt ve üst yapı elemanlarına sahip oldukları için kentin makroformunda uzun vadeli ve çok önemli değişikliklere neden olmaktadır. Kentler özellikle bu koridorlar üzerinde gelişme göstermeye başlamakta ve raylı sitem ağları kentlerin omurgalarını oluşturmaktadır. Raylı sistem yatırımları son derece pahalı yatırımlar olup; kalıcı alt ve üst yapı elemanlarına sahip oldukları için, ilk yatırım maliyetleri lastik tekerli ulaşım türlerine kıyasla daha yüksektir. Ayrıca raylı sistemler bir kez yapıldıktan sonra geri dönüşü ya hiç olmamakta ya da daha maliyetli olmaktadır. Tüm bu gerekçeler göz önüne alındığında, bu sistemlerin planlanmasında kentsel gelişme planlazrı ve imar planları ile entegrasyonu büyük bir önem taşımaktadır. Kentler ancak ulaşım sistemleri ve kent planları entegre bir şekilde ele alındığı zaman kontrollü ve düzgün bir gelişme gösterebilir. Bu sebeple raylı sistemler planlanırken fazladan özen gösterilmesi gerekmektedir.

Kentlerede arazi fiyatlarını belirleyen en önemli parametrelerden biri belli ulaşım sistemlerine yakınlıktır. Kentsel kullanımlar, daha erişilebilir bir çevre sağladığı için toplu taşıma sistemlerine yakın alanlarda yığılma göstermektedir. Kentte yaşayan insanlar da bu kullanımlara kolaylıkla ve daha ucuza erişebilmek için bu koridorlara yakın alanlarda yaşama eğilimindedir. Bu durum arz-talep dengesi doğrultusunda arazi ve aynı zamanda konut fiyatlarına yansımakta ve değer artışlarına neden olmaktadır. Günümüzde toplu taşıma sistemleri, kentlerdeki en önemli altyapı yatırımlarından biri olarak görülmektedir. Bu yüzden hem yerel hem merkezi yönetimler ulaşım plan ve projelerine büyük önem vermektedir. Özellikle metro yatırımları bir prestij göstergesi olarak kabul edildiği için yerel belediyeler raylı sistem yatırımlarını kentlerine uygulamak istemektedir. Ancak yetersiz finansal kaynak olması sebebiyle çok ihtiyacı olan kentlerde dahi bu yatırımlar çoğu zaman hayata geçirilememektedir. Dünyada raylı sistem yatırımlarının finanse edilmesi için kullanılan birçok model bulunmakta olup; bu modellerin temelinde arazinin ulaşım yatırımları ile paralel olarak planlanması gerekliliği yatmaktadır. Bu bağlamda metro yatırımları özelinde değer artışları ve dünyadaki başarılı örnekler incelenmiş; özellikle Hong Kong'da uygulanan MTRC gelişme modelinin üzerinde durulmuştur. Bu modele göre proje yapılmadan önce arazinin geliştirme haklarının yüklenicilere bu modele göre, proje yapılmadan

önce yüklenici firmalara proje sonrası fiyat üzerinden arazi geliştirme haklarının devri yapılmaktadır. Bu method sayesinde proje öncesi ve sonrası arasında doğacak değer artış miktarı proje başlamadan yükleniciden alınarak projenin finansmanı için kullanılmaktadır. Bu şekilde devlet bütçesinden para çıkmadan proje kendi kendini finanse edebilmektedir. Bu modelin Türkiye için uygulanabilirliği araştırılmış ancak, Hong Kong şehir devletinde olmayan özel mülkiyet kavramının ülkemizde projelerin yapımında en büyük kısıt olması bakımından bu tip bir gelişme modelinin Türkiye'deki kentlerde uygulanamayacağı görülmüştür. Bir diğer finansman modeli olarak Transport for London (TfL) modeli incelenmiştir. Bu modele göre; gelişmemiş bölgelere doğru ise projeler yapılırken gelişmemiş bölgelere doğru planlanan raylı sistem yatırımlarını öngören bu model ile, gelişime açık alanların devlet kontrolünde yapılaşması ve arazi geliştirme yoluyla elde edilen gelirlerin bir finansman kaynağı olarak kullanılması sağlanmaktadır. Ancak bu yöntem de sadece yerleşime sakıncalı alanların gelişime açık kaldığı İstanbul gibi fazlasıyla yapılaşmış bir kentte uygulanabilir görülmemiştir. Bu sebeple özellikle İstanbul özelinde yapılı çevre üzerinden bir finansman modeli oluşturmaya çalışılmıştır. Aynı zamanda vergilendirme konusunda incelenmiş ve kullanıcı öder ya da faydalanıcı öder şeklindeki yaklaşımlar göz önünde bulundurulmuştur. Çalışmanın temeli yatırımlardan en çok fayda sağlayan kesimin projenin finansmanına katkı sağlaması üzerine kurulmuştur.

Bu tez sırasında özellikle karşılaşılan mali çıkmazlar için bir çözüm aranmıştır. Geliştirilecek modelin sürdürülebilir olması da dikkate alınmıştır. Bütün dünyada genel literatürün ortak bir paydada buluştuğu konu kent için yapılan herhangi bir alt yapı yatırımının yapıldığı alanda bir değer artışına neden olduğu yönündedir. Ulaşım yatırımlarının etkisiyle koridor boyunca oluşan arazi fiyatlarındaki artışın internalize edilmesi uygulanabilecek seçeneklerden birisidir.

Bu çalışmanın çıkış noktası, devletin yapacağı yatırımlarda kullanılacak kaynakların insanların ödediği vergiler bakımından daha eşitlikçi bir şekilde dağılmasını sağlamak olup; ülkemizde yapılan yatırımlar genellikle hazinede toplanan vergilerle yapılmakta, bu durum yatırım yapılan projeyi hiç kullanmayacak insanların ödediği vergilerle yapılması anlamına gelmektedir. Bu durumun önüne geçmek için yatırımdan en çok fayda sağlayan kesimden yani proje sonucu mülklerinde değer artışı olan vatandaşlardan toplanan şerefiye vergisi ile projenin en azından bir kısmının finanse edilmesi, böylece devlet bütçesine olan yükün hafifletilmesi amaçlanmaktadır.

Bu çalışmada İstanbul kenti özelinde bir araştırma yapılmış olup; çalışma kapsamında iki adet raylı sitem projesi belirli kriterlere göre belirlenmiştir. Bunlardan birisi hâlihazırda işletmede olan Esenler-Kirazlı raylı sistem projesidir. Diğeri ise henüz yapım aşamasında olan Ataköy-İkitelli metro projesidir. İlk alanda emlakçılar ile yapılan anket çalışması ile elde edilen konut sektörüne ait veriler "hedonik fiyat modeli" kullanılarak modellenmiştir. Bu model, konuta dair her bir değişkenin konutun fiyatı üzerindeki etkisinin hesaplanmasına olanak sağlamaktadır. Konut fiyatı, büyüklüğü, yaşı, oda sayısı, banyo sayısı, cephesi gibi verlerin bulunduğu veri setine işletmede olan metro istasyonuna konutun uzaklığı verisi eklenmiş ve alanda çalışan emlakçılar ile yapılan anket çalışması ile bu veriler toplanmıştır. Anket çalışması istasyonu merkez kabul eden 500 metre yarıçaplı bir alanda yapılmıştır. R-Studyo programı kullanılarak fiyat bağımlı değişkeni için bir fonksiyon elde edilmiştir. Bu yöntem ile, konutun her bir metre metro istasyonuna yaklaştığı her bir metre için, fiyatındaki artış hesaplanmıştır. İnşaat halindeki proje alnında konutların istasyona olan uzaklıkları 100 metrelik zonlara ayrılmış ve her bir zon için yaklaşık değer artışı hesaplanmıştır. Toplam 5 zon oluşturulmuş olup optimum yürüme mesafesi literatür araştırmasına dayanarak 600 metre olarak kabul edilmiş, bu doğrultuda 500-600 metre arasındaki zon, tampon bölge olarak kabul edilmiştir. İnşaat halindeki proje alanında yapılan anket çalışması ve bina sayımları ile ikinci alandaki toplam konut sayısı elde edilmiş ve belirlenen şerefiye vergisi oranı ile ikinci alanda toplanılabilecek toplam vergi miktarı hesaplanmıştır. Bu şekilde projenin tamamı olmasa bile en azından bir kısmının yatırımdan en çok faydalanan kesim olan istasyon etrafındaki mülk sahiplerinden toplanmış olması ve projenin mali yükünün devlet bütçesinden azaltılması planlanmıştır. Bu çalışma, İstanbul kent özelinde yapılmış olup; diğer kentlere de entegre edilmesi planlanmıştır. Eğer uygulanacak bir sistem İstanbul gibi bir metropolde çalışıyorsa diğer kentlere de uygulanabilir diye düşünülmektedir.

Metro koridorundan toplanan değer artış vergisinin nasıl toplanacağı ve nasıl kullanılacağına dair öneriler çalışmanın sonuç ve değerlendirme kısmında detaylı bir şekilde işlenmiştir.

1. INTRODUCTION

The number of cities and the urban population has been increasing over past one hundred years. According to World Bank indicators, in 1960 the world's population living in urban areas was 33%. This ratio has reached to 55% in 2018 and is expected to increase further (Url-1). According to the United Nations, by 2050 66% of the world's total population is expected to live in urban areas (UnitedNations, 2014). Population increase has many negative consequences, such as environmental threats, rapid population growth that leads to have an increase in human activities causing expansion of the urban areas, a decrease in forested areas and loss of biodiversity. Due to its economic attractions, populations tend to accumulate in urban areas which results in the expansion of cities. This increases air/water pollution, and increases greenhouse gas emissions that contribute to global warming. The reason for these problems is not only a rapid growth in population but also unplanned and uncontrolled urban development. (Ruşen Keleş, 2015)

Most metropolitan cities in the world are planned with an emphasize on private motorised transport rather than public transportation. This encourages people to use their car more frequently and increases the number of private cars in an urban area. In order to deal with uncontrolled urban development, transportation planning and urban development planning should be integrated. In this way the share of private transport in modal split can be reduced.

Transport investments have a long-lasting impact on the economic, social and physical structure a city. Once transportation investment projects are implemented they are fixed and cannot be changed easily. Especially railway investments should be planned and implemented carefully to comprise future development tendencies of cities. This is especially true for public transportation investments in rail transit and bus transit projects. Rail systems have fixed infrastructures which result in permanent and radical changes to an urban area. The fixed infrastructure also makes rail transit projects very costly enterprises (Özgür, 2009; Cengiz and Çelik, 2018). When rail transit investments and urban development are integrated, cities can be planned better (Babalık, 2012).

According to Tang et al. (2005), in theory an integrated railway and property development provides certain benefits. Firstly, urban rail transit systems significantly improve accessibility of the land around its stations and as a result increases the value of the land. With the increase in land value, development density on the land around the stations inevitably increases. This concentration of development provides large amount of floor space to support more residents and a higher intensity of urban activities that will in return increase ridership of railway transit and its operational viability. There are also benefits for the government, society and economy. The government will have financial gains in terms of land premiums generated from property and urban developments on sites near stations that have improved accessibility, and other monetary returns from railway operations. Additionally, governments may be relieved from having to subsidizing their operation costs. Society may gain through a more sustainable form of development where the compactness of land use leads to more efficient use of scarce urban land, more open spaces, less urban sprawl and fewer roads, decrease in air pollution from motorised vehicles, and an improved pedestrian friendly environment. All these features can improve the overall quality of urban life. The economy will equally benefit as a result of an improved efficiency in transport and human activities.

Transportation systems play an important role in maintaining productivity and the quality of life in urban areas. Governments and local authorities make large investments in transportation systems. However, with limited funding and long construction periods the gap between investment and demand for mobility continues to grow. Therefore, transportation investments are never sufficient to fully meet demand.

2. RAILWAY FINANCING

Developing a good transportation network within a city and especially operating an effective rail system network has always been an expensive effort. Due to the civil engineering work involved and the rolling stock, rail systems are the most expensive urban public transportation systems. Since they are extremely expensive to implement, one of the biggest limiting factor is their funding. Rail systems are the backbones of public transportation systems in cities. Despite their high investment costs and long construction period, authorities cannot ignore investments in rail systems if they want to meet the high mobility needs in the daily life of cities. The challenges for rail system investments are the high capital, operation and maintenance costs and as the return on investment is low, they mostly require government subsidy. Most public transport operations around the world and especially rail operations are subsidized by governments, as the revenue from fares is usually not sufficient.

According to Ubbels et al. (2001) public transport companies generally get support from central governments, local funds and revenues from fares. Since existing systems already require financial support, the provision of new transit systems is in need of more financial resources. The labour-intensive nature of the public transit industry, the increasing maintenance needs of older systems and suburbanization of jobs and residences combined are a burden to the cost and revenue structures of many agencies. This has led to a general concern about the growing gap between operating expenses and revenues.

Local and central governments generally subsidize the gap between commercial revenue and operating cost. In developing countries, this is approximately 50% of the operating cost of public transport. Normally local and central governments use their general annual budget for funding this gap. (Canning and Cappaert-Blondelle, 2013)

According to Salon and Shewmake (2011), "A good public transport system is always one of the defining features of city attracting residents, business and tourists". Authors also claim that even the world's great public transport systems do not fully cover the operation costs via fares. Farebox recovery ratio which is the ratio of fares collected to operating expenses, is more commonly less than 1 even for the biggest public transport systems in the world (See Table 2.1). Most of them do not even approximate to 1 (Salon and Shewmake, 2011).

Table 2.1 : Farebox recovery ratio for different public transport systems (Salon and Shewmake, 2011).

City	Public Transport System	Year	Farebox Recovery Ratio
Tokyo	Tokyo Metro Corporation	2010	1.8
Hong Kong	Mass Transit Railway Corporation	2012	1.8
London	Underground	2012	1.2
Paris	Metro	2012	0.4
New York	New York City Transit	2012	0.5
Washington D.C.	Metro	2013	0.5
Montreal	Subway	2013	0.8
San Francisco		2012	0.3

As it is stated by Canning and Cappaert-Blondelle (2013), Union Internationale des Transports Publics, International Association of Public Transport (UITP) Financing Public Transport report, the existing urban public transport services need sufficient funding just to maintain their current quality and service levels. In the meantime a large scale of investment will be required in the future to enhance and modernize existing infrastructure and fund new projects.

There are many different ways of funding mechanisms to support transit operations. Governments and local authorities are trying to meet mobility needs of communities by imposing different policies to obtain money. These can be either property based or based on taxes, charges and fees.

There are five potential resources to fund transportation investments which are as follows (Nakagawa and Matsunaka, 2006);

1. Taxes collected from all citizens
2. Taxes collected from users
3. Usage fees collected from users
4. Funds collected from beneficiaries
5. Borrowed funds

There are two types of taxes; one is collected from all citizens, as general taxes obtained from all goods and services. The other is user pay type; taxes in the form of automobile owning taxes, vehicle usage taxes and airport taxes. Usage fees are obtained from fares paid by users, or borrowed funds that must be repaid eventually; when financial resources are considered for repayment, the borrowed funds will either have to be paid from taxes or from funds collected from beneficiaries.

Three requirements have to be fulfilled for a funding system (Nakagawa and Matsunaka, 2006);

1. Appropriate scale of investment
2. Efficient use of resources
3. Fair distribution of burden

The scale of investment varies depending on the funding resources. When barrowed funds are used, there is a risk that investments become excessively large since the parties responsible for repaying the loan in the future are not making the decision. If funds are obtained only from fares paid by users, excluding external economies, there is a risk that the scale of the investment will be too small. For efficient use of resources and fair distribution of burden, using public funds for funding is an effective means to ensure that the burden is distributed fairly. However, when there is no need to secure sufficient revenue, there is a tendency to not strive for the greatest efficiency.

According to Canning and Cappaert-Blondelle (2013), using local taxes and charges is one innovative way of funding. Those taxes and charges can be classified as polluter pays and beneficiary pays. Public transport funding can develop new financial partnerships with long-term investors including banks, private investors, urban developers and business communities. For these relations to function as intended, the right framework has to be put in place and risk distribution amongst the partners must be clearly defined.

Below is a list of transport funding instruments which will be discussed in detail.

- Congestion charging
- Payroll tax
- Sales tax
- Fuel tax
- Vehicle levy
- Road tolls
- Vehicle-km tax
- Parking sales tax
- Property based funding models
- Public Private Partnership (PPP) Model

Congestion charges are typically used to manage traffic demand. By charging road users to access certain roads and areas in the city, it aims to reduce road congestion and transport related externalities. It encourages road users to shift to a more sustainable way of transport. This system was introduced in Singapore as Area Licensing System (ALS) in 1975. Drivers had to pay 3$ to enter the central business district (CBD) during the morning peak hours. After its success, in 1984, evening peak charges were introduced. The system led to an immediate 45% decrease in Singapore's road congestion. It also nearly doubled the average speed on highways from 11 to 21 mph. In 1998 the manual system was modernized and replaced with Electronic Road Pricing (ERP). The ERP system led to a further 15% decrease in road congestion. More importantly Singapore's CBD is reported to generate about $150 million annually which is used to construct, maintain and improve roads and public transport in the city-state. As a result of these figures the system in Singapore was recognized as a successful implementation of charging to manage road congestion and improve public transport patronage, at the same time generating funds to reinvest in public transport.

Similarly in Norway the cities of Bergen and Oslo introduced toll road charges with the aim of generating revenue for infrastructure funding (ARA, 2014).

Congestion charging was implemented in London successfully, after February 2003, the traffic flows in central London have been reduced measurably, and the positive impacts on air quality was observed (Beevers and Carslaw, 2005). Congestion charging in Stockholm also had similar positive results as London and other cities introduced this model as a traffic management measurement (Eliasson, 2008).

Congestion charges have proven to be successful in reducing and managing road congestion and increasing public transit ridership, reducing emissions and generating substantial funds to develop transport systems and infrastructure. The weakness of this implementation is that it requires a strong political will to introduce these schemes as it is likely to generate strong public opposition. Furthermore, in order to apply congestion charges to an area, there has to be a strong public transportation network in that area. Without sufficient alternatives already present to access the area, charging drivers would not be a fair solution (ARA, 2014).

Payroll tax, sales tax and fuel tax are some of the examples for taxes, whose revenues are reserved for funding transport projects. Payroll tax is applied to taxable income and wages and levied which an employer either withholds or pays on behalf of their employees to the government. “Versement Transport” is one of the best known examples of an employer's tax applied in France. According to this French law, every employer, private or public, who has more than 9 employees and who is located within the area managed by a transport authority is obliged to pay tax an amount calculated between 0.55-2.2% of its total payroll as transport. Metros in Lille, Lyon and Marsellie along with some tram systems were constructed with the help of “Versement Transport”. Another good example for payroll tax is from the USA, State of Oregon, which imposed a payroll tax of up to 0.6% starting from 1970. In 1986 the payroll tax generated $44 million which is 65% of Tri-Met’s operating budget. Tri-Met, the Tri-County Metropolitan Transportation Authority in the District of Oregon, is a public agency that operates bus, light rail and commuter rail transit services in the Portland Oregon metro area (Martinez, 2010).

Sales tax is a percentage added to the purchase price of goods and services. Usually the law allows the seller to add the sales tax to the purchase price paid by the consumer pays and then the seller pays it to the government. These taxes can be introduced specifically to generate funds for transport investments (ARA, 2014).

Fuel tax has been implemented in USA and Canada to create funds for transport projects. In a century, the USA generated almost 9.2% of transit funds through state gas tax. The United States Highway Trust Fund was established in 1956 in order to build an interstate highway system and it was primarily funded by the introduction of national gas tax (Tax was 18.4 ₡ per gallon in 1993) (ARA, 2014).

There are some taxes and charges in the world that not only provide funds for infrastructure but also have some positive impact on sustainable urban development, reduction of traffic, congestion and traffic related problems.

Vehicle levy is an additional fee for vehicle registration in cities. Its impact on traffic can be observed as a small reduction in vehicle ownership and use. Its implementation is assumed to be easy, an additional charge for transportation funding can be applied when collecting a vehicle registration fee. There are 33 states and 27 jurisdictions that have implemented the vehicle registration fee for financing transportation in US. Vehicle registration fees helps to finance transportation in Canada as well (Litman, 2014).

Road tolls are similar to congestion charges. They are user fees collected for driving on a particular road or bridge. High Occupancy Toll (HOT) lanes are a variation of this implementation. The use is free for high occupancy vehicles (buses/carpools) but a fee is applied for use by single-occupant vehicles. If implemented parallel to public transit improvements, road tolls help to reduce private car travel with low occupancy rates and traffic congestion at the same time (Litman, 2014).

Vehicle-km tax is a form of road pricing that charges drivers per km travelled. Vehicle-km fees help to reduce automobile travel and encourage the use of alternative means of transport. It also encourages multi-model and compact land development (Litman, 2014).

Parking sales tax is a special tax on parking activities; drivers directly pay for parking. Increasing parking fees may reduce vehicle trips, especially in very congested city centres (Litman, 2014).

As mentioned previously, there are property based ways to make public transport more efficient and use it as a funding mechanism. A public transport system that generates substantial amounts of revenues to cover its operation costs may relieve local and central authorities from having to subsidize this system. One of the best-known examples for self-financing transport systems is used in Hong Kong. This system is one of the few known public transport systems that generates profit from the large rail+property (R+P) development model. It is also known for its successful integration of urban development and rail transit. Integration of urban development and rail transit has resulted in high density settlements and many benefits that come with agglomeration. R+P development creates sustainable communities by integrating rail with property. It develops new towns and residential areas, optimizes land utilization and improves living standards (Salon and Shewmake, 2011).

The owner operator of the city's largest rail service, Mass Transit Railway Corporation (MTRC), implemented the R+P model in Hong Kong. This model is one of the best-known examples anywhere which applies the value capture principle to finance railway investments. R+P development extends beyond the walking catchment of stations; it shapes the city and surroundings. Whilst reshaping Hong Kong's economy towards a service and information based economy, railway investments have gained more importance by spatially channelling urban growth and recycling former industrial areas. The main aim of MTRC is to construct, operate and maintain a modern, safe, reliable and efficient mass transit rail system. MTRC plays an integral and increasingly important role in Hong Kong by serving a quarter of all public transport trips in the city and connecting the region's largest activity centres including new international airport (Cervero and Murakami, 2008).

Property development has been the main tool for generating revenues covering the costs of construction and providing net profits. MTRC's general principle is that a railway alone cannot provide adequate commercial return and only with property development can the company attract private investors and remain financially viable. According to MTRC, as the network grows so does the business (Cervero and Murakami, 2008).

According to MTRC's principle, all costs of public transit investments, operations and maintenance are covered by supplementing income from fares and other revenues with income received from secondary real estate development. The value of land close to railway stations is high, thus transit agencies capture this benefit via land leases and transfers to private investors. According to the mission statement of MTRC's property division, the goal is not only value to capture and make profit for investment and cover operation and maintenance costs but also to create high quality, viable communities and improve the environment around station areas. R+P not only provides planned development but also promotes the use of public transport. As a result of high quality, reliable and accessible rail operations, private car ownership is significantly reduced in Hong Kong (Cervero and Murakami, 2008).

The R+P model is an approach that aims to finance railway investments through property development above and adjacent to railway stations. R+P has direct and indirect financial benefits. Direct benefits refer to financing infrastructure. Through R+P the public sector is relieved from the financing of the expansion of railways. Additionally, it creates a ready-made market for transit users who generate farebox revenues, such as residents living close to stations, employees working around stations and shoppers passing through stations. Indirectly R+P provides the following second order benefits: through master planning an improved station area environment is created that ensures circulation and physical integration of stations with all types of facilities around the station, such as commercial, educational, health related, cultural etc., and enrichment of land use, all of which can increase land values and ridership. Integration of retail shopping facilities into station environments generates secondary income through retail sales and motivates passing-by transit riders to purchase goods. Through governmental control of the land around stations, the land value benefits can be exploited by the governments themselves using R+P, rather than by private individuals. R+P is not only viewed as an important tool for financing railway investments but it is also observed as the real form of Transit Oriented Development (TOD). By reducing dominance of private automobile use and promoting transit riding settlement patterns, TOD is considered today as one of the most sustainable ways of urban development and is practiced in many cities of the world. According to Bukowski et. al (2013), rail transit systems are a way of integrating public transport into the larger urban areas as new settlements develop and spread. In these new areas, TOD also creates pedestrian-friendly zones around rail stations. According to Cervero and Murakami (2008), mixed-use, compact and pedestrian friendly development centered around transit stations TOD encourages residents, workers and shoppers to use mass transit systems.

According to Lu et al. (2018) the key features of TOD can be summarized within the framework of 3Ds. They are density, diversity and design (pedestrian oriented). Cervero and Murakami (2008) state that density generates high ridership as the area will be house a large number of residents, workers and shoppers at a reasonable walking distance to the transit station. Diversity means a mixture of land uses including different housing types, commercial activities and job opportunities. Finally, design refers to the physical features, a site layout that encourages walking, and the use of non-motorized transport modes and transit riding for daily activities. Nowadays, two additional dimensions are involved in TOD, these are distance to transit stops and destination accessibility, forming the 5Ds of TOD (Lu et al, 2018; Cervero and Murakami, 2008).

Studies show that transit ridership amongst users exponentially decreases with the distance from railway stations. In the case of residents, for ease of access some residents choose to rent or purchase a residence located closer to a transit line because they prefer to use the rail system rather than drive to access desired destinations (Dube et al, 2013; Zhang and Wang, 2013; Pan et al, 2014; Yen et al, 2018). Destination accessibility refers to how well a TOD is connected to retail shops, activity centres and other popular amenities, a well designed TOD generates a substantial amount of ridership. MTR stations designed according to R+P principles mostly satisfy the 5Ds of TOD with regard to density, mixed use including offices, residential towers and numerous pedestrian friendly pathways. In MTRC's development style, density decreases as the distance to a station increases. As there are a wide range of distances to stations, in order to avoid a decrease in ridership and in order to satisfy the destination accessibility dimension MTR stations are well connected to other railway networks in the region (Lu et al, 2018; Cervero and Murakami, 2008).

2.1 MTRC Development Model

MTRC is the rapid transit railway system that opened in 1979 in Hong Kong. As of 2017 the system consists of 230.9 kilometers of rail, 93 railway and 68 light rail stations. There are 10 main commuter lines and 12 light rail lines in MTR (MTRC, 2018).

MTRC was established in 1975 in order to provide a safe, reliable and efficient transport service in Hong Kong (Cheung, 2012). In 2018 the MTR network achieved overall 99.9% on-time passenger journeys. It also reached an average of 5.8 million passenger trips per week-day (MTR, 2018).

In addition to rail operations, the firm makes substantial earnings from rental space within stations and adjacent shopping malls as well as from property development. The specific mechanism for capturing rail's added value is as follows: MTRC purchases from the Hong Kong Government the development rights of the land around the railway corridor at a "before rail price" and sells these rights to selected and qualified developers for an "after rail" price. The difference is often substantial and is able to cover the cost of the railway investment (Tang et al, 2005).

While metro systems worldwide depend on public subsidy, MTRC operates without governmental support and is highly profitable. This success is only possible due to the profits MTRC makes from its real estate business. Its institutional setup is also important for the governing and coordination of the transformation of urban space in the MTRC business model. There are two different institutional setups for MTRC: Model A and Model B (Tang et al, 2005).

As seen Figure 2.1, in Model A; during site development the government and market players including MTRC and private developers come together and determine the site development plan. The railway company is one of the developers and is primarily assigned with the limited role of constructing the railway and the stations only (Tang et al, 2005).

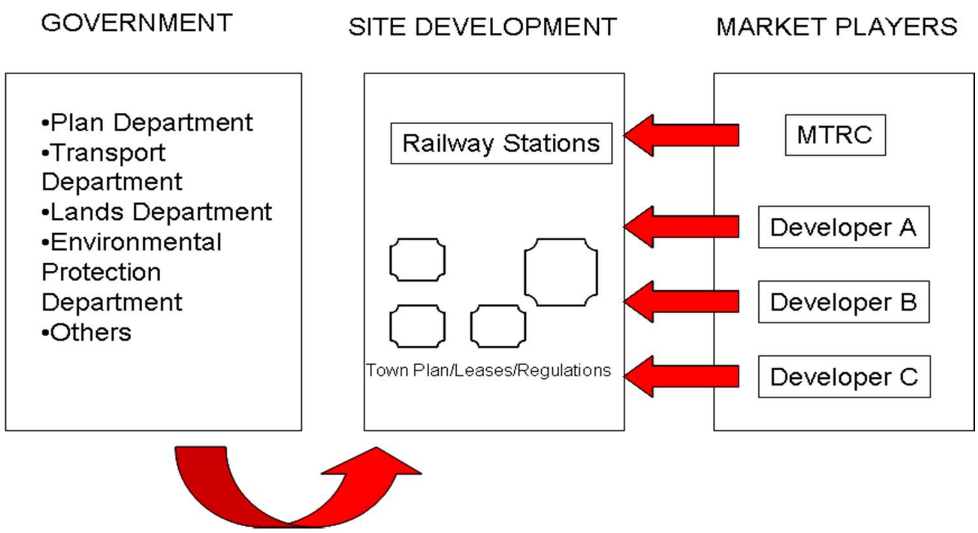


Figure 2.1 : MTRC Model A.

In the other institutional set up Model B (Figure 2.2) MTRC is at the center. It is responsible for planning and coordinating the development of the station sites. The site development details are expected to be worked out by the MTRC in negotiation and consultation with government departments and developers. Exclusive development rights for station sites are granted to the MTRC and this provides an incentive for the Corporation to plan and develop the sites in such a way as to maximize values of its entire development projects (Tang et al, 2005).

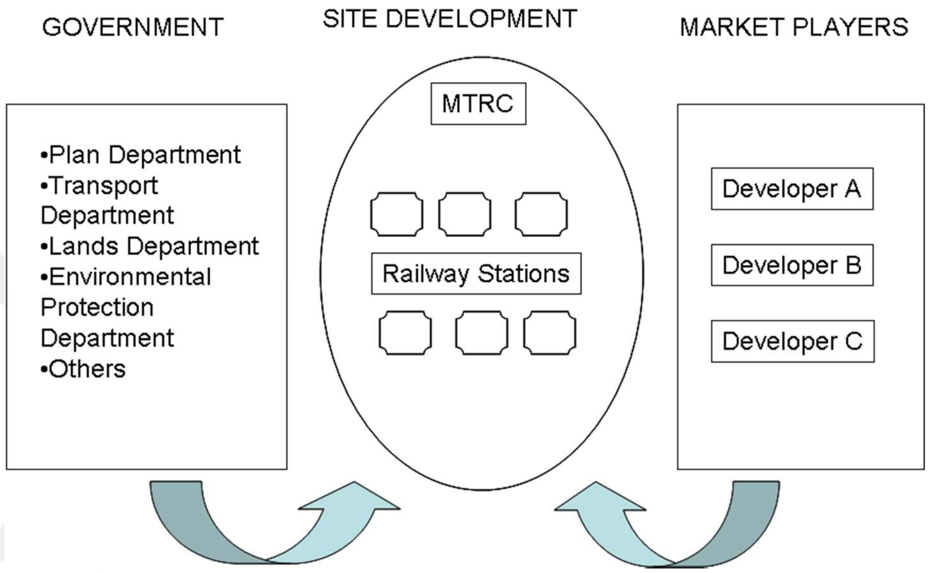


Figure 2.2 : MTRC Model B.

Sometimes these two different institutional models propose different site development schemes. In some stations the initial proposal for the use of government land was not considered to be satisfactory by MTRC. MTRC planners put forward their own proposal by revising the urban design and land use for station areas. Figure 2.3 shows the revised plan for the Tung Chung Development (Tang et al, 2005). The main difference between these two alternative models is the profit maximization from the site development.

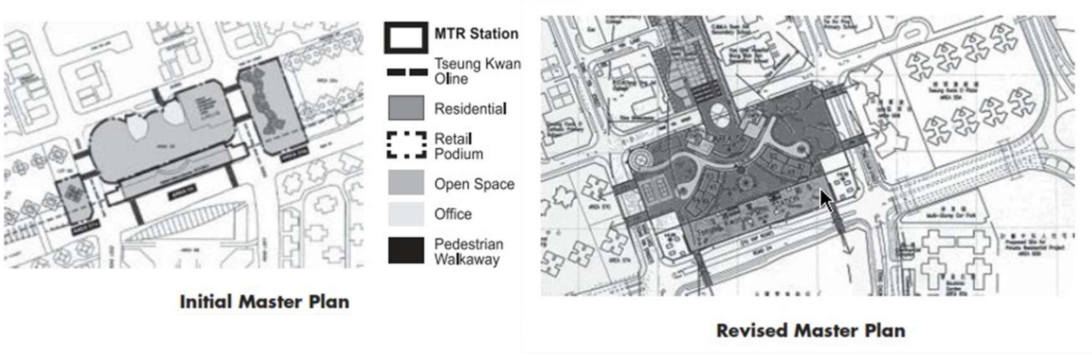


Figure 2.3 : Combining different MTRC Models in the Planning.

The basic process for the MTRC development model can be seen in Figure 2.4 (Verougstraete and Zeng, 2019).

When planning a new railway MTRC together with government assesses the cost of construction and then prepares a master plan to identify property development sites along the railway

After all necessary approvals and negotiations MTRC purchases from the government the right for a period of 50 years to develop property above railway stations and depots, as well as on land adjacent to the railway. The land premium paid to the government does not cover the land premium "after rail" implementation. It is "before rail" premium.

MTRC then prepares a public tender for allocating these property development rights to private developers

The private developers selected usually pay all development costs, including the land premium for acquiring the exclusive development rights from MTRC.

Profit sharing mechanism are included in the agreements with the private developers. *

Figure 2.4 : MTRC Working Process.

*for residential units MTRC will receive an agreed proportion of the profit generated by the sales, if the private partner manages to sell all units before the contractual deadline. Otherwise, MTRC will receive the remaining unsold units and decide whether to sell or lease in the open market. For shops and office units MTRC generates profit by leasing directly to developers or by keeping part of the assets developed in order to create long-term rental income.

While MTRC is not in charge of the construction of properties it supervises the work, carries out civil works and enforces the technical control standards and requirements for interfacing between its railway premises and the property development (Tang et al, 2004; Verougstraete & Zeng, 2019).

2.2 Transport for London (TfL) Development Model

Another good example for a self-sufficient transport system is the Transport for London (TfL)

TfL is a part of the Greater London Authority (GLA) and the Mayor of London chairs it. It was established in 2000 under the GLA Act 1999. It is responsible for carrying out the Mayor's transport strategy and regulating most of the transport modes in the London City Region, including underground, TfL rail, bus services, cycle lanes, pedestrian routes and other transport infrastructure. This multimodal integration allows the control of investment planning and scale, and has a strategic influence on transport investments across all authorities in London. It has long been recognized that in order to drive economic growth and employment in the capital, London needs a continuous programme of investment in upgrading the public transport network and extending it to address the growing pressure that the demand for transport capacity, housing supply and affordability creates. (Thomas, 2018).

London is a successful world city and attracts many people and businesses from across the world. This creates a pressure on the citywide transport system and on housing (TfL, 2017). TfL has the opportunity to combine transport networks and land use planning. It is following the R+P model. By improving transport links to under-developed areas those areas become more attractive to developers and thus the land becomes suitable for the development of affordable housing (Thomas, 2018).

TfL can create affordable housing units for the city on the land both above and adjacent to the tube stations. TfL not only develops sites for housing but also for commercial use. After the areas are developed TfL creates an income from selling or leasing these properties. TfL also gains a profit from value uplifts. The principle mechanism to capture value uplift on existing stock is land and property taxation. However, direct development methods are better at extracting value uplifts than from existing stock. The disadvantage of this method is that it involves the acquisition of land for development by a public authority using either voluntary methods or compulsory land acquisition. If the authority can obtain the developable land around transport projects at pre-project market value it can then develop and sell it. This means it can then potentially fully capture the difference between the post-project market values of the land and its pre-project market values. After receiving the land around tube stations TfL develops, sells or leases the properties at post-project values (Url-3).

In 2017/18 TfL generated £10.2 billion income. With the increased ridership, the income from fares from its bus, rail and metro operations alone was £4.8 billion, which at 47% was the largest source of TfL's income. This revenue helped to cover the cost of operating and improving the transport services, which means there was less burden on the taxpayer since the riders paid for most of TfL's operation cost. This high ridership scheme is a result of better integration of land use and mass transit systems (Url-4).

According to Sashi Verma, TfL's Director of Customer Experience, what made TfL so efficient is that its model is more like a private business rather than a public service. Verma says “improving productivity and reducing cost” is something that the private sector does every day (Url-5).

In addition to its high ridership, TfL has other secondary revenue sources. In 2017/18 fares made up 47% of TfL’s revenue, and a further 10% was generated from advertising, rental properties and congestion charges. TfL also generates considerable revenue through its real estate holdings. A part of that revenue comes from developing land owned by the agency, another part from renting out shops and concession space to vendors in and around the stations. 70% of every pound generated goes towards the every day running cost of the network, whilst the other 30% is used for improving the network for the future (Url-4).

TfL owns 5,700 acres of land across London including buildings, lands attached to tube stations, railways and highways, making the organization London’s largest landowners. Its development strategy includes listed buildings that offer opportunities for residential conversion, mixed use and residential development. (Url-4)

2.3 Public Private Partnership (PPP) Model

One of the other financing models for any kind of investment is involving the private sector into the process. The private sector is willing to be involved in projects that have a high turnovers. Since urban transport projects are rarely self-sufficient and mostly need subsidy, the private sector is not eager to get involved in urban scale transportation projects. Therefore there should be tempting offers to the private sector to attract them to urban scale transport projects.

The Public Private Partnership (PPP) is an agreement for sharing costs, risks and profit evenly between public and private sector in order to realize public services and investments.

According to Tekin, (2007), in PPP projects risks are shared between the private and public sector. The risks are allocated to the party which is most capable to solve it in a cost effective manner.

PPPs are characterized by relatively long durations of relationship that involves cooperation between the public and private partners in different aspects of a planned project like design, completion, implementation and funding. The public partner primarily concentrates on defining the desired outcomes for public interest, quality of service and pricing policy. The public partner is also responsible of monitoring conformity with the objectives (Canning and Cappaert-Blondelle, 2013).

In the conventional investment procedure all public goods and services are provided by governments. However, nowadays the role of the private sector in the provision of public goods and services is increasing (Orman, 2016).

Projects undertaken by the public sector generally experience time and budget overrun. Despite this, in the PPP model payment is made after the project is completed, and for this reason the private sector generally tries to complete the project as quickly as possible. Since payment is made for a defined quality and quantity, the level of service is guaranteed (Tekin, 2007). PPP is different from conventional investment models in that it takes advantage of the private sector. The collaboration with the private sector is not only during the construction stage but also during the operation stage. The aim is to make the maximum use of the private sector's skills in construction and operation (Orman, 2016).

Since the private sector has the capacity for operating with high efficiency and the public sector does not have sufficient fund to meet the ever increasing needs of the public, countries started to seek ways to benefit from private sector, and one of the most important countries utilizing PPP is UK. The aim in using this model is to combine the capacities of private and public sector for a common purpose (Tekin, 2007).

Initially the PPP was seen as a financial instrument for the implementation of infrastructure investments. Nowadays PPP is recognized as an establishment that combines the productive investment and operational skills of the private sector and the coordination, planning and monitoring skills of the public sector (Orman, 2016).

In PPP projects, the risks involved in the provision of a service are well analysed by the private sector as they want to avoid loss of profit and time because of underestimating the risks (Tekin, 2007).

Today infrastructure investments deplete most of the funds reserved for public investments. Especially in developing countries PPP has become an important financial instrument in order to initiate infrastructure investments (Orman, 2016).

The general characteristics of PPPs are as follows: The PPP model is generally used for large infrastructure projects but nowadays is also becoming widely used for small-scale projects. One of the most important features of the PPP model is its financing. It is procured by the private sector. PPP is not an outsourcing, a financial model, a real estate development project or a concession agreement. On the contrary, it is an application that integrates financing, construction and maintenance. The core of the model is the service and concession contract with the State. The contract phase is essential in PPP projects since it guarantees the moderate pricing of the service provided and the level of service. PPP contracts are generally long term. The main duty of the State is to organize and monitor the process. Thus the State can play an active role during the whole project cycle. By using the PPP model it is possible to initiate high quality public services with a moderate cost. In this model the State pays the cost of the service provided to private sector after the contracted level and quality of service has been obtained. Service delivery made by the private sector with an understanding of profitability enables the service to be carried out effectively from a macro-economic point of view (Tekin, 2007).

According to a survey carried out in UK, projects initiated with the PPP model provide 17% savings when compared to classical supply methods. According to another survey carried out in 2001, 80% of governmental institutions in the UK stated that the service provided is in relation to price-quality either very good, good, or satisfactory when PPP is used. Only 15% of governmental institutions stated that the advantage obtained from PPP is not very high, and 5% stated that they had bad experiences with PPP (Tekin, 2007).

2.4 The PPP Experience in Turkey

As can be seen in the Figure 2.5, the PPP model in Turkey is a service provision in between a government service delivery and a private service delivery, whereas in the conventional procurement method the government would carry the entire responsibility of a public project. There are different Public-Private Partnership models which provide different types of concessions to the private sector after it builds the project. The peak point of involving the private sector is privatization or divestiture by licence (Alpkökin et al, 2016).

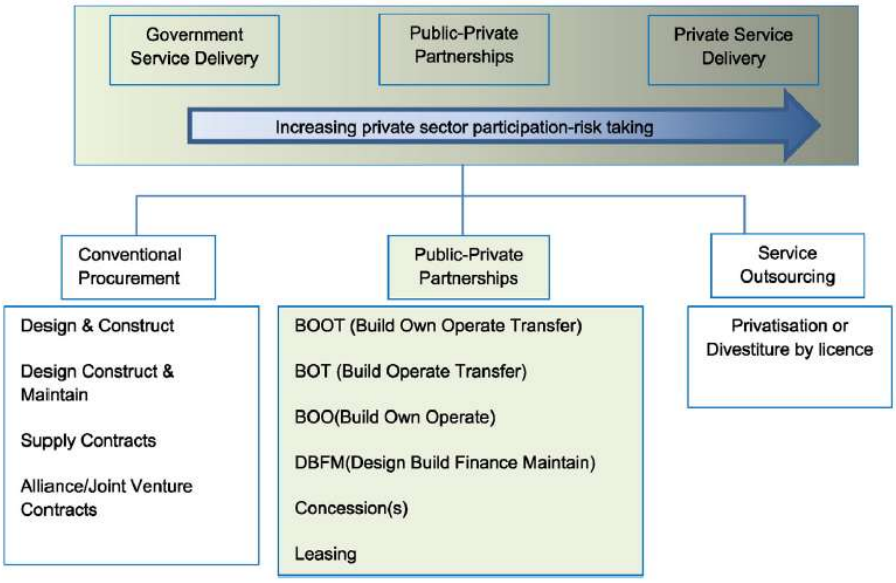


Figure 2.5 : Public Private Partnership Model in Turkey.

Turkey has been implementing PPP projects since the 1980s. The Law numbered 3096 of 1984 is the pioneer of PPP involvement in governmental services. This law gives the right to produce, distribute and trade electricity to parties other than the national electricity providing authority. After 1994 the PPP model became widely used in various public projects including energy and water projects under the built-operate-transfer and build-operate models (Uzunkaya, 2008).

The current government of Turkey aims to realize many mega projects at the same time but the economic capability of the country is not sufficient to execute all these mega projects within a given period. Thus the government tries to attract private investors with the PPP models. Large PPP projects worth over $30 billion have been commenced in Turkey in 2015. The PPP market in the world in relation to Turkey can be summarized as in the Figure 2.6 (Url-6);

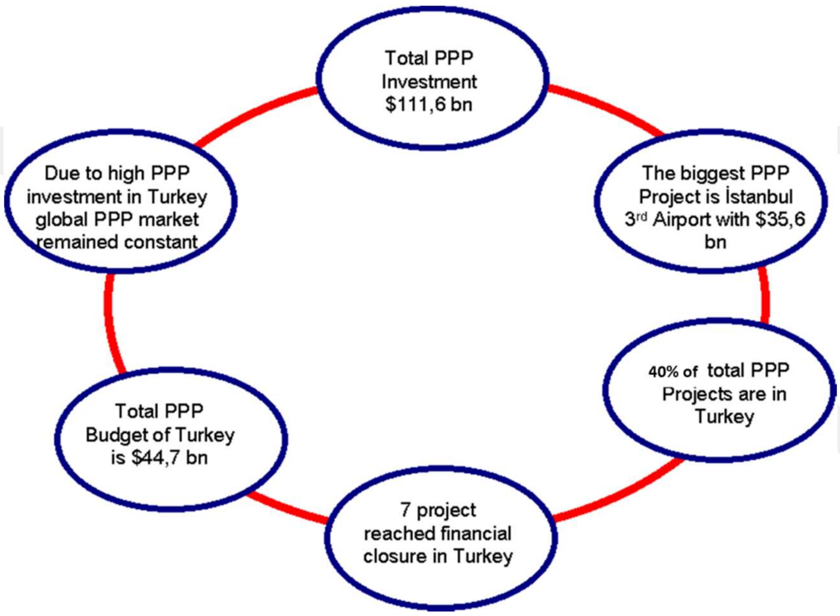


Figure 2.6 : Global PPP Market in the world in 2015.

As can be seen in the Figure 2.6, in 2015 Turkey had the biggest share in the Global PPP market. According to the World Bank Group; total infrastructure investment in 2015 was $111.6 billion globally, of which $44.7 billion was invested in Turkey alone, and 40% of total PPP projects took place in Turkey. 2015 witnessed the largest single investment commitment ever recorded in the PPP database; Turkey's $35.6 billion New Airport Project (Url-6).

These are a number of transportation projects that used the PPP model in Turkey recently. The most significant ones are Istanbul Third Airport, The Northern Marmara Motorway and Third Bridge and Eurasia tunnel.

2.5 Urban Rent

The concern of economists about rent dates back to the 18th century. In those times it came it involved agricultural land. They focused on agricultural land rather than on urban land which is highly understandable because they were living in an agricultural society where cities were relatively unimportant in the landscape. At the beginning of the 19th century David Ricardo recognized and put forward that land, which is closer to a marketplace, has lower transport costs for its products than more distant land and as there is competition amongst the farmers this advantage returns to the property owners who has land closer to a market place in the form of rent. A few years later J. H. von Thünen developed the theory of location differential rent. According to Thünen, agricultural land close to a marketplace attracts more farmers than distant ones as farmers take advantage of savings in transportation of their products. The most distant land in cultivation has higher transportation costs and therefore provides no rent. In short, the rent at any location is equal to the value of product minus production costs and transport cost (Papageorgious and Pines, 1999, p. 4; McDonald and McMillan, 2010, p.84).

Alonso explains the equilibrium of household in 1964 as follows; when an individual arrives in a city and wishes to buy some land for living he will be faced with two options: one how large a lot he should purchase and how close to the centre of the city he should settle. In reality, he will have many determinants for his decision but in theory he is an “economic man”. He is simple man who only wishes to maximize his financial satisfaction. In addition, the cities are simple formations that lie on a featureless plain where transportation is possible in all directions. All employment, all goods and services are only available in the city centre. Land is bought and sold freely. Individuals have perfect information and know the price of land at every location. Municipal services and tax rates are uniform throughout the city (Alonso, 1964).

As it is cite by (Lai and Tsai, 2008) Alonso (1964), Mills (1967) and Muth (1969) studied the city to develop a model for defining it. According to those scholars the size of the population, the cost of transport and the value of land in alternative uses simultaneously determine the overall size of the city.

The basic assumptions of the Alonso, Muth and Mills’ model are a fixed population and a given income level living around the CBD. Each individual travels into the CBD for working purposes. Since commuting is expensive and increases as the distance from CBD increases, households prefer to live closer to the city centre. However, not everybody can live close to city centre, thus the price and density of housing regulates the housing market. Land for housing becomes more expensive adjacent to the CBD which leads producers to economize on land use by building more dwellings per unit of land, that is multi-storey buildings with smaller floor area. Households can choose to live either well located but in smaller or more expensive houses or in more distant, but larger and cheaper houses towards city fringe. In short, cities are characterized by higher density with taller buildings in city centre and lower density and lower heights on the periphery (Kulish et al, 2011).

Alonso claims that land values in American cities have boomed since World War II. This boom took place largely in the peripheral areas of the city rather than the city centres. Land values in central areas remained constant and even decreased. After WWII, there was a rapid increase in urban population, automobile ownership and income. The reason why land values increased in the periphery is due to the tastes of the rich. As transport investments continued, the rich preferred to get away from the densely populated city centre with its noise and crowds. They preferred to live further away from the city centre with larger plots of land and luxury houses (Alonso, 1964).

In 1960 William Alonso extended the von Thünen's agricultural land model to urban land uses. The basic bid rent theory states that rents tend to go upwards close to city centres as individuals wish to minimize transportation costs. Residents living closer to the city centre need to travel less to reach work and other urban facilities and this increases utility. Thus there is an inverse function between distance from the city centre and rent, Conversely, rents are lower away from city centres since the transport costs of residents are high, so transportation cost and distance to the CBD are in direct proportion. The basic Bid Rent Function is shown in Figure 2.7 (Alonso, 1964; Shieh, 2003).

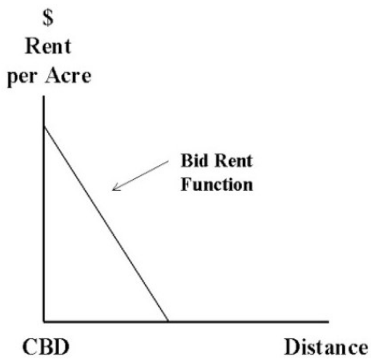


Figure 2.7 : Graphical Presentation of Alonso's Bid Rent Function.

In conclusion, rents are high near city centre and low at the periphery. Living further away from the city centre, individuals suffer higher transportation costs, but can utilize lower rents for larger and better quality housing units. Transportation cost in this model not only refers to the transportation fares and fuel consumption but also includes travel time spent. Thus any investment that makes further areas more accessible from the city centre may lead to an increase in land values close to this investment. Figure 2.8 shows the hypothetical statement for land values concerning transportation investments. Value of land is determined by the rate of accessibility to CBD. Location A is further away from CBD than location B with road transport. As a railway project implemented between A and CBD the distance decreases, so does the time travelled to reach CBD. In conclusion, accessibility rate from A becomes more than from B. This leads to an increase in land values in location A.

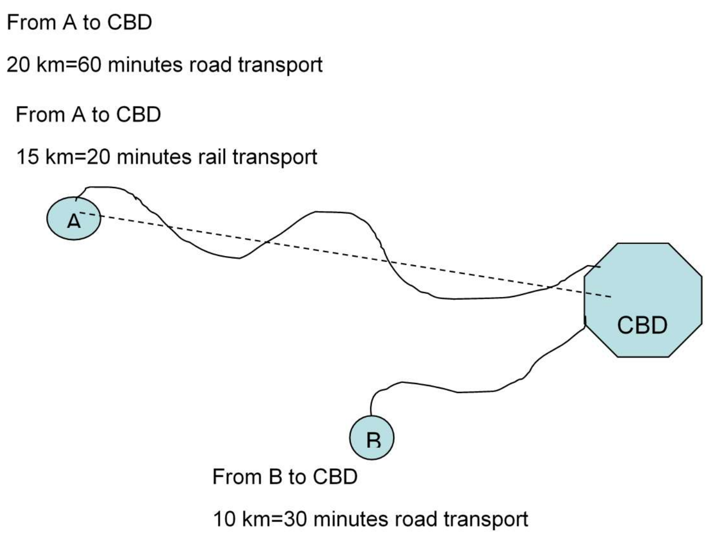


Figure 2.8 : The relationship between transport service and transport time.

As it is discussed previously in literature; transportation investments are expensive and need funding. As an alternative funding mechanism, an innovative funding mechanism will be discussed in the following part of this dissertation. This innovative way of funding takes its roots from Alonso's bid rent theory and the impact of accessibility rates on land values.

Transport systems play an important role in the economic and social development of urban life. Everyday life, social integration, competitiveness of companies and commercial activities are influenced by two important factors relating to transport facilities, namely mobility and accessibility. The quality and quantity of transit systems have an impact on real estate values. As the quality of service increases, the area becomes better connected to the rest of the city and real estate values increase (Harjunan, 2018; Gallo, 2018).

As it is claimed by Salon and Shewmake, (2011) the size of the property value increase depends on the proximity to the transport offerings, the mode of transport, quality of service and alternative transport options available in the area. In East Asia, property values close to railway lines are typically 20-25% higher than those that are not. Studies have found that a 10% increase in the distance to a public transport station reduces the value of the property by approximately 1%.

The study conducted by Dube et. al (2013) used the difference-in-differences (DID) estimator with the hedonic price model. Using the difference-in-differences estimator with the hedonic price model made it possible to conduct a before and after analysis by using repeat sales data. DID Estimator with hedonic price model provides a better and more sophisticated version of repeat sales approach, which allows to estimate the impact of a change in accessibility to an infrastructure over time. In this study, researchers estimated the value change based on the resale of the same property over a period of 17 years (1992-2009). Between 1992-2003 no major change was observed between sale and resale prices. However, the market changed in 2003 and after starting full rail operations, the average selling and reselling price of the houses increased by 18% and 16% respectively.

General literature claims that any improvement in the transport corridor will lead to a value uplift in the surrounding areas of the corridor (Dube et al, 2013; Zhang and Wang, 2013; Pan et al, 2014; Yen et al, 2018; Ransom, 2018; Diao et al, 2017).

Without a financial model only the property owners exploit these benefits. They utilize the increased accessibility rates and value increase of their properties (Nakagawa and Matsunaka, 2006).

As discussed previously, there are many ways of funding transport investments. There are three main potential sources of capital/operating funding for transport (Nakagawa and Matsunaka, 2006).

The government may fund all investments and operation costs as it is in Turkey. In Turkey all public transport investments and operation costs were funded by government, however this has begun to change with the involvement of the private sector in some mega projects, also in the transport sector. User fees cannot cover the capital cost but can only cover some part of the operating costs of public transport. Other beneficiaries, for example property owners who benefit from nearby transport investments, are not included in the funding mechanism in Turkey as this approach is not applied in Turkey; the unearned increment is not collected from property owners. In this study the aim is to capture this value increase to fund public transport investments.

According to Nakagawa and Matsunaka (2006, p. 1), in theory, the most basic concept of financial resource is that "those who enjoy the benefits of a transport investment should bear the corresponding costs". But it is not that simple to define the beneficiaries. Firstly, benefits are exploited by a wide range of parties; it is not always possible to define the extent of benefits generated for each party. Secondly, those benefits might extend into the future thus there will naturally be a degree of uncertainty in measuring future benefits. Thirdly, benefits are not necessarily in monetary terms. In some cases parties receiving the benefit may not be aware that the benefits are commensurate with the cost, such as environmental benefits. Finally, benefits are derived from complex factors, thus it is difficult to identify whether those benefits are a result of only the transport investments.

According to Nakagawa and Matsunaka (2006), it is very difficult to identify benefits derived from a transport investment on the basis of the bottlenecks explained above. Thus it is important to simplify the method. In this dissertation, benefit is defined by estimating real estate value changes via the using hedonic price model.

According to Chin and Chau (2003), the housing sector is a very important determinant of the economic health and wealth of a nation. The purchase of a residential is both an investment decision as well as consumption decision, and a high demand for housing leads to growth in many other economic sectors. It is therefore important to research variables that affect property prices.

As claimed by Nakagawa and Matsunaka, (2006) in the transport market, when new roadways/railways are built the value of the surrounding land increases, but without special funding systems in place the landowners would not undertake the cost of such constructions.

As Nakagawa and Matsunaka (2006, p. 9) state, “the existence of people who receive benefits but do not bear cost means that optimum balance in the market is not achieved.” The Figure 2.9 shows the gap between optimal investment amount and realized investment amount. It resulted from landowners not having to share their profit with the public. If a mechanism is developed to guarantee that landowners provide some part of their unearned increment, then the realized amount of transport investments can increase (Nakagawa and Matsunaka, 2006, p. 9).

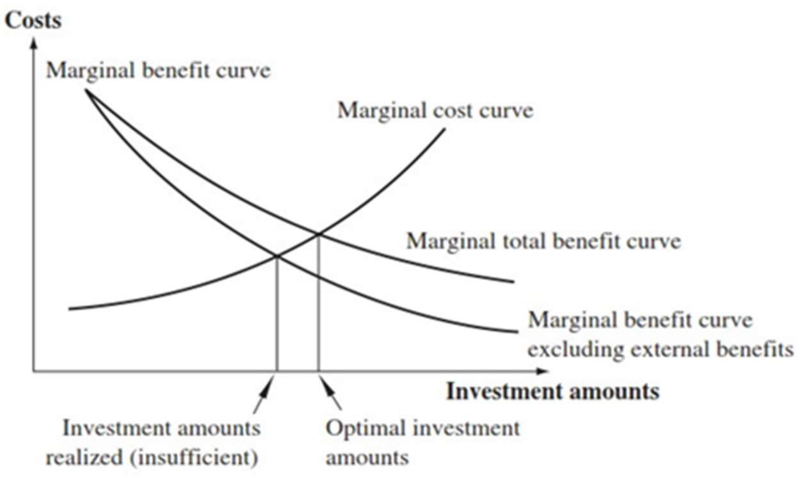


Figure 2.9 : Optimum market balance.

This dissertation takes its roots from the idea raised by Nakagawa and Matsunaka (2006), that is that whoever gets to benefit from the investment more should contribute to its capital cost. This claim takes this study to another level of discussion about positive impact of railway investments on real estate properties.

Literature proves that every transport investment results in a value increase in the surrounding areas of the project (Dube et al, 2013; Zhang and Wang, 2013; Yen et al, 2018; Ransom, 2018). Landowners will eventually utilize the value increase of their property when they either sell the property or lease it, or even whilst they are living in it and benefitting from increased accessibility and decreased transport expenses.

As it is claimed by Walters (2012), there are two reasons for collecting money from private owners after a specific infrastructure investment. One is for recovery, the other is for taxing "an unearned increment". For the first one, detailed costs associated with the project are calculated and the affected land is identified. Based on the level of the benefit to the land a levy is collected. For the second one, there is an assumption that the value of land will increase as a result of public investment. The amount of value change needs to be calculated and the taxable value adjusted. The applied tax rate needs to be sufficient to capture the share of increased value. Then the tax will be collected. The main difference between two types of collection is that the first one aims to cover the whole capital cost and the second one aims only to collect the tax for increased property value which results from the investment. In this dissertation the second one will be discussed.

According to Coleman and Grimes (2010) landowners experience a real capital gain after an increase in the local land values as a result of an infrastructure investment. This also apples to rezoned land, for example where an agricultural land is converted to residential or industrial use. The infrastructure provider can capture the value increase in land through betterment tax, which is a form of taxation collected by governments from private property owners because of their property value increase resulting from a public investment (Ingram and Hong, 2012). Otherwise, the landowner is the only one who utilizes this value uplift without any effort input. Through the betterment tax at least some portion of the investment capital can be obtained from property owners.

As argued by Plimmer and McGill (2003), if the value is created by community funds, such value belongs to the community not to landowners. Thus it is reasonable to collect some part of this gain from landowners in the form of a tax. In UK early attempts for betterment taxation date back to the 15th century, for instance when commissioners could impose a levy based on increased land value as a result of flood defence work, or in 17th century a levy could be imposed on increased land value as a result of city redevelopment in London after the Great Fire in 1666.

Based on the Land Betterment Charges Law in Sri Lanka, if the value of land has increased or is likely to increase after the construction or development of a project that is funded fully or partially by the State, the minister may order this area as a "betterment area" by publishing this in the Gazette. This "betterment area" declaration is a joint decision of the Minister and the local authority. This means it is not a local decision but a decision taken at national level. This order needs to be approved by parliament and published in the Gazette. Details of the betterment area need to be specified in the declaration, such as limits of the betterment area, the name of the project related to the betterment area, and the date from which betterment charges shall be levied in the area. There will be a government agent who is a land betterment officer working with local authorities as chef valuer. Those officers will set the value increase and calculate the tax payable by each property owner (Law, 1976).

The other term used for "betterment tax" is "special assessment". This is a compulsory contribution within the public interest framework; a proportion of capital gains on properties resulting from a specific improvement is paid back to the investor. The investor is generally a public authority and the improvement is the provision of certain infrastructure projects. Public interest is one of the elements for special assessment. Also, this special benefit should be measurable as the payments will be proportional to the benefit obtained. The aim of this implementation is to increase and improve the permanent welfare of society. It is also a compulsory implementation which contains strong enforcement (Kennedy, 2012).

There are various other countries apply land value capture mechanisms and its derivatives; for instance, Colombia Cost Recovery through the Betterment Charge (1921) and the Broader Value Capture (1997). There have been several attempts to nationalize development value in the UK but all have failed. There is also Community Infrastructure Levy (2011) which is cost recovery through betterment levy. In India, the betterment charge and cost recovery are the same. For example, Greater Hyderabad Municipal Corporation identified nearly 800 "peripheral neighbourhoods" and experts evaluated their needs. Local people and local authorities confirmed the findings. The construction plan was developed in phases and a loan of $115 million was obtained from banks. The loans had to be repaid in 10 years through a 5% property increment which was imposed as the construction in each neighbourhood was completed (Walters, 2012).

According to (Plimmer & McGill, 2003) land value taxation (LVT) is getting popular in the UK, explicitly as a method of covering the capital costs of developing and improving the transport infrastructure in London. LVT is basically a tax on increased value of land resulting from betterment created by community investment. General opinion is that when the community creates a betterment, that is the added value of land/property which is not created by the owner, it should be paid back to the community; this can be a type of tax. This tax on added value of land can be used as a financial source to pay for community based projects including transport, environment, and similar.

In Swiss Article 5 in the Space Planning Law cantons have the right to collect land value increment. According to this law, cantons are obligated to collect a tax for value increment that is the result of public works (Kılıçarslan & Yavan, 2017). Value increment tax is a tax collected from landowners as a portion of increased value that is the direct results of public investments in a particular region (Slack, 2006). The minimum rate is 20% and it may reach a figure up to 50%. Events that create the tax are construction on land and sales of land. The revenue generated is used especially for expropriation, protection of agricultural land and effective use of construction sites and arable land. After new regulations in 2012 where introduced in Austria, all real estates were subject to land value increment tax. The tax ratio for the increased value is determined was 30% in 2016 (Kılıçarslan and Yavan, 2017).

The idea of using value capture for funding infrastructure projects is getting more popular in urban policy discussions in Australia (SGS, 2016; Australian Government, 2016; Abelson, 2017). Based on studies the property gross value is a function of amenity values, population growth, state-level provision and on-site improvements in the Australian context. There are many different value capture mechanisms including taxation in Australia, some of those taxes contribute to the general state revenue, they are not project specific, but some of these could be used to fund local or state-level infrastructure projects. There are special rates for benefitting areas that are applied to certain land parcels or regions to fund specific local infrastructure needs. These are levied from land owners expected to benefit. Based on this model a boundary is drawn around the region which is predicted to benefit from the investment. All parties are expected to contribute a defined amount per year for a designated number of years as pay towards the investment. This is a levy paid by both the users and the beneficiaries. It also forces land value uplift in correlation with the new infrastructure and the raised fund is designated to the infrastructure or public works. All property owners in the designated benefitting area pay this tax annually for a specific period of time (SGS, 2016).

2.6 Urban Rent and Betterment Tax in Turkey

Urban rent arises as a result of services provided by the public sector without any effort by the property owner. The main reason for urban rent is the intense demand for urban land as a result of the monopoly of private ownership, rapid population growth and intensive internal migration. As the city grows, the rise in real estate value accelerates. Since there is no risk for land to lose value, investors tend to buy the land when the price is low and keep it until it reaches a maximum price, leading to a monopoly in private ownership. This causes land scarcity for development and to higher value benefits for the owner (Akalın, 2018).

Urban rent is an important element for defining the level of the city's economic development, fluidity and mobility of capital. In the case of no boundaries, urban rent will make it impossible to implement development plans and will have a negative impact on the physical development of the city and result in decreased quality of life. In order to deal with this adversity urban rent should be limited by certain policies. Limiting urban rent created by public investments is expected to lead both to a planned urbanization and development and to a better quality of life. Taxation of unearned increment is the most common and effective way of rent limitation. Collection of this type of tax means sharing the extreme capital gains of individuals with the community. This tax will also make a positive contribution to limiting of urban rent, a fair distribution of income, social justice and even social peace (Akalın, 2018).

Betterment tax came on the agenda in 2015 but has not yet become law in Turkey. Şerefiye is the Turkish word used for betterment tax in Turkey. It is a value increase tax. The aim is taxation of property value increase that has resulted from community investments in the precinct. It is independent from the cost, only the value increase matters. Thus sometimes the revenue can be more than the capital cost (Kılıçarslan and Yavan, 2017; Akalın, 2018).

Based on the benefit principle, the other financial obligation applied in Turkey is the share of participation in the cost. Despite being similar to betterment tax it is collected to finance infrastructure services, thus the financial goal is preliminary. The share of participation in the cost is collected from landowners for financing expenditures. The common feature of the betterment tax and the share of participation in the cost is that the landowners have no impact on the value increase of the property; the value increase is due to public works and zoning activities (Kılıçarslan and Yavan, 2017).

Although betterment tax discussions started in 2015, in Turkey in earlier years some applications came into force and were withdrawn. Betterment tax came into force in 1948 in the Municipality Revenue Code, Numbered 5237, by the name of Land Value Fee (değerleme resmi). According to this regulation the Land Value Fee is calculated based on the difference between the 'before' and 'after' selling price of the property. The rate is 50% of this difference. This amount is expected to be paid in five instalments within 5 years. Payments are registered to the Land Office and if the property is sold within 5 years the buyer has to pay the tax in one instalment. In 1978 the Land Value Fee was rejected by the Prime Minister as being contrary to the constitution. The regulation was removed from the Municipality Revenue Code, Numbered 2464, in 1981 (Arslan, 2014).

There is another form of taxation in the Law of Development Planning and Control, Numbered 3194, called Regulatory Partnership Share (Düzenleme Ortaklık Payı-DOP). This is a form of expropriation by municipalities for their rearrangement of land. In return for their public investment municipalities can confiscate 40% of land without asking for the owners' consent. This 40% of land is used to enlarge and upgrade existing roads and provide new infrastructure services (Arslan, 2014; Akalın, 2018).

In Turkey property tax is regulated on the basis of Property Tax Law Article 8 and 18 which came into force in 1970. The rate of property tax varies according to whether the property lies within Greater Municipality (GM) boundaries or not. If it is a residence within the GM boundaries the property tax is 0.2% of the property's fair value as registered in the municipality records. If it is not inside the GM boundaries it is 0.1%. This tax needs to be paid to the Municipality in two instalments every year, one in May and the other in November. Fair value of the property registered by the municipality remains the same every year but due to yearly inflation municipalities calculate a revaluation rate, apply this rate to the fair value of the property and calculate that year's property value. This new calculated value is used to calculate the property tax due in that year.

In addition to the property tax there are some other fees which make property owners financial participants in the cost of public services that are under the responsibility of public institutions. For instance, there is a participation share called cultural assets participation fee. Municipalities charge this fee annually from landowners as 10% of the property tax. The money collected is used in municipality projects for the protection of cultural assets within the municipality's boundaries. This tax is collected from the landowners, not from tenants (Ministry of Culture and Tourism; LAW 29453, 2015).

Another form of tax collected from users is the environmental cleaning tax, which again is collected by municipalities towards the cost of cleaning activities in the neighbourhoods. This tax is reflected monthly in the domestic water bills of houses. In 2019 the rate for every cubic meter of water used was 0,39 TL inside Greater Municipality boundaries and 0,29 in other municipalities (Url-7).

The main difference of these two taxes is that the cultural assets participation fee is collected from landowners, whereas the environmental cleaning tax is collected from the users of the property.

As a general opinion, since transport investments are public services, landowners may not be willing to hand out their value increase in the form of tax for financing metro projects. But as can be seen in the environmental cleaning tax and the cultural assets participation fee, the collection of such taxes is legal and not against to constitution. Cleaning activities and protection of cultural assets are municipal tasks, nevertheless in Turkey the law requires that citizens participate in the cost of these activities. Thus it is meaningful to ask landowners to make a contribution to railway projects with some part of their properties' value increase.

2.7 Discussion and Purpose of the Thesis

The MTRC and TfL development models, PPP model, urban rent and betterment tax have been comprehensively discussed in the literature review part of the study. Before selecting an implementation method for this dissertation, the suitability of all these models is discussed.

The MTRC development model is a way of funding used in Hong Kong. It is easy to apply this model in a city-state like Hong Kong. Since there is no private ownership of land in this city it is possible to use any land for public services and transfer the development rights to any developer. All land belongs to government; it is therefore substantially easy to give development rights to developers. Individuals cannot own land or property; they can only lease properties from the state for a specific period of time. This model is not applicable in Turkey since there is private land and property ownership.

The TfL model can be applied in Turkey, but when its main aim is considered, which is the development of the city's under-developed areas by means of transport investments, it does not suitable for Istanbul. In Turkey transportation investments are generally made due to mobility needs after an area is already developed. And land acquisition through expropriation in an already developed area is very expensive.

The PPP is a model that is currently being used in Turkey. But there are some difficulties when implementing it in Turkey. Because of instable economic conditions the government has to provide generous guarantees to the private sector for their involvement in PPP. These guarantees include long-term operating rights and high ridership and user guarantees. If those ridership and user figures are not achieved the government has to pay the remaining balance to the investor. In comparison to projects paid only out of the national budget this type of investment model with the involvement of the private sector makes projects more expensive for the national economy. Although used in Turkey extensively, the PPP model is not the best way of executing projects.

As discussed in the section 2.4.1, any improvement in an urban area will lead to a value increase in land and properties. In this dissertation the main hypothesis is that after a rail system is introduced there will be an increase in property values in the surrounding areas. In order to test and prove this hypothesis a model is developed which is based on the results of a new financial methodology developed for Istanbul. The model includes calculation of the value increase that results from transport investments. The focus will be on metro investments. Then the calculated value will be charged as a type of tax to property owners. The main aim is not to cover all investment and operation costs of the system but to raise funds for new rail system projects. The value increase calculation methodology and tax collection methodology is discussed in section 3.

3. METHODOLOGY

As suggested in various studies, the distance to a station corridor of a transport system has a significant impact on property values. The impact can be positive or negative (Dube et al, 2013; Pan, 2013; Zhang and Wang, 2013; Pan et al, 2014; Seo et al; 2014; Wagner et al, 2017; Yen et al, 2018; Ransom, 2018; Mulley et al, 2018; Diao et al, 2017; Sharma and Newman, 2018; Gatzlaff and Smith, 1993; Damm et al, 1980; Hiironen et al, 2015; Medda and Modelewska, 2011). Transit system investments are basically associated with a decrease in transport costs and increase in accessibility. Thus they have a positive impact on property values (Dube et al, 2013; Zhang and Wang, 2013; Pan et al, 2014; Wagner et al, 2017; Yen et al, 2018; Ransom, 2018; Diao et al, 2017; Sharma and Newman, 2018; Gatzlaff and Smith, 1993; Damm et al, 1980; Hiironen et al, 2015; Medda and Modelewska, 2011). In this study the main aim is to estimate the impact of a new railway project on property values in the areas on an existing corridor and adjacent to a station. This calculated value is used to develop a model for the funding of future railway corridor.

Two approaches are used to model housing prices. The first approach is the mono centric model that assumes that housing prices are a function of proximity to a single central business district (CBD) which is the centre of employment and work places. Housing prices reflect the savings in commuting costs from different locations (Dube et al, 2013; Pan, 2013). The housing market has its own characteristics such as durability, spatial fixity and heterogeneity, which make it different from other consumption goods. In order to model these differentiations effectively a second approach, the hedonic price model is used (Chin and Chau, 2003).

According to Harjunen (2018) there are many studies of urban and transport economics which estimate the impact of transport investments on land values and housing prices. However, the most commonly used methodology is the hedonic price model. As can be seen in Table 3.1, there are various studies using different models for estimating the impact of railway stations on housing prices. In this study the hedonic price model is used since it is the best option for the available data set.

Table 3.1 : Studies for calculating impact of impact of rail stations.

	Researchers&Date	Location	Aim	Transit Type	Methodolgy	Type of Data	Findings
1	Dube et. al. (2013)	Montreal/ Canada	To assess the impact of the implementation of a commuter train service on single family houses	Commuter rail	Difference-in-Differences estimator Hedonic Price equation with generalized least squares (GLS)	Single family house sales and resales between 1992-2009	Market premium of houses decrease as the distance increase The 9,7% of mean selling price within 0-500 m radius decreases to 2,7% within 100-1500 m.
2	Qisheng Pan (2013)	Huston/ USA	To reveal the positive or negative impact of the Huston's light rail transit line on residential property values	Light rail	Hedonic Price Model with Ordinary Least Square (OLS) and Multi Level Regression (MLS)	Home sales prices based on 2007 infoUSA transaction database	Light rail stations have significant positive impact on housing values, however if the housing unit is very close to the station due to nuisance effect prices are lower than the catchment area of the station
3	Zhang and Wang (2013)	Beijing/ China	To show the relationship between housing price and transit station to contribute literature with a Chinese case	2 light rail and a BRT	Hedonic Price Model with OLS and log-log model	Selling price of housing units around corridors	The coefficient of distance for City Rail is -0,0035 meaning as the distance increase the price of house decrease. For every 100 meters closer to the station housing price increase 0,35% The coefficient of distance for Batog Rail Line is -0,0213 meaning that 2% increase for every 100 meter closer to the station There has been no measurable influence for BRT.
4	Pan et. al. (2014)	Huston/ USA and Shanghai/ China	To make a comparative study among two large cities in the world in order to show the impact of rail stations on housing values	Light rail in Huston Heavy rail in Shanghai	Hedonic Price model with OLS and MLR	Home sale prices in both cities, for Huston infoUSA for Shanghai local real estate magazines	Models show that proximity to a rail station has significantly positive effects on residential property values in both cities.
5	Seo et. al. (2014)	Phoenix/ USA	To analyze positive and negative relationship between housing values and distance to light rail stations and highway exits	Light rail and highways	Hedonic price model with generalized spatial two stage least squares (GS2SLS) estimator	Sales price of single family detached homes in 2008	The expected contributions of railway stations and highway exits do not out weight its negative effects in the very near bands of the rail station (300m) and highway exits (350 m) The function of coefficients has an inverted U-shaped pattern

Table 3.1 (continued) : Studies for calculating impact of impact of rail stations.

	Researchers&Date	Location	Aim	Transit Type	Methodolgy	Type of Data	Findings
6	Wagner et. al. (2017)	Hampton Road/ Virginia/ USA	To examine the effect of light rail on housing market in Hampton Road	Light Rail	Difference-in-differences model	Sale price, sale list price, time on market of residential properties	Properties within 1500 meters to the light rail station experience approximately 8% decrease in sale price Potential negative effects of rail station surpass the potential accessibility benefits
7	Yen et. al. (2018)	Queensland/ Australia	To evaluate the incremental impact of accessibility of a rail investment on housing market values in time	Light Rail	Difference-in-differences	Selling price of properties over time (5 different years between 1996-2016)	Property prices in the catchment areas (800 m) start to increase after project announcement, following the financial commitment by the government highest increment of increase occurs. During the construction and operation period increase continues but with a smaller rate.
8	Ransom (2018)	Seattle/USA	To analyze the impact of new light rail service on housing market in Seattle	Light Rail	Difference-in-differences regression	Single family houses sold between 1992-2016	Results differs among seven stations, only one of them influenced positively and two of them influenced negatively for the rest of the stations the impact is either too small or insignificant
9	Mulley et. al. (2018)	Sydney/ Australia	To identify the long-run impact of light rail presence on land values	Light rail	Geographically Weighted Regression (GWR)	House price transactions in 2011	Distance variable to the rail station has a significant impact on property price For every 100 m closer to the station property price increases 0,5%, however the prices very close to station are affected by negative externalities.
10	Diao et. al. (2017)	Singapore	To test the effects of urban rail on private housing values	Heavy rail Light rail	Spatial difference-in-differences	Transaction of non-landed houses	7,8% increase in private housing values in 600 m treatment zone when compared to control zone.
11	Sharma and Newman (2018)	Bangalore/ India	To understand the influence of urban rail system on land values in a emerging city with Bangalore case	Heavy rail	Hedonic Price Model (OLS)	2012-2016 Panel Data and 2016 Cross-Sectional Data for average sale price of properties	Panel data showed a significant increase in land values even further from 500 m catchment area. 4,5% value uplift was calculated after the railway opening across the city.
12	Gatzlaff and Smith (1993)	Miami/USA	To examine the impact of Miami Metro Rail System development on property values close to station	Heavy rail	Hedonic price model	Selling prices and selling dates of properties between 1971-1990	The impact of the rail development on house values does not appear to vary significantly by distance from the station in Miami Metrorail.

Table 3.1 (continued) : Studies for calculating impact of impact of rail stations.

	Researchers&Date	Location	Aim	Transit Type	Methodolgy	Type of Data	Findings
13	Damm et. al. (1980)	Washington /USA	To determine if the aggregate value increase is driven by metro investments	Heavy rail	Hedonic price model	Transaction of properties for owner occupied single family dwellings, multifamily buildings and retail establishments	In all cases distance of property to the metro station was significant to determine transaction price of property. As the distance to the station increases the value of property decreases
14	Hiironen et. al. (2015)	Helsinki/ Finland	To test if new subway line in Helsinki will have an impact on housing values and on public revenues	Heavy rail	Hedonic price model (OLS)	Apartment prices	New railway station catchment area reaches up to 400 m and the average increase ratio is calculated as 11-15% in the studied area.
15	Medda and Modelewska (2011)	Warsaw	To test the influence of metro system on housing values in Warsaw	Heavy rail	Hedonic price model	Changes in real estate price	Results show that rail has a positive impact on housing values. Houses located within 1 km to stations have approximately 6,7% higher selling prices when compared to further away.

According to (Rosen, 1974), the hedonic price model assumes that goods are typically sold as a package of self-existing features. Therefore the price of a house is different from another due to its inherent attributes. The price of a house can be calculated with a regression analysis which includes the summation of the marginal prices of all its attributes.

As stated by (Herath & Maier, 2010), the hedonic price method is also known as hedonic regression or hedonic demand theory. This is a methodology that is used to estimate the value of a property's attributes that affect its market price. Alternatively it can be used for estimating the demand for a property. This methodology has been used extensively in real estate and housing market research (Dube et al, 2013; Pan, 2013; Zhang and Wang, 2013; Pan et al, 2014; Seo et al; 2014; Yen et al, 2018; Sharma and Newman, 2018; Gatzlaff and Smith, 1993; Damm et al, 1980; Hiironen et al, 2015; Medda and Modelewska, 2011). The idea behind this model is, that properties are characterized by their composite attributes, thus the value of a property can be calculated by adding up the estimated values of its separate attributes.

As stated by Chin and Chau (2003), several assumptions are made to apply the hedonic price model to the housing market:

1. It is assumed that housing properties are homogenous.
2. It is assumed that the housing market operates under perfect competition and there are enough buyers and sellers. This means that there are many potential buyers for properties and there are many housing developers providing houses, so that no individual buyer/seller can significantly affect the price of a property.
3. Buyers and sellers are assumed to enter and exit the market freely. There are no constraints imposed on demand and supply of housing and no restrictions on the resources used to produce the housing product.
4. It is deemed that buyers and sellers are fully informed on the housing product and price. Since buying a house demands a significant capital outlay, buyers will try to gather as much information about the attributes of the unit they are planning to buy before the carry out the purchase. Likewise, being fully informed about their core business and market prices will allow developers to increase their profit.

5. The hedonic price model can only work under the assumption of market equilibrium and there is no interrelationship between the implicit prices of the attributes.

However, according to Chin and Chau (2003), these assumptions for the hedonic price model are questionable, for instance the housing market is not homogenous, on the contrary it is heterogeneous and can be differentiated according to location related, structural and neighbourhood attributes. The free market entry and exit is also open to doubt because there might be some constraints for buyers and some capital constraints for developers. Market equilibrium is also very difficult to achieve since a balance of supply and demand may not be possible for every location. It is also not likely that potential buyers and developers are fully informed on the housing market everywhere and at any time.

Herath and Maier (2010) state, that the conventional hedonic price regression equation for the housing market is either the rent or the selling value of the house against the inherent attributes of the house. The primary assumption of regression is that the relevant determinants of the dependent variable, which are rent, price or value, is known accurately and in advance. A classical hedonic price equation is as follows:

$$R=f(P,N,L,C,t)$$

R: Rent or selling price of the property

P: Property related attributes/structural attributes

N: Neighbourhood attributes

L: Attributes related to location

C: Contract conditions

T: Time

Malpezzi (2001) claims that based on literature the following variables frequently appear in the hedonic price model in housing market research (Herath & Maier, 2010; Dube et al, 2013; Pan, 2013; Seo et al; 2014; Yen et al, 2018);

- Number of rooms and type of rooms (bedrooms, bathrooms etc.)
- Floor area
- Category (single family, multi-family, attached, detached, number of floors)

- Availability and type of heating and cooling systems
- Age
- Structural features (presence of basement, fireplace, garages)
- Structural material used and quality of finish

The variables used in the hedonic price model are site specific. The number of variables and their content may differ between countries and even cities in the same country (Medda & Modelewska, 2011).

Residential properties are multidimensional; products characterized by spatial fixity, durability and structural inflexibility. As it is cited by Chin and Chau, 2003; Goodman (1989) and Williams (1991) classified features of housing into location, structural and neighbourhood related attributes. Thus the market price of a property can be defined as a function of locational, structural and neighbourhood variables. The implicit price of each housing attribute with other conditions remaining the same can be derived from the regression coefficient. In short, the hedonic price model attempts to estimate the individual impact of each housing attribute on the housing price by holding the other factors constant (Chin and Chau, 2003).

Since the housing market cannot be explored by laboratory experiments, the hedonic price model is a very useful scientific tool, with which the impact of one or more housing attribute on the price can be calculated. This provides researchers with a tool to understand the behaviour of the players in the housing market. It is also very beneficial for developers, development consultants, investment consultants and policy makers to know how the housing market operates.

As can be seen in Table 3.2, the impact of variables commonly used in the hedonic price model on the housing market varies and can be positive or negative. In theory the distance to a CBD is inversely proportional; as the distance between the property and CBD increases the value of the property decreases. Studies show that being close to certain function such as hospitals, shopping centres and forests may have both a positive and negative impact (marked in the Table below with a question mark) as these functions may give rise to pollution, traffic congestion and security considerations (Chin and Chau, 2003).

Table 3.2 : List of housing attributes commonly used in the hedonic price model.

Locational	Distance from CBD	inverse ratio
	View of the sea, lakes/rivers	positive
	View of Hills/Valley/Golf course	positive
	Obstracted view	negative
	Length of Land Lease	positive
Structural	# of rooms, bedrooms,bathrooms	positive
	Floor Area	positive
	Basement, Garage and Patio	positive
	Building Services (air conditioning, Lift etc.	positive
	Floor Level (Multi-Storey Buildings only)	positive
	Structural Quality (e.g. design, materials, fixtures)	positive
	Facilities (e.g. Swimming pool, gym, tennis court)	positive
	Age of Building	negative
Neigborhood	Income of Residents	positive
	Proximity to Good Schools	positive
	Proximity to Hospitals	?
	Proximity to Worship	positive
	Crime Rate	negative
	Traffic/Airport noise	negative
	Proximity to Shopping Centers	?
	Proximity to Forrest	?
	Environmental Quality (e.g. Landscape, Garden, Playground)	positive

In this study the impact of proximity to a metro station is calculated by using the hedonic price model. This model allows calculating the impact of each and every attribute of a property, including location, structural and neighbourhood variables as it is seen in Table 3.2, on the property's value. One can simply add other attributes to the model to calculate its impact on the value. In order to calculate the anticipated value increase after the completion of a metro project in Istanbul, two case studies are selected for the model. This study is mainly constructed as a 'before' and 'after' analysis. However, with the data available it was not possible to perform this study in the same study area. Therefore an existing railway system was selected as the after case and a system proposed at another location as the before case. In order to make such a comparative study, those two selected case study areas need to be identical. The case study selection methodology will be discussed in detail in Section 3.1 where through similarity checks the two case study areas will be demonstrated to be identical in the context of this study. The selected case study is a metro project the construction of which is still ongoing. Thus there are no stations currently in operation to develop the model with. In order to develop hedonic price model, a second case study area is selected for the calculation of the impact of a station in the metro corridor on the surrounding housing values. For clarification; in this study the case study area in which the metro construction is not yet completed will be referred to as the main case study area, the case study area which will be used for the modelling will be referred as the control case study area.

The sample data for this study come from on-site questionnairies carried out by the survey teams with real-estate agents working around rail stations. The price and all attributes of the apartments are gathered via questionnaires for a 500 meters circular zone around 5 railway stations. In total 653 questionnaires were obtained from around the 5 stations in the control case area. The questions were prepared based on the hedonic price model variables.

The description of the variables used in the questionnaire is shown Table 3.3 below;

Table 3.3 : Description of Variables.

Definition of the Variable	Name of the Variable
Distance of the housing unit to the nearest metro station (in meters)	Straight line distance
Floor area of the housing unit (in square meters)	size
Price of the property (selling price of the housing unit in Turkish Lira)	price
Age of the building (years)	age
Number of rooms in the housing unit	rooms
Number of bathrooms in the housing unit	baths
Dummy variable asserting whether the toilet of the housing unit is a alaturka type toilet or other (1: if alaturka, 0: otherwise).	alaturka
Dummy variable indicating whether the housing unit is located on a west facade or otherwise (1: if located on west, 0: otherwise).	west
Dummy variable indicating whether the housing unit is located on a north facade or otherwise (1: if located on north, 0: otherwise).	north
Dummy variable indicating whether the housing unit is located on a south facade or otherwise (1: if located on south, 0: otherwise)	south
Dummy variable asserting whether or not there is an elevator in the building (1: if there is elevator, 0: otherwise).	elevator

In the modelling part of the study the gathered data in the control case is modelled using R Studio software. The model results will be discussed in detail in Section 5. Since there is an operating metro system, the data on the distance to stations is gathered by using Google Earth. The questionnaire study is conducted within a 500 meter circular zones around the railway stations which is taken as the catchment area of the station. The distance from apartment to station is measured as a straight line distance. The reason for using straight line distances is that there could be more than one route for any apartment to reach the station, which would make the data unreliable. The 500 meters zones are also measured with straight lines (Figure 3.1). In order to obtain the uniformity, both the distance between station and apartment and the zone radius are measured used straight lines.

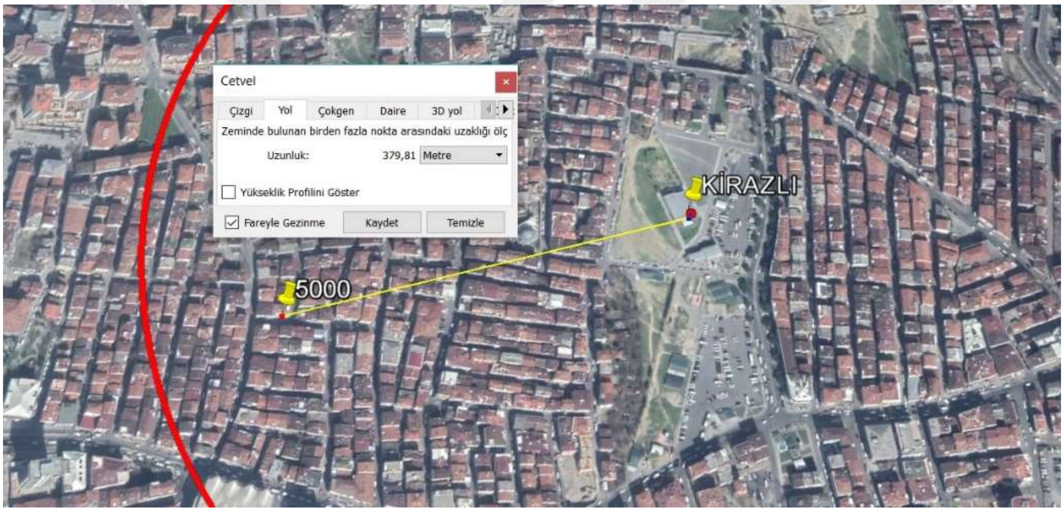


Figure 3.1 : Measuring straight line distances from the stations.

The station's catchment area is accepted as a zone with a 500 meters radius. The 500 meters radius for the catchment area is derived from the Turkish Zoning Law according to which a reasonable walking distance in Turkish cities is approximately 500 meters. However, in literature the definition of distance varies. Most of the definitions for distance to a transit stop are derived from TOD. Basically TOD is an urban environment that has a transit station in the centre, a mixed-use place with a certain urban density and high quality walking environment, located within half-a-mile (800 meters) and approximately 10 minute walk to the transit station (Vale, 2015). Based on a study conducted by Bertolini (1999) a walkable radius is defined as 700 meters. Like Bertolini there are other researchers who have defined a reasonable walking distance as 700 meters (Chorus and Bertolini, 2011; Stefan, et al, 2011).

However, unlike those scholars Kamruzzaman et al, 2014 defined the distance to the station catchment boundary as 800 meters. Most of the American scholars defined the station catchment distance as half mile (800 meters) (Higgins and Kanaroglou, 2016). In this study the main catchment area is accepted as 500 meters, but based on literature and taking into account the rugged geographical conditions of Istanbul, a buffer zone of an additional 100 meter was defined for this case, making the total radius of the catchment area 600 meters.

500 metersaround stations are divided into 100 meter ranges as seen in Figure 3.2 and for each range the value increase percentage is calculated.

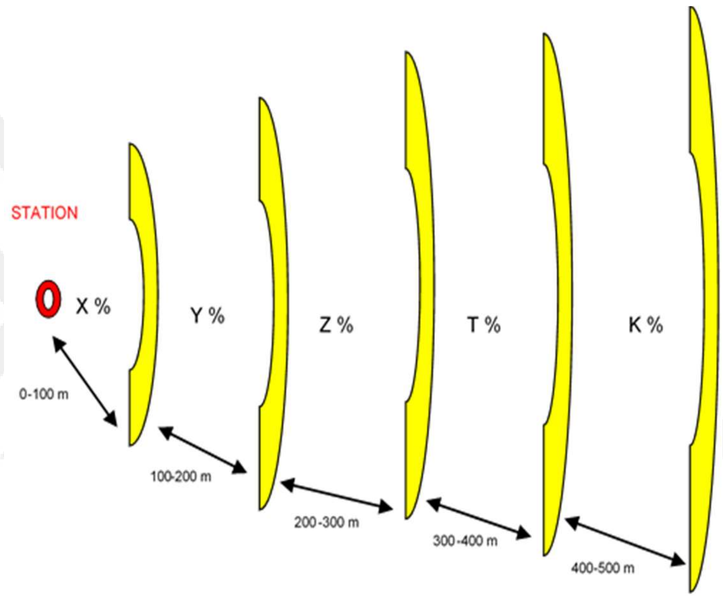


Figure 3.2 : Ranges for value increse ares around stations.

In this study, based on the percentage increase in each range, a corresponding percentage of increase is applied to the annual property tax. The reason for dividing the catchment area into ranges is for equity as every range experiences a different rate of value increase. For instance, if the property is within 0-100 m of a station the landowner is obligated to pay X% of his property tax as railway financing participation fee. The number of individual housing units within the zones is established. The average distance of each zone is accepted as follows;

1-100 meter----------50 meter

100-200 meter------150 meter

200-300 meter------250 meter

300-400 meter------350 meter

400-500 meter------450 meter

With this assumption the average value increase for each zone is calculated, the number of individual housing units around each station and in each zone is established using the Google Earth and maps.google application.
There is an inverse ratio between distance and value increase. As the distance increases the value increase rate decreases. The the accepted relationship between distance and value increase is shown Figure 3.3.

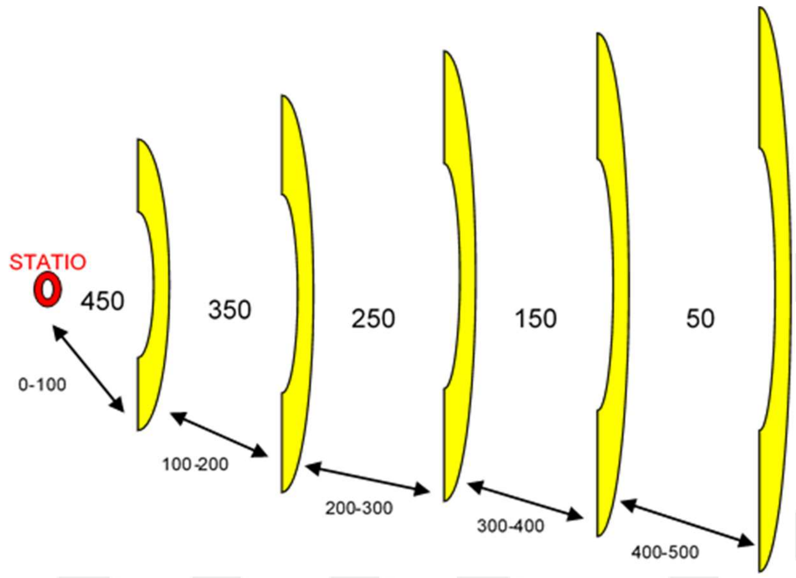


Figure 3.3 : Average distance assumptions for stations.

After the average value increase is calculated in the control case study area using the model, the average tax rate for each range is defined.
There are various studies in literature that calculate the impact of a railway station on the housing market by using different methodologies including the hedonic price model. Some of these studies have calculated value increase, some of them value decrease. What the studies have in common is that the value impact differs depending on the type of transit. Studies that investigate light rail stations have obtained negative results, probably due to light rail externalities like noise, vibration and visual pollution. The studies that focus on heavy rail obtained positive results as these are mostly underground and do not create a negative impression in the surrounding area. In this study the value change is considered to be positive as the main case is a metro project and is expected to have a positive impact on the surrounding housing market.
According to a study conducted by Pan et. al. (2014), in the Shanghai Metro in China the results obtained using the hedonic price model show that distance to rail stations

has a positive impact on residential property values. The model reveals that property values increase by 1% for houses are located 100 m closer to the stations.

Hiironen et. al. (2015) conducted a study estimating the impact of the West Metro Line on residential apartments in Helsinki, Finland. Researchers used the hedonic price model to calculate the impact of proximity to subway stations. Empirical results show that a new subway station has an impact on property values. The impact of subway station proximity on residential apartments is in average 15% within a 400 m radius and 11% within a 800 m radius. The total impact is calculated as 122 million Euros in a 0-400 m radius and 193 million Euros in 0-800 m radius.

Medda and Modelewska (2011) used the hedonic price model to estimate the impact of proximity to metro stations of the Warsaw Metro System in two districts, namely Bienlany and Targawerk. Bienlany is a district which has access to a metro since 2008, whereas at the time of survey Targawerk had a planned corridor bu no metro access yet. The empirical results obtained from the Bienlany district show that houses located within 1 km to the nearest metro station utilize 6.7% higher selling prices than houses beyond the 1 km catchment area. To estimate the value increase in the Targawerk district where there is no operating metro system but a planned metro project, researchers used the coefficient for access to a metro obtained from the regression of Bienlany. Results show that the planned metro stations will lead to 7.13% higher selling price for houses in the 1 km catchment area.

Pan (2013) claims that with improved accessibility and reduced travel costs rail transit systems may increase the value of residential properties near the transit stations but at the same time may create a nuisance effects such as noise and crime. In order to test this hypothesis researchers conducted a survey for the Huston METRORail line by using the hedonic price model. Pan (2013) divided the study area into zones. Starting from station the first zone is 0-400 m (1/4 mile), the second zone 400-800 m (1/4-1/2 mile), the third zone 800-1600 m (1/2-1 mile), the fourth zone 1600-3200 m (1-2 miles), the fifth zone 3200-4800 (2-3 miles) and finally beyond 4800 m (beyond 3 miles). Based on the InfoUSA 2007 household database, Pan (2013) proved the relationship between housing price and distance. According to the author's calculations, a younger house within a distance of 0-400 m to a station has lower $/sqft than a house within a distance of 400-800 m, which shows that the nuisance effect makes a negative contribution on housing prices. However, calculations also show that as the distance increases, the value of property between 800-4800 m decreases.

A study was conducted in Queensland Australia by Yen et al. (2018); researchers investigated the impact of railway project phases (announcement, construction and operation) on residential properties around the stations. The catchment area was defined as 800 m. This study used the DID model, thus an area between 800 m to 1600 m was defined as the control group. To investigate the impact on different distances, the catchment area was divided into 3 zones, namely 0-100 m, 101-400 m, 401-800 m. According to this survey, the highest average sale price out of these 3 zones is in the middle zone (the 101-400 m zone) and the lowest is in the zone closest to the metro station. This clearly shows the nuisance effect of light rail stations on people's preferences who favour to be neither too close nor too far from a rail station. In a study conducted in Hampton Roads, Virginia, by Wagner et al. (2017) calculated the impact of Tide Light Rail line on the residential property market by using the DID model. The results show that properties experience approximately 8% sale price decline within a 1500 m distance to a rail station. This shows that the negative effects of a station are outweighed by the positive accessibility benefits. The total aggregate decline in the housing market due to light rail is estimated to be $75 million.

A study was conducted by Seo et. al. (2014) in Phoenix, Arizona to demonstrate the impact of light rail stations and highway exits on the surrounding residential properties. The researchers used the hedonic price model and defined zones to estimate the value impact on housing at different distances. For light rail stations zones of 300 m width were defined reaching a total width of 3000 m which means that 10 zones surround the LRT station. For highway exits, zones of 400 m width were defined which makes a total distance of 3200 m to the station. Study results showed that the disamenities associated with rail stations and highway exits are particularly felt in the first 300 m from rail stations and 350 m from highway exits.

3.1 Case study selection

Istanbul is one of the most important cities in Turkey. The city spreads in two parts in on different continents which makes it one of the most intersting cities in the world. One part of the city lies in Europe and the other in Asia. It is the biggest city in Turkey in terms of both economy and population, more than 15 million people live in Istanbul. (Url-8). This high population and economic activities create high mobility needs. Istanbul has a diversified modal split including rail, road and sea transportation. As it is seen in Figure 3.4, The Bosphorus Straight is the geographical element that divides the city into two parts.

Figure 3.4 : Bosporus Straight**.**

The urban development pattern of the city is mainly determined by geographical limitations. Istanbul has limited areas for development. The forrested land to the north is protected. The city has a linear macroform located along Marmara Sea Coast. The linear development of the city is a result of the two main highways, the first being the state highway (D-100) and the second the motorway which is a part of Trans European Motorway (TEM). These two main axes attracted development and reinforced the linear growth of the city in a east-west direction. However, today urban sprawl and development trends are also observed towards the northen protected areas. Furthermore, the 3rd roadway bridge that started operation in 2016 is located at the northern tip of the Bosphorus Straight and is likely to increase the development pressure towards north. The Figure 3.5 shows the urban sprawl around bridges in Istanbul.

Figure 3.5 : Bridges in Istanbul.

Istanbul has been investing in public transportation systems especially rail sytems since 1990s. However, the coverage of the urban rail systems is rather low. Despite expanding constantly, progress is slow due to the construction time and cost involved in these systems. The Bosporus Straight has always been an obstacle preventing the creation of an integrated rail transportation network in the city. Each part of the city has its separate public transport networks. As a result, the share of rail transport is relatively small in terms of daily trips in Istanbul. As can be seen in the Figure 3.6 the transportation mode used most is road transport and its use continues to increase (IBB, 2020). Over 15 years, the share of rail transport has slightly increased, yet the share is still low. The rail networks in the two continents were connected with the Marmaray which opened in 2013 and includes the Bosphorus railway tube crossing, an underwater railway tunnel accross the Bosphorus. Although the city has a unique location the share of sea transport is relatively small.

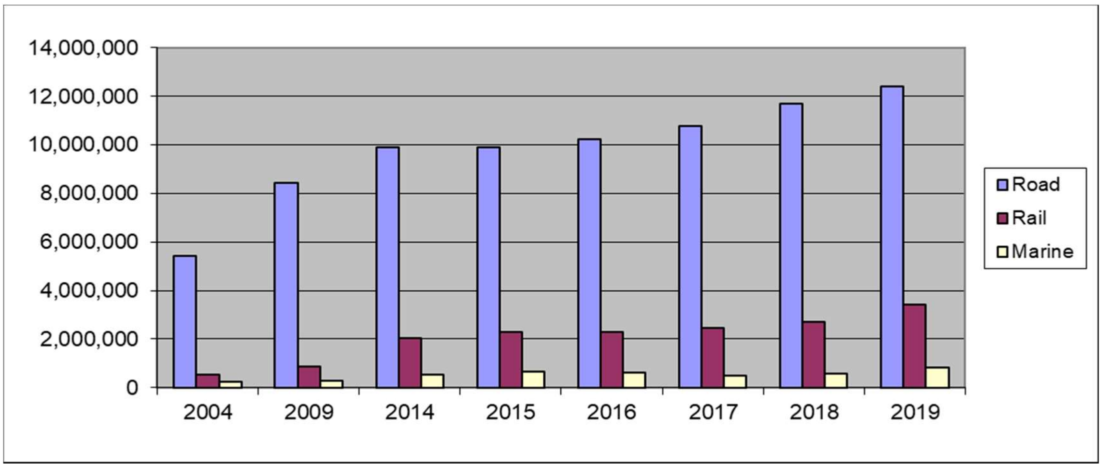


Figure 3.6 : Distribution of use of transport modes in Istanbul.

There are 28 different rail lines in Istanbul including heavy rail, light rail, tramway and funicular. The total length of the rail network in Istanbul is 233 km (IBB, 2020). When its linear macroform is considered this is not enough. Only central areas can utilize railway services, whereas peripheral areas depend mostly on bus and minibus services. Istanbul has a rough geography which makes rail investments expensive. Even the railway in Istanbul serves a limited area. Daily ridership is relatively high. In 2018 daily ridership on the total rail network was 2.709.914 (Url-9).

As can be seen in Table 3.4, there are 11 possible railway projects which can be selected as case study. In order to reduce the number of potential projects, tramway and funicular lines were eliminated and only metro projects were left, because literature suggests that the impact of light rail and monorail projects is very low when compared to metro lines. There are scholars who claim that property values are affected by the investment depending on its scale, whereby small scale investments affecting accessibility of a location but large scale investments affecting the property market (Banister, 2007).

In a study conducted by Zhang et al (2014) researchers categorized urban public transit in three categories. BRT, LRT and metro. Results show that metro projects bring the highest premium to housing prices, LRT brings a moderate and BRT the lowest premium.

Table 3.4 : List of Possible case studies.

No	LINE	TYPE	LENGHT (km)
1	Eminönü-Alibeyköy	Tramway	10.10
2	Kabataş-Mecidiyeköy-Mahmutbey	Metro	24.50
3	Ikitelli-Ataköy	Metro	13.00
4	Başakşehir-Kayaşehir	Metro	6.20
5	Kirazlı-Halkalı	Metro	9.70
6	Rumeli-Hisarüstü-Aşiyan	Funicular	0.80
7	Mahmutbey-Bahçeşehir-Esenyurt	Metro	18.50
8	Çekmeköy-Sancaktepe-Sultanbeyli	Metro	10.90
9	Ümraniye-Ataşehir-Göztepe	Metro	13.00
10	Dudullu-Bostancı	Metro	14.30
11	Kaynarca-Pendik-Tuzla	Metro	13.00

After tramway and funicular lines were eliminated, nine projects remained for the case study selection.

Still the number of projects was very high for selecting a case study, thus it was important to introduce some limitations. It is very hard to handle a long corridor to assess value increase. Thus, the maximum corridor length was limited to 20 kilometers. Short lines were also eliminated from the project samples because they are not adequate to show the value changes. Samples that are selected need to have a suitable length and enough numbers of stations. In short, only projects between 10 to 20 kilometres were examined for the selection of a case study (Cengiz & Çelik, 2019).

Projects limited by length are shown in the Table 3.5. There are 6 potential case studies that have more than 10 km and less than 20 km route length. A new filter is introduced to select one case study for this work. Ridership is another variable that makes public transit systems effective. Thus it is important to see the potential ridership figures of all these projects. There are 39 districts in Istanbul, 25 of them are on the European side and 14 of them are on the Asian side. Depending on the length of their corridor they pass through one or more district. In order to make an estimation of ridership, the districts and their total population was considered. Table 3.5 shows all the lines, their route through different districts and their population figures (Cengiz & Çelik, 2019).

Table 3.5 : Average population served.

LINE	DISTRICTS	POPULATION	LENGTH (KM)	AVE. POP. SERVED/KM
Ikitelli-Ataköy	Bakırköy	54612		
	Bahçelievler	51106		
	Bağcılar	43126		
	Küçükçekmece	58232		
	Başakşehir	9649		
	TOTAL	**216725**	13.0	16,671.15
Mahmutbey-Bahçeşehir-Esenyurt	Bağcılar	43126		
	Küçükçekmece	58232		
	Avcılar	25333		
	Esenyurt	14075		
	TOTAL	**140766**	18.5	7,608.97
Çekmeköy-Sancaktepe-Sultanbeyli	Sultanbeyli	5501		
	Sancaktepe	5666		
	Çekmeköy	22170		
	TOTAL	**33337**	10.9	3,058.44
Ümraniye-Ataşehir-Göztepe	Kadıköy	118232		
	Ataşehir	16693		
	Ümraniye	34689		
	TOTAL	**169614**	13.0	13,047.23
Dudullu-Bostancı	Kadıköy	118232		
	Ataşehir	16693		
	Ümraniye	34689		
	TOTAL	**169614**	14.3	11,861.12
Kaynarca-Pendik-Tuzla	Pendik	37759		
	Tuzla	13434		
	TOTAL	**51193**	13.0	3,937.92

As can be seen in Table 3.7, the Ikitelli-Ataköy line has the highest potential ridership with 16.671 person/km. According to the case study selection criteria this line was selected as the main case study area. When this corridor is completed it is going to serve as one of the most important corridors between two main axes of Istanbul, namely the D-100 and TEM (Cengiz & Çelik, 2019).

This corridor will have 12 stations with a 13 km route length. There are some attraction points around the proposed stations, like the wholesale jewellery shopping mall, industrial sites, and one of the two whole sale furniture sites in Istanbul is also in this corridor. This line passes through 5 different districts, some of which are very old settlements of Istanbul, others were developed recently. In Figure 3.7 the selected case study area and its stations are shown. The metro line starts in Ataköy, one of the neighbourhoods in Istanbul designed as a collective housing area in 1950s. This neighbourhood was designed as a self-sufficient satellite city with high-rise buildings, green areas and commercial activities (TMH, 2006). The corridor ends in the İkitelli industrial zone. This line also has transfer stations, such as in Ataköy with the Marmaray, in Yenibosna with M1-A line connecting Yenikapi and the old Airport, and with BRT line again in Yenibosna.

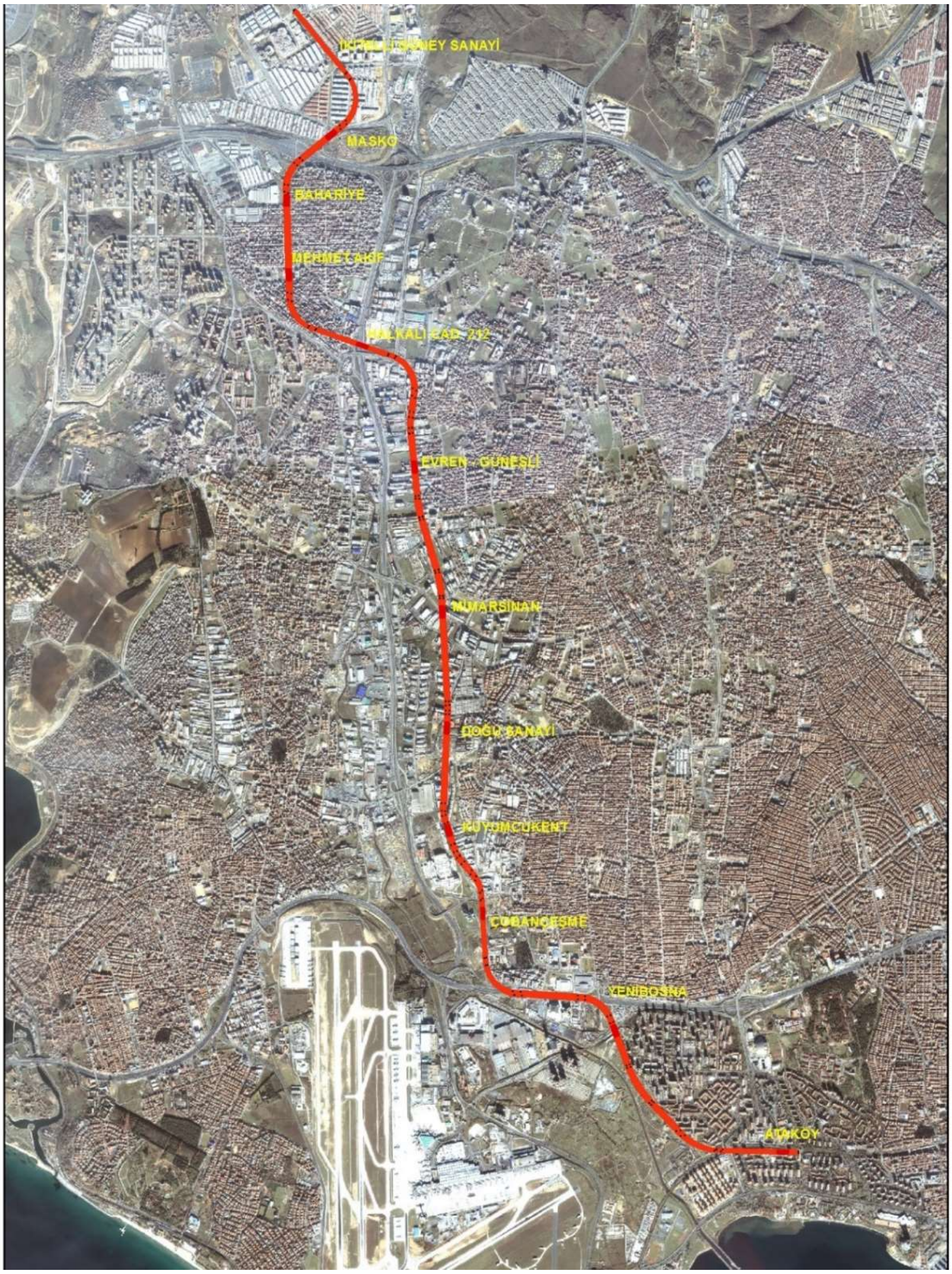


Figure 3.7 : Ataköy ikitelli metro line and stations.

This is a proposed metro project, and the construction has just started. However, the impact of railway investments on property values should be calculated on a completed railway project which is already in operation. A new study area was selected to develop the hedonic price model to calculate the impact of distance to the station on housing prices. The M1 Line between the old Atatürk Airport and Yenikapı was selected for the study. This is one of the most important railway corridors that connect old Atatürk Airport with the city centre. The first section has started operating in 1989. Additional sections were commissioned gradually over time. In 2013 the M1B section started operating between Esenler and Kirazlı (Cengiz & Çelik, 2019). The two selected case study areas can be seen in Figure 3.8.

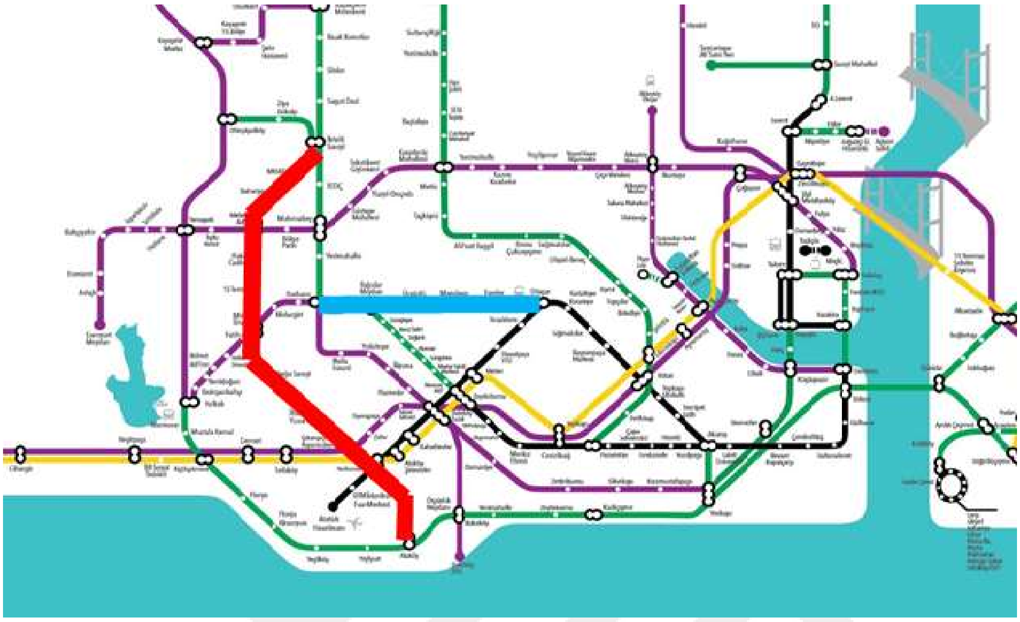


Figure 3.8 : Location of Esenler-Kirazlı Railway corridor.

This railway line is selected because it is very close to the main case study area. Istanbul is a unique city with complicated dynamics. The case that will be used as the control case has to have similar features as the main case. This area has similar uses and similar population characteristics such as socio-economic, population density, average age, schooling years, university education level and household size (Url-10). These data are obtained from a real estate website, which serves all cities in Turkey. Only observational similarities are not enough for a comparison; a similarity check test of the two case study areas has to be conducted. Similarities of these case areas are checked in two main categories; namely, the socio-economic characteristics and the housing attributes of each case area. Some statistical tests were conducted in order to be sure that the socio-economic characteristics and the related housing attributes of the selected case areas are similar. Herein the related socio-economic characteristics are represented by population, average age, average schooling year, university graduation degree, and household size of each case area. In addition to the socio-economic characteristics of the case areas, the housing attributes were also tested for similarities which are distance to the nearest metro station, age of the building, size of the housing unit, number of rooms, number of bathrooms, type of the toilet (alaturka), corner location, facing south, west or north, and the dummy variable with refers to the elevator system of the houses of these two districts. Paired t-tests were conducted for each pair of these factors. A two sided hypothesis test was conducted with the null hypothesis (H0) asserting that the related means of the socio-economic factors and housing attributes for the two case areas are the same in terms of related factors, versus the alternative hypothesis (H1) that asserts that the related means are not the same for the related factors. According to the calculations of the paired t-values, if the critical t-value of the related confidence level is less than the calculated one, then the null hypothesis is rejected (Hickman & Hilton, 1971; Sproull, 1988; Kirk & Audrey, 1990; Mosteller et al, 2013; Çubukçu, 2015). In other words, if the calculated t-value is less than the critical value for the asserted confidence level, then the null hypothesis is accepted revealing that the related factors between these two areas do not differ significantly.

Before discussing the results of the model it has to be noted that according to the results of the similarity checks through the paired sample t-test the case areas are almost the same in terms of their housing attributes, within a confidence level of at least 98% (see the related tables in Appendix A). In addition, the socio-economic characteristics of these two case areas are also almost the same with a confidence level of at least 93%, except for the population (the populations are the same only at a 41.6% confidence level; please see the related tables in Appendix B). That is to say, according to their housing attributes (and prices) and according to their socio-economic characteristics, these two case areas explicitly exhibit statistically significant similar patterns.

3.2 Railway Investments in Istanbul

Railway networks are the most important public transport option in many cities, especially cities that have a high population and high mobility needs. Istanbul is the largest and most populated city in Turkey. It is also one of the most important mega-cities in the world with more than 15 million residents. Istanbul has experienced very rapid population growth in the 50s due to economic attractions. However, the city was not ready for such rapid growth, thus faced significant social, environmental and economic problems. The funicular in Şişhane is the oldest underground urban rail system in Istanbul. It started operating in January 1875. Despite this early start further investments in railway systems did not happen in Istanbul for a while. This was probably due to financial constraints in the newly established Republic of Turkey and the influence of the global trend for road investments in the world. The M1 line, a light rail system, opened in 1989. It was the first rapid transit line in Istanbul and Turkey. The population of Istanbul exceeded 8 million in 2000s, but the rail network did not expand as fast as the population. In 2004 the total length of the rail network was 45 km which was mostly concentrated in the city centre. There was only a ring service on the Asian side, the M1 line connecting CBD to Atatürk Airport and the M2 line that connects modern CBD to northern parts of the city on the European side (Figure 3.9).

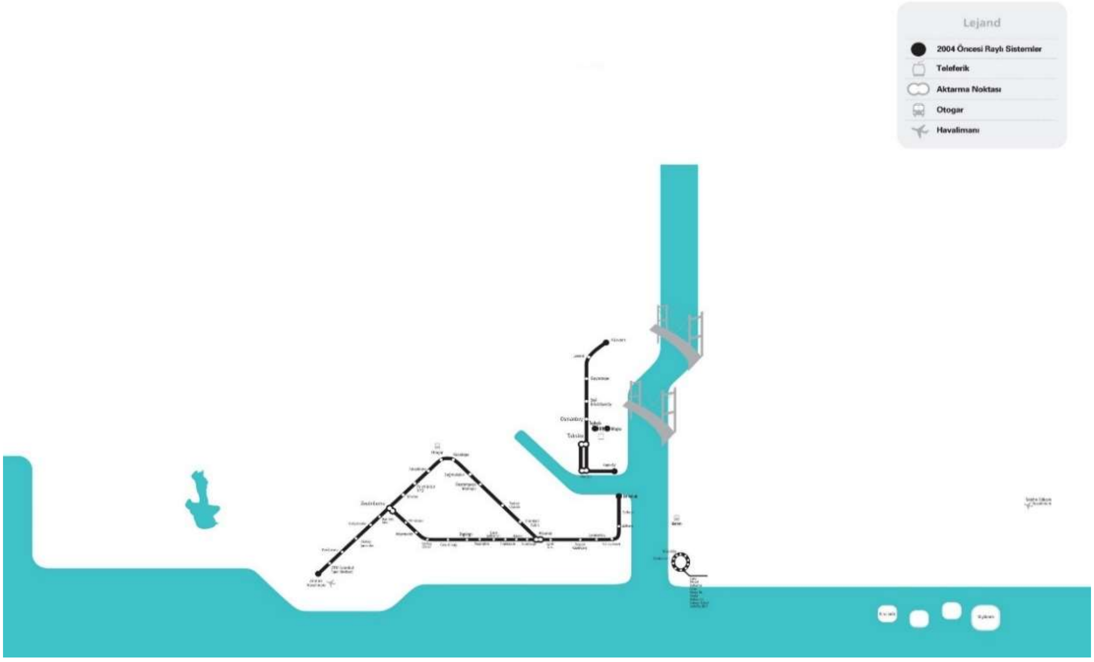


Figure 3.9 : Railway network up to 2004 (Url-11).

After 2004 the rail network underwent improvement. Today the total route length has reached 233 km and the network includes tramway, metro funicular and monorail lines (Figure 3.10).

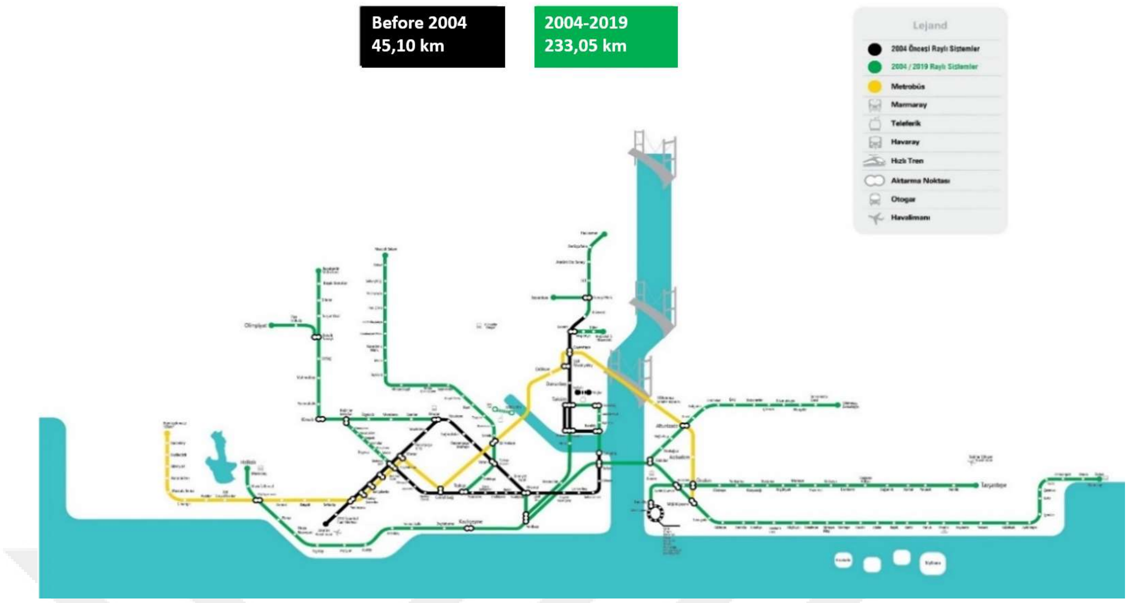


Figure 3.10 : Current rail network of Istanbul (Url-11).

There is the BRT line which operates like a railway with fully segregated median bus ways and special busses. It has 44 stations and 52 km route length. Until 2013 it was the only rapid transit connection between the two continents, and then the underwater Marmaray Railway Bosporus Tube Crossing started operations and the railway networks of two continents were finally connected.

The proposed railway network to be completed by the end of 2024 is shown in Figure 3.11. After these projects are completed, the total railway network will reach a length of 460 km.

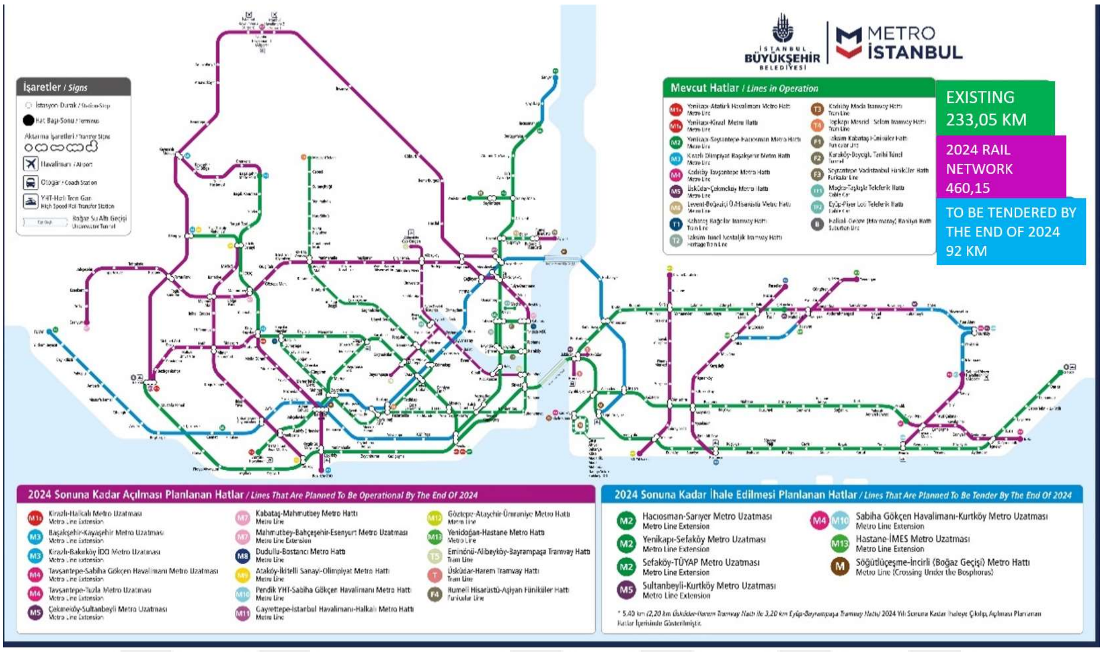


Figure 3.11 : Proposed railway network up to 2024 (Url-11).

Figure 3.12 shows a simplified version of the methodology used in this study. It started with a literature review, then two case studies were selected, thereafter the data collected with a questionnaire survey was modelled and the expected value increase was calculated. Finally a tax collection methodology was developed for financing railway projects in Turkey.

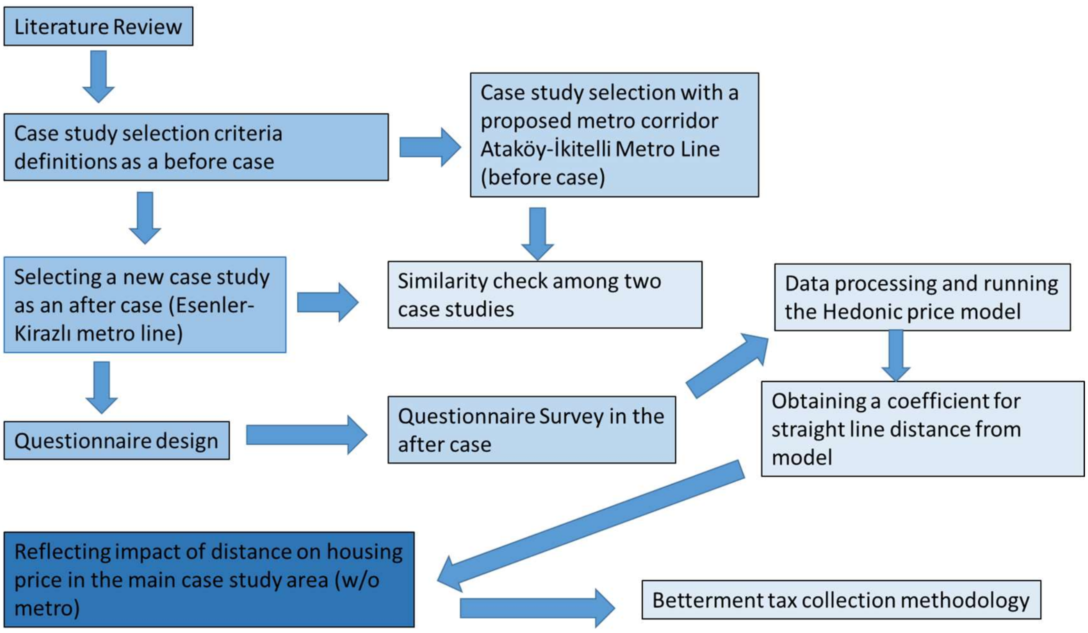


Figure 3.12 : Methodology flow chart.

4. QUESTIONNAIRE ANALYSIS

In the first area, 665 questionnaires were processed in the control case. The general characteristics of the questionnaires will be analysed in this part. The questionnaire survey was conducted within a 500 m radius from metro station. The average straight line distance of all housing units in the area to the metro station was 234 meters. The highest number of housing units lies in a 300-400 meter range to the stations. (See Figure 4.1).

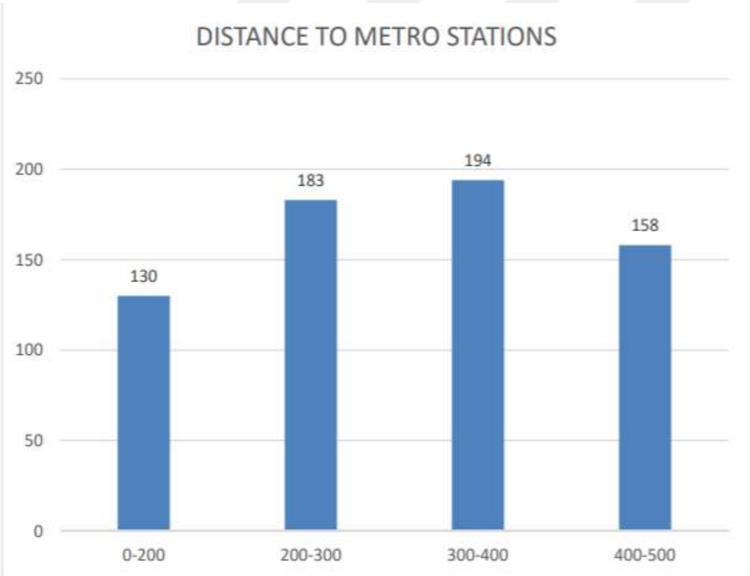


Figure 4.1 : Number of apartments in each range.

Among 665 apartments the average price for a housing unit is around 275.000 TL, with the maximum price being 565.000 TL and the minimum price 95.000 TL. The highest proportion of the apartments lies in the 200.000-300.000 TL price range which is 47.2% of all housing units.

Of the 665 questionnaires the highest proportion belongs to new buildings. As can be seen in Figure 4.2, 37% of all apartments are newly built. This is followed by 1-5 range with 22%. The age of the oldest building is between 31-35 years which is less than 1%. The average building age is around 6.7 years. This is mostly because of urban regeneration projects undertaken on this site for which old and low quality buildings were tore down and rebuild.

The average building size is 103.6 m^2, the maximum apartment size 260 m^2, and the minimum apartment size 60 m^2. Approximately 52% of housing units are more than 100 m^2 in size which means that these apartments are either single family or multifamily houses. The average number of rooms is 3.3.

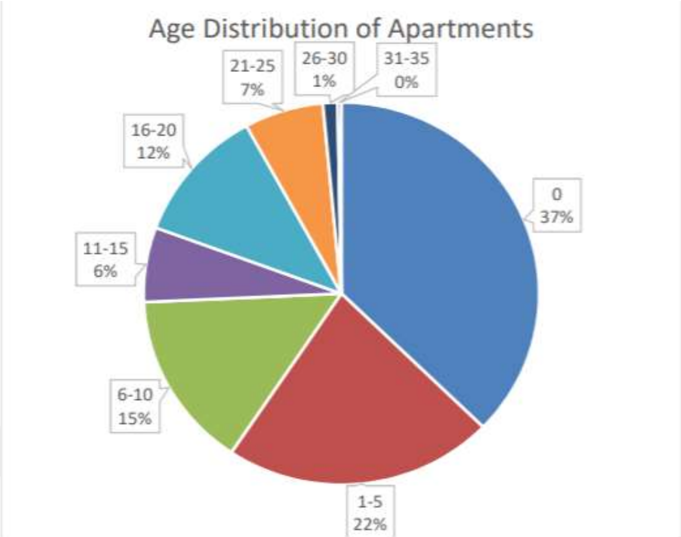


Figure 4.2 : Age distribution of apartment.

5. MODEL RESULTS

In order to develop the model that will be used to calculate the estimated impact of a metro project on housing prices, and to achieve a 95% confidence interval with a 10% margin for error for the control case area, the number of questionnaires should have been approximately 742.

$$N = \frac{1.962 \times var}{0.10 \times mean} \qquad (5.1)$$

However, during the questionnaire survey in this area only 665 questionnaire could be obtained from real estate agents. Different models with different variables were developed in this study.

The first model is run with all variables obtained from questionnaire survey (Table 5.1).

Table 5.1 : First model run with all variables.

	Estimate Std.	Error	t value	Pr(>|t|)
(Intercept)	168446.17	14921.70	11.289	< 2e-16 ***
Distance	-43.44	17.13	-2.535	0.011466 *
age	-3844.61	242.05	-15.883	< 2e-16 ***
size	616.83	158.66	3.888	0.000111 ***
#rooms	18461.10	5135.92	3.595	0.000349 ***
#bathroom	23519.68	6671.49	3.525	0.000452 ***
alaturka	14449.61	4803.83	3.008	0.002731 **
corner	-24736.05	10817.50	-2.287	0.022534 *
south	-21784.47	10420.13	-2.091	0.036949 *
West	-20410.84	11372.98	-1.795	0.073167 .
north	-18845.78	14073.42	-1.339	0.181003
elevator	21964.14	4826.48	4.551	6.37e-06 ***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 46040 on 653 degrees of freedom
Multiple R-squared: 0.5727,   Adjusted R-squared: 0.5655
F-statistic: 79.57 on 11 and 653 DF, p-value: < 2.2e-16

The model was developed using all varibles in the questionnaire study conducted with real estate agents in the control case study area. Although all t-values are significant, this model was not used for the betterment tax calculation methodology. The reason is uniformity. The distance variable in this model is the walking distance from the apartments to the nearest metro station. The walking distance is obtained using the Google Earth program as shown Figure 5.1. Since the 100 meter zones in the study as discussed in Section 3 are defined by using straight line distances from the stations, the distance variable should be obtained with the same methodolgy. In order to use a consistent data the distance variable is used as a straight line distance from the apartment to the nearest metro station.

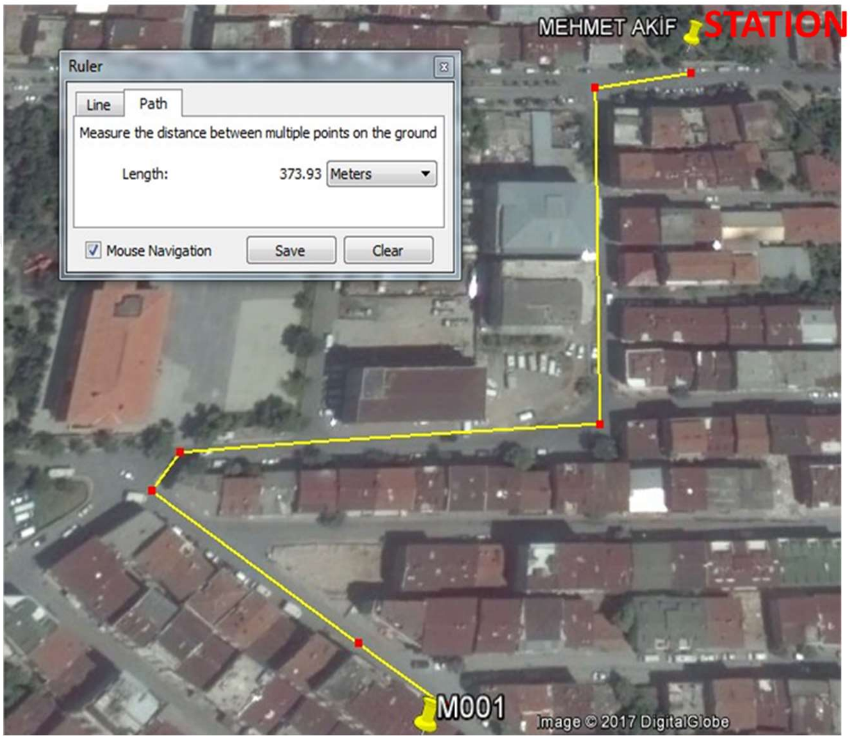


Figure 5.1 : Obtaining walking distance data via Google Earth Program.

The second model is developed by using all variables and straight line data (Table 5.2). The model results are as follows. (This model was also not used for this study.)

Table 5.2 : Second model run with straight-line distance.

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	167937.96	14697.03	11.427	< 2e-16 ***
Distance	-53.85	19.81	-2.718	0.006733 **
age	-3856.09	241.43	-15.972	< 2e-16 ***
size	612.05	158.61	3.859	0.000125 ***
#rooms	18641.78	5134.59	3.631	0.000305 ***
#bathroom	23672.19	6665.66	3.551	0.000411 ***
alaturka	14625.76	4799.83	3.047	0.002404 **
corner	-25102.66	10815.10	-2.321	0.020590 *
south	-22210.63	10416.01	-2.132	0.033350 *
west	-20810.50	11364.87	-1.831	0.067537 .
north	-19716.20	14065.37	-1.402	0.161464
elevator	22008.68	4815.63	4.570	5.83e-06 ***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 46040 on 653 degrees of freedom
Multiple R-squared: 0.5727, Adjusted R-squared: 0.5655
F-statistic: 79.57 on 11 and 653 DF, p-value: < 2.2e-16

Although t-values are significant except for the north variable, this model was not used as none of the facade variables yielded meaningful results. According to the results of this model all facades of an apartment affect the price negatively. This may be true for north, south and west facades, but does not apply to corner apartments which according to general literature have a positive impact.

Finally, a new model was developed by excluding facade variables. The final model is run with the variables shown below. The t-values are significant, which means that the model has acceptable results (Table5.3).

Table 5.3 : Final model run without facade variables.

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	145653.29	10548.08	13.809	< 2e-16 ***
Distance	-50.87	19.73	-2.578	0.010162 *
Age	-3870.72	241.01	-16.060	< 2e-16 ***
size	602.13	158.64	3.796	0.000161 ***
#rooms	18514.33	5136.19	3.605	0.000336 ***
#bathroom	24422.53	6656.81	3.669	0.000263 ***
alaturka	15114.86	4767.24	3.171	0.001592 **
elevator	22238.93	4670.32	4.762	2.36e-06 ***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 46060 on 657 degrees of freedom
(3 observations deleted due to missingness)
Multiple R-squared: 0.5698, Adjusted R-squared: 0.5652
F-statistic: 124.3 on 7 and 657 DF, p-value: < 2.2e-16

Although the gathered data includes facade variables, they were excluded in the model because they do not yield meaningful results. As shown in Table 5.3, only seven variables are used to run the model. According to the hedonic price model, based on the t-test all variables are significant, since all t-values are bigger than the absolute value of 1.64. One of the reasons for the results not being logical is that the importance of facade orientation has decreased nowadays when buildings are jacketed against winter colds and people increasingly use air conditioning during the summer.

The other test which helps to understand how the model works is the R^2 test. If the R^2 value is bigger than 0.5 this also makes the model valid in terms of this study. The R^2 value calculated for this model is R^2=0.5667. This means that all variables together have a 56% impact on the price of the housing units. In conclusion, related t and R^2 values are significant on multiple linearity.

The price of housing units calculated with the hedonic price model is as follows;

$$\begin{aligned} Price = {} & 145{,}653.29 - 50.87 \times Distance - 3{,}870.72 \times age + 602.13 \\ & \times size + 18{,}514.33 \times \#room + 24{,}422.53 \times \#bathroom \\ & + 15{,}114.86 \times alaturka + 22{,}238.93 \times elevator \end{aligned} \tag{5.2}$$

Price is a dependent variable. All the variables are the characteristics that have an impact on the price of the housing unit.

The most important variable in this work is x1=straight line distance (meter) because it aims to calculate the impact of closeness to the metro station on property values.

The results of the model are as expected. The coefficient for distance is negative as expected, which means that as the distance of the apartment to the station increases the price decreases. According to the model an apartment that is one meter closer to the station is 50.87 TL more expensive when compared to an apartment with the same characteristics. To make it clearer it is possible to say, that if an apartment is 100 meter closer to the station it is at least 5,087 TL more expensive, provided that other variables are constant. In the following parts of this dissertation this straight line distance coefficient is used for the calculation of value increase taxation as holding the other factors constant.

According to the results of the model the coefficient for age is negative; this is also an expected result. As the age of the building increases the value of the apartments in that building decreases. The model shows that every year an apartment's value decreases by more than 3,000 TL. The number of bathrooms is also a variable which affects price. Addition of a bathroom makes the apartment approximately 24,000 TL more expensive. Again the existence of an elevator in the building increases the price by approximately 22,000 TL. As a cultural issue, the presence of an alaturka toilet increases the price by approximately 15,000 TL.

When the two models, one including and one excluding facades, are compared, we see that the coefficient of the distance variable is different. In the following part of the study the second model was used, excluding the impact of facades. It is important to say that in order to measure the impact of distance on the housing prices only, the impact of all other variables except distance have been ignored in this study.

6. CALCULATIONS AND RECOMMENDATIONS

In the final part of this study the value increase around the stations is calculated. The calculation methodology has been explained in Section 3. All stations are divided into 100 meter circular zones as seen in the Figure 6.1. Then all individual housing units are counted by using suitable computer software.

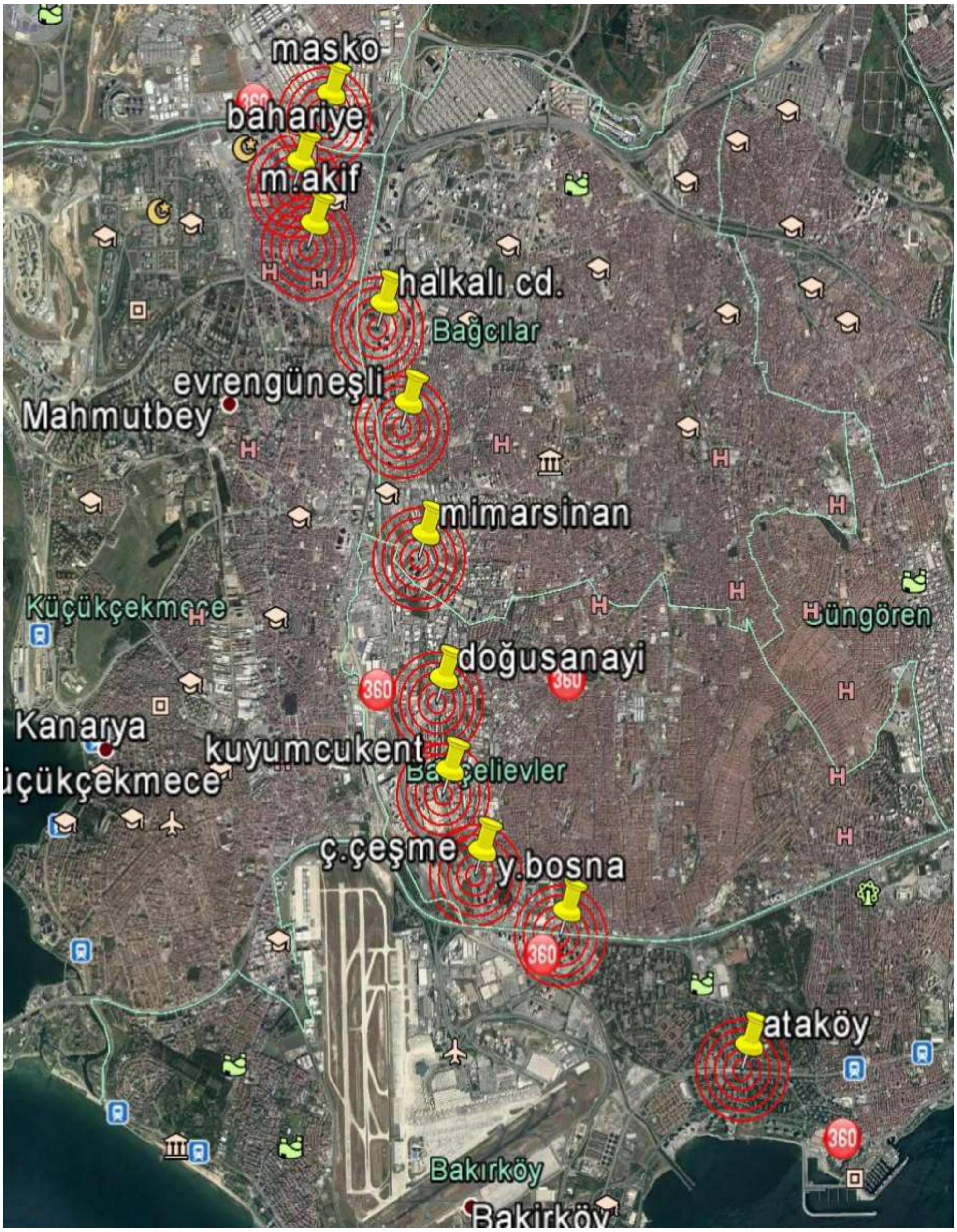


Figure 6.1 : 100-meters cirsular zones for each stations.

There are some stations whose zones partially overlap. In that case, the distance of the housing unit to the nearest station was used. As discussed in Section 3 , a 500 meter optimum walking distance was taken into consideration. The zones were divided into 100 meter zones. But as a buffer zone a 500-600 meter zone was also added to the calculation. Because the buffer zone added is 1/5th of the total 0-500 meter catchment area, the tax ratio in this zone will be 1/5 of the last 400-500 meter zone. In the following part, the stations will be discussed and number of housing units will be shown in tables. Data on building heights and number of apartments on one floor is collected from Google Maps street view and site inspections. The number of buildings was determined by counting and from data obtained from the questionnaire survey. The same methodology was applied to all stations on the Ikitelli-Ataköy corridor except for Ikitelli station, as it is an industrial area and contains no housing units.

Figure 6.2 shows the calculation of building numbers in Ataköy station. After this counting methodology, total number of individual housing units were calculated.

Figure 6.2 : Number of housing units around Ataköy Station.

The number of individual apartments per each 100 meter zone around Ataköy station are given in Table 6.1.

Table 6.1 : Number of apartments for Ataköy Station.

Station Name	0-100	100-200	200-300	300-400	400-500	500-600
Ataköy	192	1152	1824	3424	3360	4055

The number of individual housing unit around each station is collected. The total figure can be seen in the Table 6.2.

Table 6.2 : Total number of apartments for every station and each zone.

StationName	0-100	100-200	200-300	300-400	400-500	500-600
Ataköy	192	1152	1824	3424	3360	4055
Yenibosna	541	1109	501	2137	3323	4580
Çobançeşme	0	0	585	600	1000	2200
Kuyumcukent	0	0	120	736	1001	1472
Doğu Sanayi	0	238	370	1895	1270	1060
Mimarsinan	282	0	0	916	960	880
Evrengüneşli	256	1168	1488	3086	6029	8297
Halkalı Cd.	230	1267	0	607	900	1776
Mehmet Akif	1408	5104	7952	10976	8848	6144
Bahariye	1456	4096	9252	4544	4256	3936
Masko	0	0	1081	0	0	464
TOTAL	**4365**	**14134**	**23173**	**28921**	**30947**	**34864**

The calculation of tax based on the straight line distance will be discussed in the following part. As discussed in Section 3 and shown in Figure 3.4, there is an inverse ratio between distance and value increase. The highest value increase is expected to be in the first zone, namely the 0-100 meter zone. The average anticipated value for each zone is shown below.

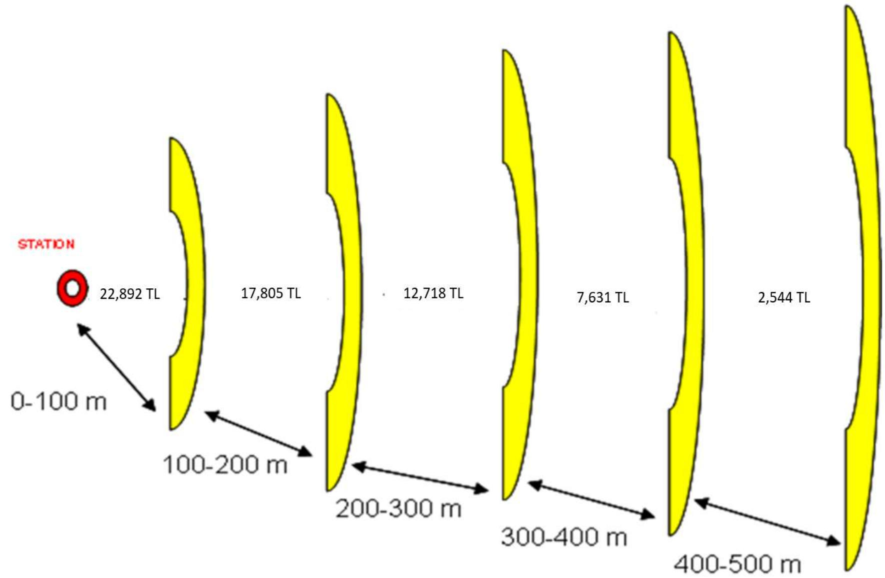


Figure 6.3 : Calculated average value increase for each zone.

This average value increase is calculated as follows.

0-100 meter zone 450m*50.87=22,892 TL

100-200 meter zone 350*50.87=17,805 TL

200-300 meter zone 250*50.87= 12,718 TL

300-400 meter zone 150*50.87=7,631 TL

400-500 meter zone 50*50.87= 2,544 TL

500-600 meter zone (buffer zone)2,544/5= 508.7 TL

The total value increase is calculated as shown in Table 6.3. This value is calculated by multiplying number of individual housing units in each zone with the average value increase for that zone. As it is seen in table 6.3 the total anticipated value increase is calculated as nearly one million TL.

Table 6.3 : Total value increase for each station in the corridor.

TOTAL VALUE INCREASE							
STATION NAME	0-100	100-200	200-300	300-400	400-500	500-600	TOTAL (TL)
Ataköy	4,395,168	20,510,784	23,196,720	26,126,832	8,546,160	2,062,779	84,838,443
Yenibosna	12,384,302	19,745,191	6,371,468	16,306,379	8,452,051	2,329,846	65,589,235
Çobançeşme	0	0	7,439,738	4,578,300	2,543,500	1,119,140	15,680,678
Kuyumcukent	0	0	1,526,100	5,616,048	2,546,044	748,806	10,436,998
Doğu Sanayi	0	4,237,471	4,705,475	14,459,798	3,230,245	539,222	27,172,211
Mimarsinan	6,455,403	0	0	6,989,538	2,441,760	447,656	16,334,357
Evrengüneşli	5,860,224	20,795,656	18,923,640	23,547,723	15,334,762	4,220,684	88,682,688
Halkalı Cd.	5,265,045	22,558,302	0	4,631,714	2,289,150	903,451	35,647,661
Mehmet Akif	32,231,232	90,874,168	101,129,560	83,752,368	22,504,888	3,125,453	333,617,669
Bahariye	33,330,024	72,927,232	117,662,310	34,672,992	10,825,136	2,002,243	271,419,937
Masko	0	0	13,747,618	0	0	236,037	13,983,654
			TOTAL				963,403,530

In the following part of the study, stakeholders and taxing methodology will be discussed.

6.1 Stakeholders

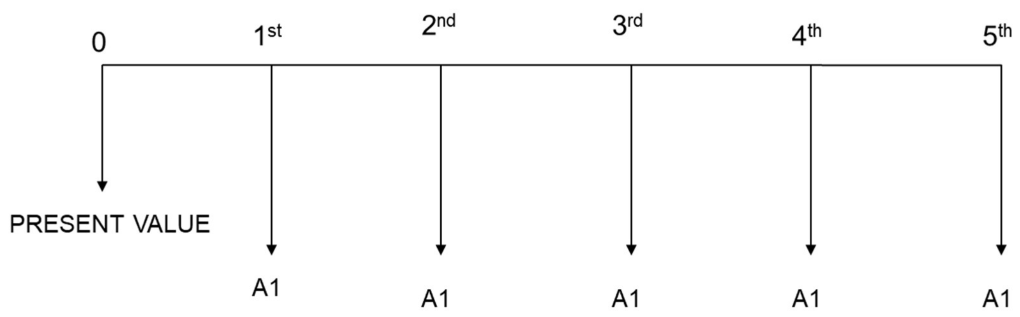
Stakeholders can be defined as the potential affected parties from the project or the individuals, organizations and/or the groups interested in the projects and their impacts. For this study it is important to identify stakeholders in advance, since one group of stakeholders are the input for this process as they are the property owners along İkitelli-Ataköy metro corridor, the second group of stakeholders includes the organizations which will take the action to implement the process. First group is the local communities and businesses around metro corridor. Second group of stakeholders can be grouped in national, provincial and local level. National level stakeholders include Grand National Assembly which will declare the metro corridor as a betterment area and legalize the value increase tax, Ministry of Transport and Infrastructure which is the key stakeholder since all railway projects are subject to Ministry's permit, Ministry of Environment and Urbanization which has the regulatory position for giving Environmental Impact Assessment permits for railway projects and permits for urban planning and the next stakeholder is The Treasury the governmental body provides the funding. Provincial level stakeholders are Istanbul Governorship, The Istanbul Metropolitan Municipality and its administrative units. The local level of stakeholders are local governorships, local municipalities and headman (muhtar). Besides those governmental institutions NGOs are also the primary stakeholders in this process such as Chamber of Engineers and Architects, Chamber of Urban Planners.

6.2 Taxing

In the usual railway project cycle local municipality starts planning the railway projects in coordination with The Istanbul Metropolitan Municipality. After getting first approval from Ministry of Transport and Infrastructure. Local Municipality continues with prefeasibility and preliminary project. After getting second approval from Ministry of Transport and Infrastructure local authority prepares final project and feasibility. After getting final approval from Ministry of Transport and Infrastructure and Treasury, the funding research starts. In this stage local authority, Ministry of Transport and Infrastructure and Treasury work together.

In the scope of this study during preparation of feasibility and preliminary projects, local authority will work on expected value increase in the project area. This will be done in local municipality level first and The Istanbul Metropolitan Municipality support local authority both financially and technically. Engineers, urban planners, mathematicians, statisticians, independent real estate agents, will form the project team and corporate real estate companies and the team will prepare a complementary report. During final approval from Ministry of Transport and Infrastructure, the experts will evaluate this report also. Those experts will be a core team composed by representatives from Ministry of Transport and Infrastructure, Ministry of Environment and Urbanization and Treasury. This team will evaluate the pre-study of local authorities. If they consider it necessary, they will make the study again. While searching fund for the project this report will be a pre-study for increased value taxation.

After getting final approval of the project, the project area will be declared as an urban betterment area and published in the official gazette. After calculation is finalized, the stakeholder group one will be informed officially. After the construction work finishes, the payment procedure will start. The local authority will be responsible to collect 50% of increased value in a special fund for financing railway projects. This money will be collected in 5 instalments through the annual real estate tax. The payment will not be the exact expected value increase. Since in5 years, there is possibility for money to lose its value due to economic instability. This value of money for 5 years will be calculated based on the interest rate of Turkish Central Bank. The value loss of the currency over time over a period of 5 years will be calculated and the instalments will be defined on the basis of this calculations. Figure 6.4 shows the payment calculation methodology. The payment methodology depends on the payers preferences. They may prefer to pay this debt at once with the calculated amount without paying the value of money 5 years. The other option is to pay this money with fewer numbers of instalments. The defined 5 years for repayment is derived from betterment tax (şerefiye) methodology applied previously in Turkey for property owners for their unearned increment resulted from public investments.



TOTAL=5A1

$$A = P\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right]$$

i=interest rate
n=number of years
P=present value
A=arithmetic gradient

Figure 6.4 : Tax payment calculation methodology.

The formula uses the annual interest rate based on the Turkish Central Bank's weighted average interest rates on commercial and consumer loans which is 12.23 on 3 January 2020. This rate is used as the interest rate for calculating the five year repayment plan for each zone.

The value increase, annual payment of tax and total amount of money that will be paid at the end of five years is shown in Table 6.4. For instance, the 0-100 meter zone will experience a value increase of 22,862 TL after the metro project starts operation. 50% of this amount which is 11,446 TL will be collected as value increase tax. The property owner will pay this amount over a year in five instalments of 3.193 TL. Taking into account the value loss of the currency by the end of the payment period as explained above, a total amount of 15,966 TL will have been paid.

Table 6.4 : Total payment for each zones.

Zones	Total value increase (TL)	Present value (TL)	Annual Payment (TL)	Total (TL)
0-100	22,892	11,446.00	3,193.34	15,966.72
100-200	17,805	8,902.00	2,483.59	12,417.94
200-300	12,718	6,359.00	1,774.11	8,870.55
300-400	7,631	3,815.00	1,064.35	5,321.77
400-500	2,544	1,272.00	354.88	1,774.39
500-600	1,016	508.00	141.73	708.64

6.3 Reason for 50% tax

There are many countries in the world that apply betterment taxes. Some of these countries were examined and in this study the procedure for Şerefiye Vergisi is accepted as the tax collection mechanism for Turkey. In the current discussions on rent increase and tax in Turkey it is proposed that property owners who enjoy a value increase in their property as a result of changes to the development plans pay a tax reflecting their value increase. Initially it was suggested that 70% of this rate would go to the government, and 30% of it would remain with the owner. But during the last discussions it was suggested that 100% of it should be paid to the government. This proposal has not yet been legalized, but the discussions continue and the subject is on the agenda of the Ministry of Environment and Urbanism. As discussed previously, in many countries the betterment tax is a form of funding for transport related projects.

In Switzerland, according to Article 5 of the Space Planning Law cantons have a right to collect land value increment. Cantons are obligated to collect a tax for value increment which resulted from public works. The minimum rate is 20% and can reach a figure up to 50%. The reason for charging this tax is a construction on a land or the sale of the land. The revenue generated is used for expropriation costs, the protection of agricultural land and the effective use of construction sites and arable lands. In Austria after new regulations in 2012 all real estates became subject to land value increment tax. The tax ratio for the increased value was determined as 30% in 2016 (Kılıçarslan and Yavan, 2017).

Although betterment tax discussions started in 2015, there were some earlier applications in Turkey which came into force but were subsequently withdrawn. The betterment tax came into force in 1948 with the Municipality Revenue Code Number 5237 by the name of Land Value Fee (Değerleme Resmi). According to this regulation, Land Value Fee was calculated based on the difference between the before and after selling price of the property. The rate of tax was 50% of this difference. This amount was to be paid in 5 instalments within 5 years. Payments were registered to the Land Office. If the property was sold within these 5 years, the corresponding tax had to be paid by the buyer. In 1978 the Prime Minister rejected the Land Value Fee on the basis that it is contrary to the Constitution. Subsequently in 1981 this regulation was removed from Municipality Revenue Code Numbered 2464 (Aslan, 2014).

There is another form of taxation in the Law for Development Planning and Control, Number 3194, called the Regulatory Partnership Share (Düzenleme Ortaklık Payı-DOP). This is a form of expropriation by municipalities for their rearrangements on land. In return of their public investments which are expected to increase the value of a property, municipalities can take up to 40% of the land without asking the owners for their consent. This 40% of land is used to enlarge and upgrade existing roads and provide new infrastructure services (Aslan, 2014).

In this study it is recommended that 50% of increased value should be collected from property owners. The rate can be regarded as very high but in this study the calculated maximum value increase is in the 0-100 meter zone, that is 22.892 TL, 50% of it being 11.446 TL. However, this model only takes into account the value impact of distance to a station. If the value increase is calculated with the R-Studio program with all variables, the expected actual increase will be more as shown below;

Value increase in the 0-100 meter zone:

235.000>>>>>>282.049 (47.049 TL)

115.000>>>>>>227.450 (112.450 TL)

175.000>>>>>>283.300 (108.300 TL)

The actual increase is more than the calculated 22.892 TL; the 50% tax amount to be paid is 11.446 TL.

In zone 100-200 meter the calculated value increase is 17.805 TL; the %50 tax to be paid is 8.902,50 TL.

150.000>>>>>251.211 (101.211 TL)

180.000>>>>>280.140 (100.140 TL)

175.000>>>>>252.988 (77.988 TL)

In zone 200-300 meter the calculated value increase is 12.718 TL, the %50 tax to be paid is 6.359 TL.

270.000>>>>>384.148 (114.148 TL)

150.000>>>>>262.867 (112.867 TL)

114.000>>>>>209.929 (95.929 TL)

In zone 300-400 meter the calculated value increase is 7.631 TL, the %50 tax to be paid 3.815,50 TL.

170.000>>>>267.015 (97.015 TL)

209.000>>>>280.193 (71.193 TL)

275.000>>>>290.654 (15.654 TL)

In zone 400-500 meter the calculated value increase is 2.544 TL, the %50 tax to be paid 1.272 TL.

160.000>>>>220.028 (60.028 TL)

150.000>>>>229.622 (79622 TL)

265.000>>>>275.271 (10.271 TL)

In the zone 500-600 the total tax to be paid is 508,7 TL. As can be seen in the figure above this zone too will experience an ultimate value increase. But whether or not to collect tax from this zone will be a joint decision of the local authority and the Ministry of Transport.

After charging 50% of the calculated distance based value increase, the total amount of fund collected will be 481.701.765 TL.

7. CONCLUSIONS

Transportation systems are one of the most important city investments that shape urban form by creating new land values, job opportunities increased global integration, enhancing mobility, reducing the greenhouse gas emissions and so on. Governments and local authorities have to make large investments in transportation systems with limited budgets that may require creative approaches in monetary regulations. City officials are seeking alternative funding models for railway projects. In this context, the possibility of betterment tax implementation in Turkey as an alternative funding mechanism has been examined in this study through the exemplary case of Istanbul. Istanbul, as the most populated city in Turkey, has been selected as a case study because of its large networks with budget constraints for further rail system projects. Furthermore, both speculative and real land value uplifts after an urban investment has long been observed in Istanbul. The starting point of this study was to prove the positive impact of metro projects on surrounding housing market in Istanbul, then propose a funding model using this increased value. In this study the hedonic price model is used. This is a model which is very commonly used methodology to estimate the response of housing market to any kind of urban infrastructure investments. However Istanbul has not been studied with the hedonic price model before. This is the most important contribution of this study to the literature by using Istanbul as a case study. This study is filling this gap and proposes an alternative scheme to fund large investments in the subway network to the literature.

7.1 Main Findings of The Study

Findings show that metro investments have positive impact on housing market around stations. It is indicated that this study in Istanbul impact of metro stations have similarities with the world cases. The results resemble with the literature that used heavy rail corridors to calculate the impact of rail on real estate market. This is an expected result for Istanbul due to late initiation of rail networks, residents trying to escape acute traffic problems prefers to live closer to railway stations. The hedonic price model is adopted to show the extent of impact of distance variable on housing values in Istanbul. The variables used for the model is site-specific. According to the model results of all variables are as expected. For instance; adding one more bathroom to the apartment increases the price approximately 24.000 TL, similarly adding one more bedroom increases the price 18.000 TL. The model results for this area shows that as the distance to the rail station decrease the value of apartment increases, with this result the distance variable has proven its validity with the high degree of significance in the t-stastics. Since being close to metro stations provides accessibility benefits, an apartment with exactly same characteristics to another but 100 meter closer to the station will experience approximately 5087 TL more selling price on average. Even though this study is site specific and the data is limited, the expected value increase cannot be underestimated. The value increase is expected to be at least 8.15% on average in zone 0-100 meter.

7.2 Future of this study and recommendations

This study shows to the policy makers with empirical analysis the existence and the scale of railway station impact on housing values in Istanbul.

This value increase is resulted by a public investment; without a public intervention this increased value of property will only be capitalized by property owners. As a policy part of this study, a form of betterment tax is recommended. Betterment tax methodology fits better for Istanbul and particularly for this case, as new development is not possible for this area meaning that the area is a fully built environment with very limited new developing area and, housing stuck is very young and newly built. Also the betterment tax is not a new concept for Turkey. It has been collected from property owners in return of their value increase until 1981. By this way the biggest limitation for rail system investments could be funded and further projects could be realized. The proposed tax is 50% of expected value increase due to locational factors which is the ratio of previous implementation of betterment tax in Turkey. This amount will be paid in addition to annual property tax, this also makes the payment and collection of tax easier to implement. This betterment tax will be collected from landlords who have apartments around railway station in return of their property value increase due to being closer to a station. It is also recommended to collect this tax on a special fund and only use it for rail system investments. Thence a funding source can be created for rail system investments and the burden on governments can be diminished by sharing some part of investment cost with people who utilize more of the project. As the tender price of selected Ikitelli-Ataköy metro line and the recommended betterment tax methodology is compared, the 21% of project investment cost can be covered only with value increase around stations.

This study can be an initial work for creating an alternative funding model for urban rail system investments for Istanbul and even for other cities in the developing part of the world.

However before going further some main issues should be investigated more and solved in short run to make this model work; One is the equal taxation of increased value. The economic power of people living around stations is not equal; some have the financial means to pay this tax, others do not. This might lead to the gentrification problem. If people who live in the station catchment area were not able to pay the tax, they would have to sell their apartments and move further away from stations. This will lead to the displacement of the residents from their homes and to the gentrification of the area. Those might be the biggest limitation for this methodology will face to. There might be public oppositions for this implementation in order to deal with these appraisals there should be very strong stakeholder information meetings. All procedures should be transparent and will not lead any doubt on people's minds. There should be a common approach and well-defined guidelines for each step of implementations. Furthermore if needed there should be different calculation methodologies for different stations which have different social formations. The calculation methodology, results and recommendations are not complete and binding, the exact opposite they are open for improvement for practical implementations. There has also been some limitations in this study, one is related to data gathering since there is not an official authority recording accurate data for housing the data collected via questionnaire survey with real estate agents because the officially declared value of the housing units are well below the real transactions. Thus, if this methodology is going to be implemented, there should be an official authority that describes a better methodology that records the housing data accurately. Also there should be another official authority that will monitor all process from the beginning for better rightness among affected parties.

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APPENDICES

APPENDIX A T-Tests for Mesuring Similarities of housing Attributes Between the Two Case Study Areas (Ataköy-İkitelli and Esenler-Kirazlı Rail Systems)

APPENDIX B T-Tests for Mesuring Similarities of Socio-Economic Characteristics Between the Two Case Study Areas (Ataköy-İkitelli and Esenler-Kirazlı Rail Systems)

APPENDIX A

Table A.1 : t-test for similarity tests between two case study areas on behalf of distance.

	Variable Name	Number of Observations	Mean	Standard Error	Standard Deviation	95 % Confidence Interval	
1st Line	distance	1,151	3.13119	0.029822	1.011753	3.072679	3.189702
2nd Line		665	3.344361	0.0266727	0.6878259	3.291988	3.396734
Combined		1,816	3.209251	0.0214073	0.9122625	3.167266	3.251237
Difference			-0.2131706	0.044165		- 0.2997902	-0.1265511

difference = mean(1st Distr.) - mean(2nd Distr.) t = -4.8267

Ho: difference = 0 degrees of freedom = 1814

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

Pr(T < t) = 0.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 1.0000

Table A.2 : t-test for similarity tests between two case study areas on behalf of price.

	Variable Name	Number of Observations	Mean	Standard Error	Standard Deviation	95 % Confidence Interval	
1st Line	price	1,151	396.841	6.78525	230.1991	383.5282	3.189702
2nd Line		665	275.8	2.708657	69.84974	270.4814	3.396734
Combined		1,816	352.5171	4.620103	196.8836	343.4558	3.251237
Difference			121.041	9.162007		103.0718	-0.1265511

diff = mean(0) - mean(1) t = 13.2112

Ho: diff = 0 degrees of freedom = 1814

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

Pr(T < t) = 1.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 0.0000

Table A.3 : t-test for similarity tests between two case study areas on behalf of age.

	Variable Name	Number of Observations	Mean	Standard Error	Standard Deviation	95 % Confidence Interval	
1st Line	*age*	1,151	5.468288	0.2557311	8.676034	4.966537	5.97004
2nd Line		665	6.772932	0.3181225	8.203613	6.148285	7.39758
Combined		1,816	5.946035	0.2000964	8.527018	5.553592	6.338479
Difference			-1.304644	0.4143264		-2.117251	-0.4920369

diff = mean(0) - mean(1)   t = -3.1488

Ho: diff = 0   degrees of freedom = 1814

Ha: diff < 0   Ha: diff != 0   Ha: diff > 0

Pr(T < t) = 0.0008   Pr(|T| > |t|) = 0.0017   Pr(T > t) = 0.9992

Table A.4 : t-test for similarity tests between two case study areas on behalf of size.

	Variable Name	Number of Observations	Mean	Standard Error	Standard Deviation	95 % Confidence Interval	
1st Line	*size*	1,151	99.81234	0.9708	32.93574	97.9076	101.7171
2nd Line		665	103.5579	0.9246722	23.84507	101.7423	105.3735
Combined		1,816	101.1839	0.7034314	29.97641	99.8043	102.5635
Difference			-3.745558	1.457874		-6.604847	-0.8862687

diff = mean(0) - mean(1)   t = -2.5692

Ho: diff = 0   degrees of freedom = 1814

Ha: diff < 0   Ha: diff != 0   Ha: diff > 0

Pr(T < t) = 0.0051   Pr(|T| > |t|) = 0.0103   Pr(T > t) = 0.9949

Table A.5 : t-test for similarity tests between two case study areas on behalf of number of rooms.

	Variable Name	Number of Observations	Mean	Standard Error	Standard Deviation	95 % Confidence Interval	
1st Line	*rooms*	1,151	3.13119	0.029822	1.011753	3.072679	3.189702
2nd Line		665	3.344361	0.0266727	0.6878259	3.291988	3.396734
Combined		1,816	3.209251	0.0214073	0.9122625	3.167266	3.251237
Difference			-0.2131706	0.044165		-0.2997902	-0.1265511

diff = mean(0) - mean(1) t = -4.8267

Ho: diff = 0 degrees of freedom = 1814

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

Pr(T < t) = 0.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 1.0000

Table A.6 : t-test for similarity tests between two case study areas on behalf of number of bathrooms.

	Variable Name	Number of Observations	Mean	Standard Error	Standard Deviation	95 % Confidence Interval	
1st Line	*baths*	1,151	1.227628	0.0126663	0.4297233	1.202776	1.25248
2nd Line		665	1.15188	0.3591744	0.0139282	1.124531	1.179228
Combined		1,816	1.19989	0.0095473	0.4068558	1.181165	1.218615
Difference			0.0757485	0.0197431		0.0370269	0.11447

diff = mean(0) - mean(1) t = 3.8367

Ho: diff = 0 degrees of freedom = 1814

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

Pr(T < t) = 0.9999 Pr(|T| > |t|) = 0.0001 Pr(T > t) = 0.0001

Table A.7 : t-test for similarity tests between two case study areas on behalf of alaturka.

	Variable Name	Number of Observations	Mean	Standard Error	Standard Deviation	95 % Confidence Interval	
1st Line	*alaturka*	1,151	0.4257168	0.0145806	0.4946661	0.3971093	0.4543243
2nd Line		665	0.7142857	0.0175315	0.452094	0.679862	0.7487095
Combined		1,816	0.5313877	0.0117132	0.4991513	0.508415	0.5543604
Difference			-0.2885689	0.023357		-0.3343785	-0.2427594
		diff = mean(0) - mean(1)			t = -12.3547		
		Ho: diff = 0		degrees of freedom = 1814			
		Ha: diff < 0		Ha: diff != 0		Ha: diff > 0	
		Pr(T < t) = 0.0000		Pr(|T| > |t|) = 0.0000		Pr(T > t) = 1.0000	

Table A.8 : t-test for similarity tests between two case study areas on behalf of corner.

	Variable Name	Number of Observations	Mean	Standard Error	Standard Deviation	95 % Confidence Interval	
1st Line	*corner*	1,151	0.3727194	0.0142585	0.4837385	0.3447438	0.4006949
2nd Line		665	0.2120301	0.0158624	0.4090537	0.1808835	0.2431766
Combined		1,816	0.3138767	0.0108929	0.4641947	0.2925128	0.3352405
Difference			0.1606893	0.0222998		0.1169533	0.2044253
		diff = mean(0) - mean(1)			t = 7.2059		
		Ho: diff = 0		degrees of freedom = 1814			
		Ha: diff < 0		Ha: diff != 0		Ha: diff > 0	
		Pr(T < t) = 1.0000		Pr(|T| > |t|) = 0.0000		Pr(T > t) = 0.0000	

Table A.9 : t-test for similarity tests between two case study areas on behalf of south.

	Variable Name	Number of Observations	Mean	Standard Error	Standard Deviation	95 % Confidence Interval	
1st Line	south	1,151	0.2406603	0.0126058	0.4276702	0.2159273	0.2653933
2nd Line		665	0.6045113	0.0189751	0.4893235	0.5672528	0.6417698
Combined		1,816	0.3738987	0.0113569	0.4839705	0.3516247	0.3961727
Difference			-0.363851	0.0219783		-0.4069564	-0.3207455

diff = mean(0) - mean(1) t = -16.5550

Ho: diff = 0 degrees of freedom = 1814

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

Pr(T < t) = 0.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 1.0000

Table A.10 : t-test for similarity tests between two case study areas on behalf of west.

	Variable Name	Number of Observations	Mean	Standard Error	Standard Deviation	95 % Confidence Interval	
1st Line	west	1,151	0.0834057	0.0081534	0.2766147	0.0674086	0.0994029
2nd Line		665	0.1172932	0.0124871	0.3220116	0.0927743	0.1418121
Combined		1,816	0.095815	0.0069089	0.2944184	0.0822648	0.1093652
Difference		-0.0338875	0.0143227			-0.0619782	-0.0057968

diff = mean(0) - mean(1) t = -2.3660

Ho: diff = 0 degrees of freedom = 1814

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

Pr(T < t) = 0.0090 Pr(|T| > |t|) = 0.0181 Pr(T > t) = 0.9910

Table A.11 : t-test for similarity tests between two case study areas on behalf of north.

	Variable Name	Number of Observations	Mean	Standard Error	Standard Deviation	95 % Confidence Interval	
1st Line	*north*	1,151	0.2302346	0.0124141	0.4211659	0.2058777	0.2545914
2nd Line		665	0.0345865	0.0070913	0.1828675	0.0206624	0.0485105
Combined		1,816	0.1585903	0.0085744	0.3653942	0.1417736	0.175407
Difference			0.1956481	0.0172001		0.1619141	0.2293821
		diff = mean(0) - mean(1)			t = 11.3749		
		Ho: diff = 0		degrees of freedom = 1814			
		Ha: diff < 0		Ha: diff != 0		Ha: diff > 0	
		Pr(T < t) = 1.0000		Pr(|T| > |t|) = 0.0000		Pr(T > t) = 0.0000	

Table A.12 : t-test for similarity tests between two case study areas on behalf of elevator.

	Variable Name	Number of Observations	Mean	Standard Error	Standard Deviation	95 % Confidence Interval	
1st Line	*elevator*	1,151	0.7958297	0.0118866	0.4032692	0.7725079	0.8191516
2nd Line		665	0.2285714	0.0162958	0.4202286	0.196574	0.2605689
Combined		1,816	0.5881057	0.0115527	0.4923117	0.5654478	0.6107636
Difference			0.5672583	0.0199492		0.5281325	0.6063841
		diff = mean(0) - mean(1)			t = 28.4351		
		Ho: diff = 0		degrees of freedom = 1814			
		Ha: diff < 0		Ha: diff != 0		Ha: diff > 0	
		Pr(T < t) = 1.0000		Pr(|T| > |t|) = 0.0000		Pr(T > t) = 0.0000	

APPENDIX B

Table B.1 : t-test for similarity tests between two case study areas on behalf of the population.

	Variable Name	Number of Observations	Mean	Standard Error	Standard Deviation	95 % Confidence Interval	
1st Line	*population*	17	32030.18	2843.09	11722.36	26003.1	38057.26
2nd Line		13	35374.92	5832.193	21028.27	22667.67	48082.18
Combined		30	33479.57	2953.138	16175	27439.72	39519.41
Difference			-3344.747	6031.944		15700.62	-9011.13

diff = mean(1) - mean(2) t = -0.5545

Ho: diff = 0 degrees of freedom = 28

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

Pr(T < t) = 0.2918 Pr(|T| > |t|) = 0.5836 Pr(T > t) = 0.7082

Table B.2 : t-test for similarity tests between two case study areas on behalf of the population density.

	Variable Name	Number of Observations	Mean	Standard Error	Standard Deviation	95 % Confidence Interval	
1st Line	*Population_density*	17	60.46765	4.794787	19.76941	50.30315	70.63214
2nd Line		13	30.70077	7.298652	26.31566	14.79837	46.60317
Combined		30	47.56867	4.923648	26.96793	37.49868	57.63866
Difference			29.76688	8.402675		12.55478	46.97898

diff = mean(1) - mean(2) t = 3.5425

Ho: diff = 0 degrees of freedom = 28

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

Pr(T < t) = 0.9993 Pr(|T| > |t|) = 0.0014 Pr(T > t) = 0.0007

Table B.3 : t-test for similarity tests between two case study areas on behalf of the average age.

	Variable Name	Number of Observations	Mean	Standard Error	Standard Deviation	95 % Confidence Interval	
1st Line		17	30.62588	.2625778	1.082636	30.06924	31.18252
2nd Line	*Average_age*	13	32.73615	1.24554	4.490858	30.02236	35.44995
Combined		30	31.54033	.580896	3.181698	30.35227	32.7284
Difference			-2.110272	1.124377		-4.41345	.1929104

diff = mean(1) - mean(2) t = -1.8768

Ho: diff = 0 degrees of freedom = 28

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

Pr(T < t) = 0.0355 Pr(|T| > |t|) = 0.0710 Pr(T > t) = 0.9645

Table B.4 : t-test for similarity tests between two case study areas on behalf of the schooling years.

	Variable Name	Number of Observations	Mean	Standard Error	Standard Deviation	95 % Confidence Interval	
1st Line	*Schooling_year*	17	7.230588	.0747322	.3081288	7.072163	7.389013
2nd Line		13	8.497692	.5416572	1.952973	7.317523	9.677862
Combined		30	7.779667	.2606709	1.427753	7.246535	8.312799
Difference			-1.267104	.4788091		-2.2479	-.286308

diff = mean(1) - mean(2) t = -2.6464

Ho: diff = 0 degrees of freedom = 28

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

Pr(T < t) = 0.0066 Pr(|T| > |t|) = 0.0132 Pr(T > t) = 0.9934

Table B.5 : t-test for similarity tests between two case study areas on behalf of the university education.

	Variable Name	Number of Observations	Mean	Standard Error	Standard Deviation	95 % Confidence Interval	
1st Line	*University_education*	17	8.747059	.3497328	1.441985	8.005658	9.488459
2nd Line		13	17.24154	3.696397	13.32755	9.187781	25.2953
Combined		30	12.428	1.760454	9.642404	8.827467	16.02853
Difference			-8.49448	3.239586		-15.1305	-1.85848

diff = mean(1) - mean(2) t = -2.6221

Ho: diff = 0 degrees of freedom = 28

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

Pr(T < t) = 0.0070 Pr(|T| > |t|) = 0.0140 Pr(T > t) = 0.9930

Table B.6 : t-test for similarity tests between two case study areas on behalf of the household size.

	Variable Name	Number of Observations	Mean	Standard Error	Standard Deviation	95 % Confidence Interval	
1st Line	*Household_size*	17	4.016	.0336592	.1387804	3.944646	4.087354
2nd Line		13	3.672308	.144702	.5217304	3.357029	3.987586
Combined		30	3.867067	.0714768	.3914946	3.72088	4.013253
Difference			.3436923	.1316433		.0740333	.6133513

diff = mean(1) - mean(2) t = 2.6108

Ho: diff = 0 degrees of freedom = 28

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

Pr(T < t) = 0.9928 Pr(|T| > |t|) = 0.0143 Pr(T > t) = 0.0072

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