EVALUATION OF REGIONAL RAILWAY INVESTMENT WITH URBAN DEVELOPMENT DYNAMICS: THE CASE OF IZBAN IN IZMIR

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ABSTRACT

INTEGRATION OF RAILWAY INVESTMENT WITH URBAN DEVELOPMENT DYNAMICS: THE CASE OF IZBAN IN IZMIR

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With the technological developments, railway transportation has become an important part of urban transport. Besides increasing the accessibility in the city, the railway creates demographic, economic, and spatial effects. In planning, railways are used to increase or direct urban development. This study evaluates the railway investment as an exogenous effect on the city. Furthermore, this study examines the railway's as a complementary factor of the urban development trends. Urban development is analyzed with two main factors; population and employment. When the urban development in the city of Izmir between the years 2009 and 2019 is examined, it is observed that population and employment were decentralized from the metropolitan region to the north and south subregions which IZBAN serves; in addition, while sectors such as industry and agriculture are decentralized in sectoral employment in the metropolitan area, it is observed that the service sector is concentrated. Neighborhoods within the Izban impact area (IZBAN neighborhoods) and outside the IZBAN impact area (non-IZBAN neighborhoods) were compared based on population and employment changes. At the same time, the increase in employment in the metropolitan area was

concentrated around the station, both population and employment change in the north and south sub-regions. There is a significant difference between IZBAN non-IZBAN neighborhoods. As the distance to the station decreased in the north and south subregions, employment increased, and employment intensified around the station. It has accelerated the suburbanization around the north and south sub-regions.

Keywords: Urban Transportation, Suburban Rail, Urban Development, Employment Distribution, Population Change

ÖZ

DEMİRYOLU YATIRIMLARININ KENTSEL GELİŞİM DİNAMİKLERİ İLE ENTEGRASYONU: İZMİR KENTİ İZBAN ÖRNEĞİ.

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Demiryolu ulaşımı teknolojik gelişmelerle birlikte kentsel ulaşımın önemli bir parçası olmuştur. Demiryolu kentte erişilebilirliği arttırması ile birlikte demografik, ekonomik ve makansal bir çok etki oluşturmaktadır. Planlama alanında kentsel gelişimi arttırmak yada yönlendirmek için bir araç olarak kullanımı artmaktadır. Bu çalışmada demiryolu yatırımı kent üzerinde dışsal bir etki olarak değerlendirilmiştir. Ayrıca bu çalışma, demiryolunun kentsel gelişim eğilimlerinin tamamlayıcı bir faktörü olarak incelenmektedir. Çalışmada kentsel gelişim, nüfus ve istihdam olmak üzere iki ana faktörle analiz edilmiştir. 2009-2019 yılları arasındaki İzmir kenti gelişimi, metropoliten bölgeden İZBAN'ın hizmet verdiği kuzey ve güney altbölgelere doğru decentralize olmuştur. Ayrıca metropoliten alanda sanayi ve tarım gibi sektörler decentralize olurken hizmet sektörü ise yoğunlaşmıştır. İZBAN etki alanı içerisindeki mahalleler (İZBAN mahalleleri) ve İZBAN etki alanı dışındaki mahalleler (İZBAN-dışı mahalle) nüfus ve istihdam değişimi üzerinden karşılaştırılmıştır. Metropoliten alanda istihdam artışı yoğunluklu olarak istasyon çevresinde gerçekleşirken, kuzey ve güney altbölgelerde ise hem nüfus hem de istihdam değişimi İZBAN mahalleleri ile

İZBAN dışı mahallerde belirgin bir şekilde farklılaşmıştır. Kuzey ve güney altbölgelerde istasyona olan mesafe azaldıkça istihdam artmış ve istasyon çevresinde istihdam yoğunlaşmıştır. İZBAN sistemi kuzey ve güney altbölgelerde ise istasyon çevresinde istihdam ve nüfus yoğunluğunu arttırarak kentleşmeyi arttırmıştır.

Keywords: Kentsel Ulaşım, Banliyö Treni, Kentsel gelişim, İstihdam Dağılımı, Nüfus Değişimi

To My Family

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CHAPTER 1

INTRODUCTION

The concentration of production, trade, and services in the urban area has increased the urban population. Accordingly, it has increased the spatial growth in cities and the spread towards the city periphery. Especially after the industrial revolution, urban growth has begun in many cities. With the development of motor vehicles, transportation opportunities have increased, and accordingly, there has been an increase in transportation distances. Accessibility problems have emerged, especially in metropolitan cities. Therefore, traffic, increasing environmental pollution, and the rising cost of transportation has been one of these cities' main problems.

The clustering of working, production and accommodation areas has decreased the transportation distances for business and daily activities. On the contrary, the transportation distances and invasion of natural spaces increase due to the urban sprawl. Besides, access to accommodation and activity areas gradually gets more complicated. The most optimal solution of this trip generation between the regions has also become one of the essential agenda topics of the city. The public transportation system is seen as the most effective method to meet this transportation demand in cities. To ensure transportation sustainability, determining the type of public transportation according to the distances and the number of passengers is crucial. Since rubber-tired public transportation types generally trip on the highway, they cause traffic congestion, thus increasing the transportation time.

On the other hand, railways are a better alternative for solving the transportation problem in densely populated and congested cities. The railways generally proceed on a separate route from the traffic, and the passenger capacity is higher than the

rubber-tired public transport. However, with the rapid increase in urban spatial growth and population, alternative railway types such as tram and metro can serve mainly within the borders of metropolitan areas. However, they cannot serve sub-regions and city peripheries. On the other hand, regional trains with higher passenger capacity and speed provide access to the metropolitan area and satellite cities along with sub-regions. For this reason, investments in suburban railways have been growing recently, especially in large-scale cities. The accessibility opportunities around the station cause spatial, economic, and demographic changes. The changes brought about by accessibility directly or indirectly affect the workplace and residential location choices of the urban space.

With the development of transportation technologies in Turkey, transportation distances have increased, and urban sprawl has occurred in many cities. Especially the formation of sub-regions in metropolitan cities and the spatial growth in the city peripheries can be seen as the results of this sprawl. Izmir is one of the places where these sprawls occur, especially with the effect of being a city region. While the metro and tram systems serve in the east-west direction of the city, the need for access to the sub-centers in the north-south direction of the city has become inevitable. With the protocol signed between the local government and the Republic of Turkey State Railways, a suburban railway was established, with the existing regional train being modernized. In this way, the accessibility of the central region of the city and the sub-regions on the north-south line has been increased. After the establishment of IZBAN, it was seen that similar agreements were also made in Istanbul and Ankara.

In the planning stage, integration of transportation investments with the existing urban growth supports and stimulates the development of urban growth. For this reason, conformity between the realized investment decision and the current growth trend is crucial. Besides, these investment decisions should be consistent with the city vision. By the information above, the urban growth dynamics of Izmir between 2009-2019 and its relationship with IZBAN are revealed in this study. Furthermore, whether it has a complementary role in this growth is also measured.

The second chapter examines the short history of the railway and its development over time. Additionally, the differences of the suburban railway from other railway types, the historical development of the railway, and the existing suburban railways in Turkey are examined. This study also mentions the short history of railway development in Izmir. The third chapter investigates the railway's spatial, economic, and environmental effects on the city. The main subjects of the study are the impact of the railway investment on economic growth, property values, spatial changes, sustainability, urban form, and population. Concerning these general impacts, the city center's decentralization and suburbanization of the city periphery are associated with one another.

The fourth chapter mentions the general characteristics of Izmir. In 10 years, employment and population change occurred throughout the city. Izmir's plans' decisions about urban growth are compared with the existing urban growth. To what extent the plan's decisions about transportation is applied is observed. In the fifth chapter, the methodology of the research is explained. In the study, quantitative analysis was conducted with the number of workplaces, employees, type of business, and address information obtained from the social security institution for 2009 and 2019. In the last chapter, tests and findings prepared according to the hypotheses are given.

CHAPTER 2

RAILWAY TRANSPORTATION

The rapid population growth in ties results in spatial growth, affecting citizens' transportation habits. With these changes, improving urban transportation becomes an essential agenda for cities. Private vehicle ownership, which has increased rapidly in cities, has led to denser traffic congestion, environmental pollution, noise, etc. To solve these problems, railway transportation types such as metro, suburban train, and high-speed train with high passenger capacity and speed are increasing.

This chapter explains the change and development of railways in the historical process, the definition of the suburban railway, and how it differs according to other railway transportation types. In addition, the historical development of the railway in Turkey and the current railways in the province of Izmir are described.

2.1. Historical Development of Railway Transportation

The first line was opened between Wandsworth and Croydon in the suburbs of London in 1801 when the first chartered carriage line was decommissioned (Dempsey,2002). The first railway in the USA, Baltimore, and Ohio, began its operation in 1819. City railways, which replaced horse-drawn carriages, became an important mode of transit. The steam-powered subway was introduced in London in 1843, the elevated railroad in New York City in 1867, the electric streetcar in 1888, and the first American subway in Boston in 1897 (Heath, 1957).

Until the steam-powered railway was established in the 17th century, there was no significant development in the railways. The first modern railway was established

in Great Britain, with the discovery of the steam-power. The railways had two different uses in that period. One of it freight transport, which was found to transport the raw materials required with industrialization and ensure the product's access to the market. Another was light rail systems that provided passenger transportation by moving on a fixed rail used in urban transport (Teodorovic & Janic, 2016). The main differences between these two types of railways were their scales and the energies they used. While the freight trains served with coal and steam power, the trams were powered by animals and human power. With the invention of electrically powered railways in 1863, ıt was used for the first time in 1881. With this development, the existing railway lines were also electrified. In this way, the railway has become a more effective and efficient type of transportation. It works with electrical energy instead of human and animal power.

With globalization, the whole world has entered the process of producing similar products and services. Thus, international competition has increased. Places with logistic opportunities and capabilities required to transport the services and products to the market have become more advantageous. This competitive environment in world trade has led to transformations in logistics and transportation (Çekerol & Nalçakan, 2011). Although the railway causes very high costs at the investment stage, these costs decrease after the operation phase. With the increased detrimental effect (traffic density, accidents, noise pollution, etc.) of the highway, railway transportation investments have become more preferred in cities. (Thompson, 2013). In the same period, the types that provide rail passenger transportation like mass rapid transit, high-speed train, suburban rail, monorail, and light rail transit (LRT) have increased. These new types increase accessibility and mobility and reduce traffic congestion in cities (Zakaria et al., 2010).

2.2. Historical Development of Suburban Rail

The emergence and development of suburban railways are directly related to the historical development of cities. Towards the end of the 19th century, urbanization

increased rapidly with the large population movements from rural to urban areas (Bodo, 2019). This population movement accelerated towards the middle of the 20th century, and urban development increased. Today, these developments are observed more prominently in developing countries. In developed countries, demographic and spatial redistribution occurred between 1970 and 1990. In developing countries, this change has emerged after 1990. This movement caused, rapid increase in pollution, traffic, and real estate values with the dense population and construction in the city center. In addition, the rise in motor vehicle ownership has increased the trip distance. Thus, suburban regions began to form in areas far from the city center and closer to the city periphery, which did not include some handicaps the city centers had.

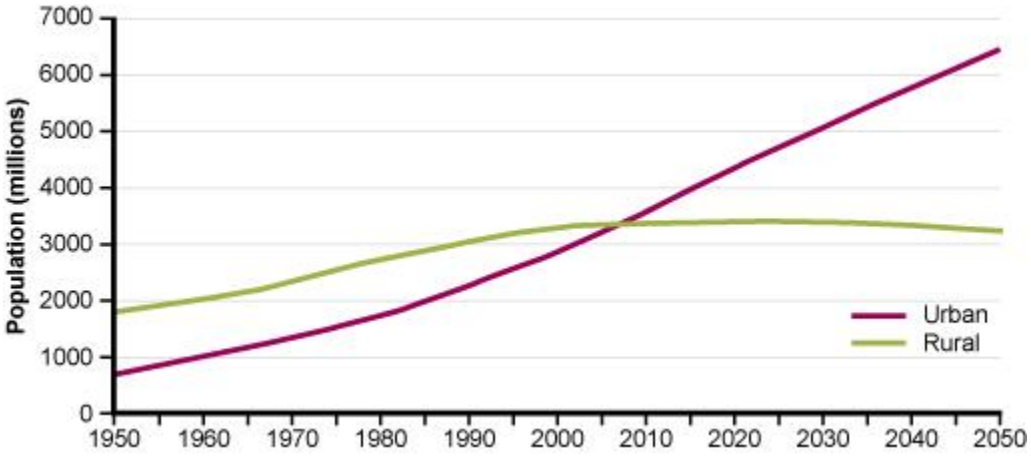

Figure 1: Urban and Rural Population of the World, 1950-2050 (UNDESA,2014)

With the enlarge in the distance between the activities and residential areas, trip distances and the dependence on motor vehicles have increased. Urban transportation and environmental problems have also come out with the reliance on motor vehicles. Thus, the importance of public transportation investments between the city center and suburban areas became more evident. In addition to the systems serving the inner city, the suburban railway has emerged as the type of railway that provides access to the suburban areas. The difference of this type from the tram and metro serving the city is that it serves longer distances. The distance between

stations is higher. It generally uses the existing freight train line, and its speed is higher than the urban railways. It also has a higher passenger capacity than urban rail systems (Nelson et al., 2019). With the suburban line investments, the adverse effects of the urban sprawl process in the cities were reduced.

Comparison of Suburban Rail

Suburban rail is a railway that links suburban locations to city centers. Suburban rail generally operates in an existing freight rail right of way. Suburban rails offer less frequent service than LRT systems because of their right of way with freight trains (Arndt et al., 2009). Suburban railway vehicles have a higher passenger capacity than the LRT system. The length of the route and the distance between the stations are higher than the LRT. In another study (Ganning et al., 2015), it is defined that suburban railway acts as rail system corridors that connect the city center or other important activity and business centers to suburban centers or settlements. Making the definition of the suburban line concerning the description of the suburb (Kurtz., 1958), it is defined that suburb is a residential area far from the city center and close to the city periphery. With this explanation, a suburban train is a connecting tool that combines the city center and the residential areas close to the periphery.

The energy source in suburban rails is electric, but diesel lines are seen in many North American cities. They are operated individually or as trains pulling multiple units or locomotives (Vuchic, 2007). Suburban trains typically run-on existing freight rail lines, often facilitating business trips between the city center and suburban areas. Although the passenger capacity is higher than the light rail system, the frequency is lower as it shares the rail network with freight trains. trip frequency increases during peak hours. (Arndt et al., 2009).

Most suburban networks serve between central business districts and suburbs. The stations of the suburban rails passing through the city center are usually combined with the intercity train stations and the transfer station in the area close to the city

center. Cities such as Chicago, London, Moscow, New York, and Philadelphia are examples of cities served by suburban rail. (Vuchic, 2007).

2.3. Development of Suburban Railways in Turkey

In Turkey, with more emphasis on the highway in transportation policies, the highway length increased by 80% between 1950-1997. However, the length of the railway increased only 11%. In the same period, the share of railways in passenger transportation decreased from 22% to 2% (Aydemir, 2016).
1724 km of new railway lines were created between the years 2004 and 2013. The annual average construction of the railway increased from 16 km to 121 km between the periods 1950-2002 and 2003-2013 (Turkish State Railways 2019-2023 Strategic Plan, 2019).

The share of road transport in passenger transportation was around 50% in 1950 and increased to 97.8% in 2010. Although its rate decreased to 88% in 2017, this decrease in road transport is due to the increase in the share of airlines in passenger transport. In this period, as after 1950, the share of the passenger in railway decreased from 1.6 to 1. Investments for rail passenger transportation have increased, and accordingly, the number of rail passengers has also increased. However, this increase was lower than the increase in other types of transportation and the proportion of the railway in passenger transportation decreased according to the types of transportation.

Aydemir and Çubuk (2016) compared some countries according to the ratio between population and railway length. As a result of these comparisons, Turkey's railway length per 100,000 people has increased to 13 km. It has been observed that this value is higher than only China and India, which have a population of over 1 billion, among the countries which they compared in the research. As a result of these evaluations, despite the increase in railway investments in Turkey after the year 2000, the imbalance between transportation modes continued to increase. The

share of the railway in passenger transportation did not improve. It has been observed that the railway line length is lower than in the European countries.

There are three suburban lines in Turkey. One of them is located in Istanbul, which is the most populated city in Turkey, the second one in Ankara, the capital city of Turkey, and the third one is operated in Izmir. Gaziray suburban line, which is still under construction in Gaziantep and planned to be opened in 2022, is another line. When the years of operation are compared, the foundation of Başkentray reaches the end of the 19th century, which is the last period of the Ottoman Empire. While IZBAN started to operate in 2010 and Marmaray in 2013. In this section, Başkentray and Marmaray's projects will be briefly mentioned. Although suburban lines in Turkey are generally realized through the central government (TCDD), the IZBAN line is the first suburban line in Turkey to be recognized by the joint venture of central and local governments. The detailed information is given in the following chapters.

Ankara Başkentray Suburban Line

The first regular suburban services between Ankara and Kayaş were established in 1929 (Tekeli, 2010). It was formed by the renewal and rearrangement of the 37 km section of the Anatolian-Baghdad line, which is connected to the state railways, on the line passing through Ankara in the east-west direction (Baykan, 2009). It connected the city center to the villages and small settlements in the east and west in the 1930s, and this line only fridays were used to provide urban residents access to the rural landscape. These regions were not settlements on a scale that could be called suburban, so it is observed that the Sincan-Kayaş line directs the urban development rather than increasing the access between the center and the suburban areas (Emiroğlu & Uzmay, 2013). With the rapidly growing migration from rural to urban areas after 1950, squatter settlements increased, especially in the east of Mamak, around the railway. In the following years, areas with different land use began to form in the western part. Atatürk Forest Farm as a recreation area in the west, industrial regions of the far west, and Etimesgut and Sincan settlements in

further west began to form (Özdemir & Demirkol 2014). In 2016, the modernization works of the line between Sincan and Kayaş started, and the capacity, the number of stops, and the line's speed were increased.

Marmaray Suburban Line

Under the Marmara Sea with tube passages, the Marmaray project combines two suburban lines, Haydarpaşa-Gebze on the Anatolian side and Sirkeci-Halkalı on the European side. This project aims to increase the modernization speed, comfort, and the number of services of the two existing suburban lines. Also, it increases the accessibility between the European and Anatolian sides of Istanbul by combining these two lines. The total length of the line is 76 km, and it serves 43 stations in total. It is integrated with the other transportation types at (Gebze, Halkalı, Bakırköy, Pendik, Bostancı, and Söğütlüçeşme stations).

The trip generation estimation studies for the Marmaray Project date back to 1985. It was revised parallel with the city's development in 1996 Istanbul Transportation Master Plan (IUAP). With the data collected in 2002 and 2003, The transportation model designed for Marmaray was updated. It is estimated that the total number of daily journeys in 2025 will be approximately 1,700,000 passengers. In 2025, it is predicted that the maximum number of passengers using the system will be about 75,000 in one direction per hour, and the total number of hours earned in a year for all passengers will be 36 million hours (Keski, 2014).

2.4. Historical Development of Railway in Izmir

Izmir has been an important city for transportation throughout history due to its geopolitical location. (Izmir Metropolitan Municipality, 2021). In the second half of the 19th century, with the initiative of British investors, the Izmir-Bandırma-Afyonkarahisar line connecting Izmir and the surrounding provinces was established. The primary establishment purpose of this line is to increase the

market area of the port. The railway was not used for passenger transport but rather for freight transport in this period. (Yazıcı, 1995).

The first highway investment was established in the 19th century between the Izmir peninsula and Seferihisar. Passenger transportation in the rail system started in the 19th century with the Alsancak-Konak line. It began with horse-drawn trams serving in the Konak-Guzelyalı direction in the following years. In the 1900s, technological developmaffectffected the rail systems, which used electrical systems instead of horses. Transportation investments made between 1930 and 1980 were generally realized as the development of highways or the opening of new roads. In the same period, the zoning of regions accelerated, but actions for public transportation were not carried out. Although the Izmir-Aydin highway reaches Ankara, it increases the accessibility to the city. Still, due to the inadequacy of the transportation infrastructure in the city, it has increased the transportation problems, especially in the city center. After 1984, the interest in railway investments increased, and it was seen as a way to reduce urban transportation problems. Developments in public transportation accelerated with the transfer of urban transportation services to another organization (ESHOT) in Izmir. With ESHOT's investments in trams and buses, the urban areas served by public transport have increased. (Şenbil, 2018a).

There are three types of rail systems serving passenger transportation in Izmir. The metro line was planned in the Izmir Transportation Master Plan in 1989. Between the years 2000-2012, the 20 km section started to serve. The line serves in the east-west direction of the metropolitan area; thus, reducing this region's dependence on motor vehicles. Another rail system in the city is the tram system. On the other hand, the tram extends along with the coastal areas, increasing the accessibility on the coast.

Figure 2. Izmir Metropolitan Municipality Railway Network Map (İzmir Metro, 2021)

As a result, the cities that became the center of production and consumption after the Industrial Revolution increased migration from the rural area to the city. The proportion of the population living in the urban area has increased. With the development of transportation technologies, growing investments in road transport infrastructure, and increasing the purchasing power of urban residents, there has been a significant increase in private vehicle ownership. Accordingly, traffic, air, and noise pollution have increased in cities, and infrastructure investments in transportation have become insufficient. With these developments, interest in public trans has increased.

Railway transportation, which has a high passenger capacity in public trantransit and is independent from traffic, has been one of the important alternatives for public transportation. Railway transportation is divided into light rail systems that

provide urban transportation services and regional trains that connect the city center to subregions or other centers. Suburban railways are in the group of regional trains, which are faster and have a higher passenger capacity than urban light rail systems. This type of railway provides public transport between the city center and the suburbs. Although the railway investments have increased the ed in the 21st century, the share of the railway in passenger transportation has decreased between 1950-2010. In addition to investments in high-speed trains, suburban investments that provide urban transportation also increase in metropolitan cities. Başkentray line was established in Ankara, Marmaray in Istanbul and IZBAN line was established in Izmir. IZBAN commuter line, which is integrated with the metro system serving the east-west direction in Izmir city center and the tramway serving the metropolitan coastal region, connects the metropolitan area to the north and south subregions.

CHAPTER 3

EFFECTS OF RAILWAY ON THE CITY

This chapter has examined the spatial, economic, and environmental effects of railway investments on the city. These effects have been studied in different scales, the findings of case studies investigating these effects have been evaluated, and comparisons have been made between the regions. At the end of this chapter, the railway's investment's impact on center decentralization and suburbanization is explained considering spatial, economic, and environmental effects.

3.1. The Impact of Railway Investments on the Economic Growth

Transportation is one of the essential activities required for economic activities. Many researchers assume that rail transport has a significant impact on economic development; they state that railways reduce transportation costs, expand markets, and accelerate the growth of modern industries (Fogel, 1964: Donaldson, 2010). Thus, railway investment increases the market's productivity, which is directly affected by this investment.

Studies examining the effects of railway transportation investments on the region's economy date back to the 1700s. Smith (1776) revealed that factors affecting market size are related to transportation facilities and labor force distribution. Cervantes (2013) investigated the effects of railway transportation on production output in the United States in the 19th century and stated that if there were no railways in the USA in the 9th century, the production output would decrease 9.6%. The railway's impact on urban economic development is examined through the railway's effects on productivity, employment, business activity, and investment (Forkenbrock & Weisbrod, 2001).

Around the station, land-use intensification and clustering increased. This concentration and clustering result in the aggregation of activities, ease access to services, transportation cost decreases, and productivity increases. Doubling the county-level density index, productivity increased by 6% nationwide (Haughwout, 2000).

The economic benefits of railway transportation are examined in two different categories as direct and indirect. When considering the immediate effect, it creates a multiplier effect in sectors directly related to the investments made in railway transportation, railway production, and the provision of services. For example, the construction firms' economic environment serving in establishing the railway line's station area and the workers to realize this investment is the section where railway investments directly affect the economy. The railway also indirectly affects the economy, reducing transportation and time-related expenditures with transportation investments. Convenience in access to the market increases inter-regional technical efficienfacilitatesilitates resource relocation. Ease of access to the labor force or the activity areas and ease of disseminating information and technologies also increase efficiency and facilitate the relocation (Zou et al., 2018). With the establishment of the railway, the new development areas around the station become the clustering place of many firms. Thus, new employment areas can be created in these fields. The increase in the property values and accessibility around the stations attracts the citizens to that area; thus, population density increases. New working areas move to stations; as a result of this increasing employment around station occur (Litman, 2009).

The way of studies deals with and classify the subject may also change. For example, the Europe report of the economic footprint of railway transport published by the Community of European Railway and Infrastructure Companies (CER) evaluates this issue with four subtitles. Operations within railway transport created direct effects. Upstream supplier relations led to indirect impacts. For example, the jobs and value-added depend on supply relationships with railway transport operations (e.g., manufacture of locomotives, maintenance, accounting,

etc.). Besides, the employment and value created through railway infrastructure investments (e.g., laying tracks or building tunnels) create indirect effects. Induced effects, also called "income effects," could be exemplified with the jobs and value-added created due to spending by those workers who, directly or indirectly, earn profits from railway transport. Broader effects include more widespread financial results connected to rail transport activities and infrastructure. For instance, agglomeration effects (spatial concentration effects), e.g., local business development, and local real estate markets labor and product market impacts produced by lower transport times or costs (Bennet, 2016)

In other studies, the effect of railway investments on GDP has been examined. It has been observed that there is generally a positive correlation between railway investments and GDP in these studies. In the research conducted by Yoshino and Abidhadjaev (2015) in Uzbekistan, it was observed that the GDP growth in the regions with railways was 1.8% higher when compared with the areas with railway transportation and the areas without railway transportation. Saatçioğlu and Orhan (2013), in their research, 1% improvement in Turkey's transport infrastructure, regional per capita income levels increase between %29 to %34. Also, many studies have been conducted predominantly in Far Eastern countries. In these studies, it has been observed that railway investments positively affect GDP. It has been revealed that railway transportation investments can also reduce urban-rural income differences (Banerjee et al., 2012: Liu et al., 2012). However, some studies have revealed that railway investments have a negative effect on GDP. For example, Shi (2018) analyzed the impact of the high-speed railway on GDP and observed that GDP per capita decreased against the region's rapid increase. Some studies reveal that the effect on GDP differs according to the railway route (Baum-Snow et al., 2013). GDP in each railway in the city center with radial routes built on urban centers increase GDP by 26%, each of the railways to be built in linear routes on city center observed that it reduced the GDP by 50%.

3.2. The Impact of Railway Transportation on Property Values Around Station

Location plays an essential role in choosing a place for firms and housing. The level of accessibility to employment and recreation areas within an urban area is crucial for location selection. Railway transportation investments increase access to the railway station's business areas and amenities. Accessibility improvements caused by transportation investment will result in a reduction in transportation costs and travel time. According to the classical urban land economics theory, there is an inverse proportion between transportation cost and property value. As the transportation cost increases, the land value decreases, and as the transportation cost decreases, the land value increases. In the research of Mulley and Du (2006), due to the increase in the distance to the CBD (Central Business District), transport costs also increase, decreasing property values. In such studies, the transfer cost is calculated from both the cost of the money paid and the time passenger spends on the trip.

Employment and income are other factors that affect the rise in property values (Yankaya & Çelik, 2016). The investment is created value with the increase in accessibility resulting from transport investment and a well-established connection with the rest of the urban area. The lands benefiting from transportation enhancement become more appealing for companies and housing units. In this case, the attractiveness of the station increases competition for location selection. This competition affects property values in the region.

Researches generally emphasize that railway investments affect the property values around the station positively. However, studies showed that investments in railways do not always have a positive effect. They show variability with the differentiation of the type of property and the type of railway. For instance, Cervero and Duncan (2002) observed the change of heavy rail (HR) and light rail (LR) modes of transportation on the values of residential properties around the station in their study in Los Angeles. As a result of the research, it was observed

that the heavy rail system increased the residential property values upatiby to 14.2%, while the light rail system decreased them by 15.2%.

Davouti (1993) investigated the effect of the light rail system on two different land-use values in his research conducted in the Tyne and Wear regions of England. According to the findings, it has been observed that the light rail system has a positive effect on the values of the house but affects the commercial uses negatively. These results clearly show us that the value change is different according to land use. The effect of the railway investment on the property value may change according to the determined working areas' socio-economic and cultural values. Nelson (1992) investigated the change in the heavy railway's property values in the low-income and high-income regions in his study in the Atlanta region. He observed that railway investment affected property values positively in low-income areas and negatively in high-income areas. As a result, as the railway investments generally increase the property values around the station, the property value's effect varies according to the type of selected railway, the determined land use, and the region's socio-economic differences.

In Izmir, Yankaya and Çelik (2016) named the research modeling the effect of public transportation investments on real estate values; they examined the impact of Izmir metro on the real estate values in its vicinity. They tried to measure the metro impact area by creating a belt around the station every 100 meters. As a result, for every 100 meters away from the station, an average of 955 dollars decrease in value occurs.

3.3. Environmental Effect of Railway

Recently, because of the rapid increase in world population and the uncontrolled consumption of resources, sustainability has been an essential issue on the world agenda. The meaning of sustainability is meeting the needs of the present without compromising future generations' ability to meet their needs. (United Nations,

2021). Sustainability is examined under three main headings: social sustainability, economic sustainability, and environmental sustainability. This section mentions the impact of rail transport investments on the city's ecological sustainability. 20% of the total CO_2 emission in the world is caused by transportation. When the distribution of transportation-related CO_2 emissions is examined, it is observed that the transportation-related CO_2 emissions are the highest with road transportation with 74%. It is observed that air transport is 11.6%, maritime transport is 10.6%, railway transport is 1%, and other transport types are 2.2%, respectively (International Energy Agency, 2020). As we can see from the International Energy Agency data, the impact of rail transport on CO_2 emissions from transport is shallow. Figure 3 shows CO_2 emission per passenger-km and per mode of transport between the years 2000-2014 (EEA,2009).

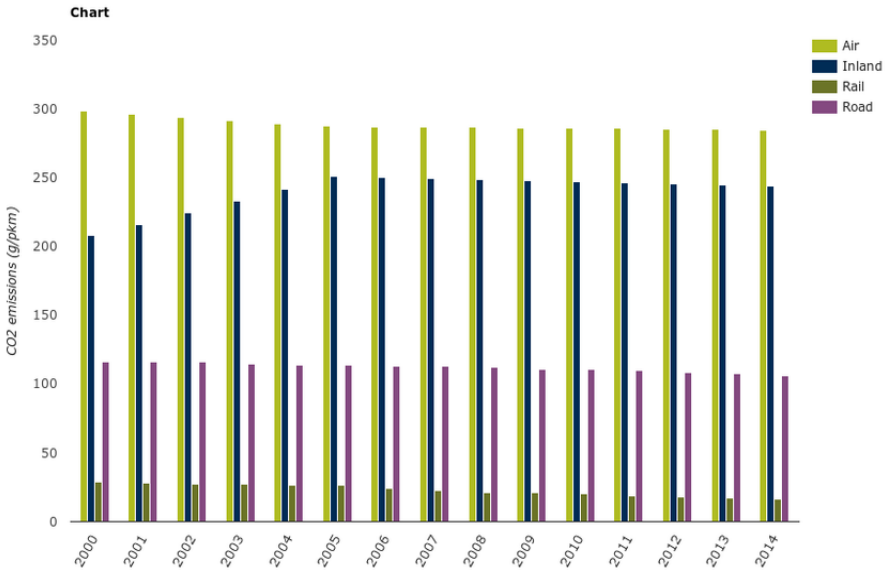

Figure 3. CO2 Emission Per Passenger-km and PER Mode of Transport in Europe (European Environment Agency, 2009)

As shown in the chart above, among the types of transportation lowest CO_2 emission is caused by railway transportation. CO_2 emission per capita in railway transportation started to be calculated after 2000, and this value decreased with

each passing year until 2014. Between 1975 and 2013, energy efficiency in railway transportation increased by 63% (Internatıonal Union of Railway, 2019).

According to the international energy agency research, with the increase of per capita income and population of developing countries, the use of private vehicles will increase 20 times more in 2050 compared to 2010. According to this result, the traffic density in the city will be more than 20 times. The report of (Salat & Ollivier, 2017) refers to one of the most effective methods of eliminating the use of motor vehicles to create a compact, mixed-use, pedestrian-friendly environment around the station by making railway investments. According to the researches of (Hayashi & Kato, 2012), in Bangkok, where railway transportation is not developed, and Tokyo, where the railway transportation network is set and whose populations are close to each other, were compared. Consequently, it has been observed that the CO_2 emission from transportation in Bangkok is four times higher than in Tokyo.

Urban development and transportation investments in developing countries are parallel to each other. With the economic development and the increase in household income, citizens' ability to buy private cars has increased, and vehicle ownership has increased accordingly. These improvements also allowed people to settle further in their workplace. With this development, urban sprawl has occurred in many cities. Besides, public transport systems such as rail have been obliged to serve more expansively in metropolitan area due to the urban sprawl. The costs required to establish a public transport service have increased (Hayashi & Kato, 2011).

There are two ways to reduce CO_2 use in transport, avoiding trips and switching from high-carbon to low-carbon (Modal Shift). Station regions become attractive for residences, factories, and commercial firms. As a result, compact development formed around the station. With this development, the distances required for commuting and activities are decreasing. Instead of using motor vehicles,

alternative transportation methods such as walking and bicycles can be chosen for those areas. For example, (Mandel et al., 2007) found that communities living within walking distance of the station use 30% fewer private vehicles than societies that are more within walking distance (Lund et al., 2004). On the other hand, it is observed that rail transportation usage in areas within walking distance of the station is five times more than in areas not within walking distance.

While evaluating the model shift between transportation types, the area's population density was considered where transportation types are applied. They observed that if the region's population density is more than 7,000 per km^2, the most optimal transportation mode to reduce CO_2 emissions is to choose light rail or heavy rail transport. In places exceeding 11,000 people per km^2, the use of the subway or monorail would be more effective in reducing CO_2 emissions. Finally, in an area of fewer than 3,500 people per km^2, the use of vehicles (cars) would be more helpful (Hayashi & Kato, 2011).

3.4. The Impact of Railway Investments on the Transit-Oriented Development

One of the essential features distinguishing railways from roadways is that the highway provides services from the station points while the road is continuous (Dröes & Rietveld, 2013). Therefore, it is crucial to analyze the developments in the station and its surroundings while examining the railway's effects. According to Bertolini's definition in 1996, railway stations are described as both nodes and places in an ambivalent structure within the city. Station areas can serve as nodes for both transportation and non-transportation business or consumption connections. Besides, train stations are defined as permanent or temporary living spaces in the city, where usage is intense and diverse (Bertolini, 1996). In other words, stations have two essential features; the first is to provide intra-regional and inter-regional connections. The second is to create a living space with mix-land use and diversity.

Station areas in cities have become focal points for creating integrated transport areas and developing land uses (Cervero, 1998: Dittmar & Ohland, 2004). Developments in these areas improve as these two factors affect each other. Developments in transportation, strengthening regional connections, which increased with establishing the HSR or LRT system, and accessibility paves the way for new enhancements in these areas. Recent developments in production and distribution and sectoral clustering tendencies are valuable for the city's station areas becoming attraction centers. These developments lead to Transit-Oriented Development (TOD) formation in North America and redevelopment areas around the station in Europe (Bertolini & Spit 1998: Dunphy et al., 2005).

Another factor that makes these areas attractive is increasing the region’s competitiveness. The population concentrated around large projects, intensive and mixed-use offices, retail, leisure, and large-scale housing projects focusing on these areas increase land values and positively affect productivity. The station environment's development is seen as an essential tool in reducing the city's urban sprawl effect and reducing vehicle dependency. (Bertolini, 2008). The most crucial feature of TOD developments around the station is that it has mixed land use and densely populated areas. Besides, it has access to all these facilities within walking distance in communities that live at point A, work at point B, and perform daily activities at point C. In this way, along with reducing the number of trips and the duration of the journey, it offers alternatives such as walking and cycling, which offer a healthier life instead of transportation that harms both nature and health, such as motor vehicles.

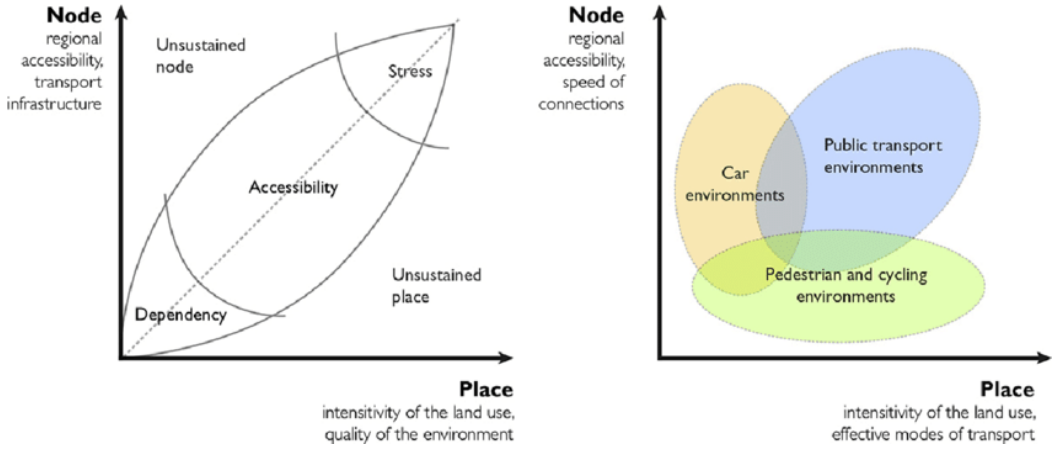

Figure 4. Node and Place Model (Bertolini,2008)

Maintaining a balance between node and place in TOD areas is crucial. Figure 4, created by Bertolini (2008), regarding this balance, is as follows. The model above shows the node-value in the region with the direction of the y-axis. Node explains the level of accessibility and network resulting from transportation investments in this region. And the x-axis shows the level of intensification and diversification in land use. The figure's stress zone is the high level of accessibility in the region and the areas where urban activities are intense and diverse. Limited development areas and increased development in these areas cause problems. The balance region is the area where the node and place values are equally distributed, and this threshold range should be tried to be reached in the areas where TOD is present. In the case of dependence, a problem such as the lack of transportation and activity areas arises in the region. In summary, it is crucial not only to strengthen the transportation network or to create activity areas in the region but also to balance these two factors in creating TOD areas in the urban station environment.

In the light of the information given above, we can list the TOD fields' general properties as follows. They are areas with high population density, where commercial spaces such as office retail are located on the main streets. Walking and cycling can be used comfortably in this transportation network, generally with grid street patterns and efficiently managed car parking areas.

The benefits of TOD fields can be examined under three main headings: environmental, economic, and social. Its environmental benefits are reducing energy and CO_2 absorption as it is created according to the region's non-motorized development criteria. To decrease the amount of energy per person due to the high population and density of buildings and prevent urban sprawl by accommodating more population in less space. To reduce the construction pressure on areas with high ecological importance, such as natural resources and agricultural areas, because increasing the density decreases the is used by construction. Its economic benefits are facilitating access to public transport and increasing wage income and purchasing power by reducing transportation-related costs and rising property values around transit centers. This also resulted in a rise in this area's property tax earnings. With the increasing access opportunities in this area, the labor market and the convenience of access to the customer attract new businesses and create new business areas in the region. As for the social benefits, the times when people can socialize increase due to the shortening of the transportation time. It provides the residents with an active life opportunity with possibilities such as walking and cycling. The person's stress level decreases with the decrease in noise and pollution caused by traffic (Gomez et al.,2019).

3.5. Effect of Railway on Urban Form

The first theory in which the relationship between urban development and transportation was put forward in 1826 with Von Thünen's agricultural land use theory. In this theory, a city form was created depending on the distance to the city center, and land uses were also arranged according to transportation distances. For example, it is observed that the agricultural land closest to the city center is designed as a production area of high and perishable products, and the furthest site from the city center is producing low-value crops. Alonso further developed this model in the following years. According to Alonso, the value of the house prices and the change in the value of the transportation costs depending on the distance to

the center are useful in the household's location choice (Alonso, 1982). The city center's attractiveness did not develop as Von Thünen modeled, and it lost its effect over time, especially in the choice of residential location.

There is a simultaneous and reciprocal interaction between transportation and land use. Increased accessibility and transportation investments affect location decisions (Perez et al., 2003). At the same time, land use characteristics affect the efficiency and use of transport systems (Ewing & Cervero, 2001). Railway investments are seen as the most critical tool in ensuring sustainable urban development against growth trends that negatively affect the city, such as urban sprawl and urban expansion. Towards the middle of the 20th century, it has been observed that vehicle ownership has increased in Europe and U.S. The upper and middle-income groups living in urban centers started to settle out of the city to get away from the adverse effects of the center, such as increasing pollution traffic and high rents, and to get the opportunity to live in larger buildings in larger areas outside the center. These changes led to urban decentralization for both population end employment (Ewing et al., 2002). Sprawled zones on the city's outskirts have also been low population density, and urban facilities or services cannot be provided. With these developments, it has been observed that daily basic needs are supplied by road transport from the city center, and residential areas formed disconnected from the city. These developments have increased vehicle ownership and, consequently, both traffic congestion and CO_2 emissions. Natural resources outside the city have been under the pressure of construction. Moreover, the natural environment has started to be threatened. Due to the increase in the distance between origin and destination, the amount of investment required to provide transportation infrastructure has also increased.

There should be found solutions to two main problems for reducing the effect of the urban sprawl. The first one should be for population density, traffic, noise, and environmental pollution that may cause the city population to move away from the city center. The second solution should be for alleviating the urban sprawl's harmful effects that have already taken place. The railway function is essential in

decentralizing the density of CBD areas in city centers, creating a polycentric structure in station areas, and making sprawled areas outside the city more compact around the station.

The source of the city center's problems can be explained by the node place graph created by Bertonelli in the TOD section. Due to the high node and place values, stress zones occur in the city center. It is observed that there are dependence regions where the node and place values are lower than the balance point as citizens move away from the center. The UIC (2019) report states that it is necessary to support developments around railway stations and create polycentric cities to develop healthier, safe, and sustainable cities. With the suburban railway investment, the stress in the city center will be reduced, and the dependent regions outside the center will become more balanced.

Lopez et al. (2016) researched in Paris for investigated how the railroad affects centers' formation within and outside the metropolitan area. According to this research, the number of jobs in the Paris metropolitan area increased by 30%. In comparison, the number of jobs in the city center decreased by 7.1%, and the number in the suburban area increased by 65%. As can be deduced, railways caused job decentralization in the center of Paris. In suburban areas, they showed that some municipalities turned into subcenters. The number of subcenters increased from 21 to 35 between 1968 and 2010. Again, this study showed that the works decentralized from the center clustered instead of spreading in the subcenters. As a result, it has been observed that the railway transformed the city into a polycentric structure.

Baum Snow (2017) handled the spatial relationship of jobs-housing and job access as indicators while examining the railroad's impact on the urban form. In this study conducted in Beijing, China, it was observed that the population spread along the railway line but was concentrated in the station area. It showed that business areas are focused on railway stations in regions with high accessibility. There is a

mismatch between jobs and housing, and although business areas are concentrated in the city center, residential centers are concentrated in suburban areas.

Even though enhanced transport infrastructure fosters a decentralization process, such a development diminishes transit services' efficiency as in sprawled areas. When there is not enough demand for travel to maintain fixed-route transit services, park and ride facilities became a good solution with the extending rail transit stations' catchment areas far beyond walking distance of 10–15 minutes thus ensure the demand for investing in railway (Horner & Grubesic, 2001). Thanks to park and ride in areas that are scattered in areas more remote from the urban area, people can use the railway for travel and reduce their travel distances by private car.

Railway investments not only affect the current urban development but also lead to new developments in the city. Here, it appears that there is a two-way interaction between railway investments and urban development. Although suburbanization started to occur before railway investments, it has been observed that railway investments also cause suburbanization (Crampton, 2000). Many studies show how the railroad and urban development affect each other in both directions. For example, (Cervero 1998) observed in their research that the railway had a significant effect on the strengthening of central business areas and suburban areas. While railway investments are being made, it is observed that European countries, where supportive policies and plans are made, have more impact than America. When examining the effect of railways on urban form, it was observed that construction and population increased in areas farther from the city center with the realization of railway investments. It was also observed that the average distance between work and accommodation increased (Levinson, 2008). The scales of spatial effects may also differ according to railway transportation types (Porter, 1998). While heavy rail and suburban railway systems primarily affect the metropolitan and non-metropolitan fringing areas, light rail systems are limited to denser central areas.

Another study from (Dröes & Rietveld, 2013) investigated rail transport's effect on urban form; they investigated rail access's impact on the urban spatial structure in a polycentric city. In the study, the same railway line's urban spatial effects having a limited number of stations and having omnipresent stations were examined. The indicators based on the study were population density, job density, and traffic density over the time spent for 1 km, and comparisons were made. As a result of the comparison, if the railway has multiple stops, access to the railroad increases, but the employment density and population density, which is the urbanization indicators, do not increase. Traffic density decreases up to 20% in this corridor. If the number of stops is omnipresent, accessibility decreases. However, job density and population density increase. In other words, clustering increases in these areas. With clustering, the traffic density on the line does not decrease. It reveals that there is a trade-off between urbanization and traffic density.

3.6. The Impact of Railway on Population

The railway's impact on the city's population can be identified by examining the change in trip habits, residential self-selection, and the effects on the built environment. The railway affects the city's population size, population density, and spatial distribution of population. In the studies conducted, the population could not be directly correlated statistically with the increase in railway investment. Instead, the railway's role as one of the factors affecting population growth and distribution was evaluated.

Henneberg and Mojika (2011), who examined railways' effect on the population in Portugal, France, and Spain, observed that the railway caused population concentration with industrialization. He found that the railroad's impact on population growth was low, increasing regional disparities. In Portugal, Silveira et al. (2011) observed that the railroad increased regional inequality and showed that the railroad increased internal migration, positively affecting population growth. Kotavaara (2011) obtained some results about population distribution in his study.

According to these results, the population is distributed more homogeneously in the towns that do not have a railway. In contrast, the clustering in the cities where the railway serves and the population density around the railway is higher.

Examining the railway's effect on the population in Turkey, Akgüngör et al. (2011) found out that the railway increases the city's productivity and job opportunities, thus improving the city's living standards. This led to increasing the migration rate around the railway in the town. As a result, population growth and population density rise in the cities where railways operate. Unlike these studies, Atack et al. (2009) examine the railway's effect on the population, studies' results differ. He researched the population increase in the Midwest region between 1850 and 1860 with the railway and put its impact of the railway on population density and urbanization. According to the research, railway investments increased by 76%. Wisconsin's population increased 20 times, Michigan 15 times, and Illinois 4 times during this period. When the railway's effect on this population growth is examined, it is observed that it does not significantly impact urban population growth and population density but influences urbanization and causes an increase in the urban population.

The effect also differs according to the region served by the railway. Büchel and Kyburz (2016) observed that the railroad has a positive influence on population growth, according to their research in the city of Switzerland. It has been observed that the municipality has an annual population growth rate of 0.4% higher than those without access to railways. Railway's impact on the population decreases depending on the distance. The highest impact area is in the distance regions with a radius of 2 km. It decreases gradually to a distance of 6 to 8 km, and this effect is set to zero when the distance is around 20 km. When examining the impact of the railroad on urban population growth, it was observed that the effects on urban and rural towns differed. It causes 1% to 2% growth in the city, while this effect is much less in the countryside.

Davidson et al. (2016) observed the effect of the railway on rural areas. According to his studies, the railway increased the commercial efficiency, competition, and agricultural income in the rural as it increased accessibility to the market. The rate of migration from rural to urban is lower in that areas where there is a railway station. In rural areas that benefit from railway services, these new jobs create job opportunities and the developments in non-agricultural, especially in the field of industry, thus reducing migration from rural to urban.

Baum et al. (2017), in their study examining the impact of rail and highway on population distribution in China between 1990-2000, found out that the railway increases the region's population with access to the city center and reduces transportation costs. Thus, it creates new alternatives to areas where land rent is high in the city center and increases migration from the center to suburban areas. Therefore, he observed that 4% of the city center population migrated from the city center for each radial railway passing through the city center.

In the study named the effect of IZBAN on neighborhood population change in the Izmir city region in 2020, the impact of the neighborhoods around IZBAN on the population change between 2013-2018 was examined. It was observed that the population weight decreased in the metropolitan area, and the population weight increased in the North and South regions of the city. They observed that it caused an average population to 5.02% rise in the neighborhoods around the IZBAN line and increased by 29.91 % and 14.02% in the North and South regions, respectively (Şenbil et al. 2020).

3.7. The Impact of Railway Investments on CBD Decentralization and Suburbanisation

There are two aspects to the decentralization of the central business area in terms of population and employment, together with the railway investment. One of them is the problems resulting from the excessive urbanization of the central business area.

According to Bertolini's model, these regions are stress zones with intense transportation opportunities, high density, and diversified land uses. Another reason for decentralization in central areas is the possibilities in the city periphery.

CBD areas with high density increase innovation and productivity by creating a rich information environment. For this reason, these areas have become points of attraction for companies (Lucas, 1988). However, due to supply and demand imbalance in these areas, which are the attraction points for companies, land values , and labor costs increase much faster than in regions outside the CBD. In developed economies, business and financial services are concentrated in urban centers to take advantage of the rich information environment, one of the most important advantages offered by CBD (Arzaghi & Henderson, 2008). In the manufacturing industry, on the other hand, to reduce costs and keep up with the competitive environment, it has started to shift from the CBD, where the land and labor costs are high, to the city peripheries, where the prices are lower (Kolko, 2000). In a study conducted to examine the effect of the railway on the decentralization of population and industrial production from the CBD area in China, it was observed that the industrial GDP in the CBD area decreased by 20% with the realization of the railway investment (Baum, 2017).

The reasons that negatively affect the welfare level, such as high rent prices and high-density urbanization in the city centers, as well as increased traffic and pollution, pushed the population from the city center to its periphery. In addition, the fact that the city center production areas move out of the center also affects the housing location choice of the production workers and directs the population out of the center. With railway investments, reaching further and wider areas is more accessible for people living on lower land costs. With the reduction of land and transportation costs, living costs decrease. In addition, living standards increase by moving away from adverse effects such as traffic and pollution in the city center (Baum, 2007). For these reasons, the population in the city centers is decentralized towards the city periphery.

The population in the central area and the decentralization of some sectors have increased the movements towards the city periphery. The decentralized population from the central location and how employment is reorganized outside the center are among the most important factors affecting urban development. The decentralization that took place with the highway investments and the increase in automobile ownership caused the population to settle in a dispersed manner in the city peripheries and caused urban sprawl. With the urban sprawl, natural resources and energy use have increased. The realization of railway investments has been one of the most important solutions to prevent urban sprawl. It creates an attraction point around the station with suburban railway investments connecting the city center and outside the center. These node regions with high access have become important points in selecting residential and non-residential activities. With the increasing demand for these areas, land values increase, and the clustering of residential and employment areas around the station also causes an agglomeration of economies. Thus, productivity increases in these regions. In addition, the station areas have been the attraction point for the integration of transportation types and land uses, and transit-oriented development has increased in these regions. Thus, regions with dense populations and mixed land uses have emerged.

In summary, with the realization of railway investments, the access of central regions to the out-of-center increases, thus accelerating population growth and decentralization of some sectors. It also provides reorganization around the station for the population and businesses that are decentralized from the center. The decentralized population and workplaces are reorganized around the station, and intensive and mixed-use developments emerge in these areas. Thus, the adverse effects of urban sprawl are also reduced.

CHAPTER 4

METHODOLOGY

4.1. Aims, Objectives, Research Questions

There are many studies on how the railway affects urban transportation. Many studies have been conducted on how it affects travel behaviors and how it provides modal shifts between transportation types. Some studies emphasize how it affects the urban form spatially and how it causes spatial developments around the station. In addition, it is noted that the use of the land around the station is diversified, and the density of land uses around the station increases. Economic research emphasizes the importance of growing transportation opportunities in workplace location selection. The complementary effect of railway investments on urban development with population and employment dynamics is also revealed. For this purpose, the metropolitan subregion and the north-south subregions were examined separately. While examining the complementary effect of IZBAN on urban development, demographic, economic and spatial changes within the station domain were evaluated and these indicators were compared with the locations outside the station impact area. To make this assessment, the study introduces two main research questions;

1) Do the urban development trends of the Izmir metropolitan area coincide with the impact area of IZBAN, where accessibility is increasing?

- Do IZBAN and non-IZBAN neighborhoods differ in terms of demographic change in metropolitan sub-region?
- Do IZBAN and non-IZBAN neighborhoods differ in terms of employment change in metropolitan sub-region?
- Do spatial distribution of demographic and economic indicators change according to the impact zone of IZBAN stations.

2) Do the urban development trends of the north and south subregion coincide with the affected area of IZBAN, where accessibility is increasing?

- Do IZBAN and non-IZBAN neighborhoods differ in terms of demographic change in the south and north subregion?
- Do IZBAN and non-IZBAN neighborhoods differ in employment change in the south and north sub-region?
- Which economic sector is more responsive to railway investments?
- Do the suburban railway cause a concentration of employment around the station?

Based on the above research questions, the following hypotheses have been established.

- IZBAN and non-IZBAN neighborhoods differ in terms of demographic change in metropolitan sub-region.
- IZBAN and non-IZBAN neighborhoods differ in terms of employment change in metropolitan sub-region.
- Spatial distribution of demographic and economic indicators change according to the impact zone of IZBAN stations.
- IZBAN and non-IZBAN neighborhoods differ in terms of demographic change in the south and north subregion.
- Service sector is more responsive to suburban railway investments than agriculture and industry sector.
- Suburban railway cause a concentration of employment around the station.

4.2. Case Study Selection

The province of Izmir was chosen as the subject of the study. The reason for choosing the province of Izmir as the study area is that one of the suburban

railways in Turkey is located in this district. It is also an important factor that IZBAN was put into service in 2010 and that enough time has passed to measure its effects. In addition, directing the railway investments concentrated in the east-west direction before IZBAN towards a different direction, north-south, as stated in the plans, was an important factor in selecting this area.

In this study, zoning has been made on various scales to reveal regional change and differentiation. As Şenbil et al. (2020) also stated in the study about IZBAN's effect on the district's population, the main regions are divided into six. These are; the north, metropolitan, south, Kemalpaşa, southeastern, and peninsula regions. By the station zoning published on IZBAN's official website, Izban's line axis is Aliağa-Çiğli as the north axis, Menderes-Selçuk as the south axis, and Karşıyaka-Gaziemir as the center axis. To evaluate the railway's effect, an impact area within a radius of 1 km was determined around the station, and the neighborhoods within the border were identified as IZBAN neighborhoods.

4.3. Data

Numerical data were obtained from the Social Security Institution. To make a before-after comparison of the data obtained, when IZBAN was put into operation the year 2009 before 2010, the year 2014 to measure the short-term effect (2009-2014 comparison, 5-year process), and the year 2019 (to examine the long-term impact). The 2009-2019 year comparison, 10-year period) data were used. In addition, the workplace sectors (Agriculture, Industry, Service) was obtained in the form of Nace codes. Nace code is used to create a universal standard for classifying the field of work. The resulting Nace codes are grouped according to the OECD three-sector economic activity classification.

Code	Economic Area
A	Agriculture, Forestry and Fishing
B	Mining and Quarrying
C	Manufacturing
D	Electricity, Gas, Steam and Air Conditioning Supply
E	Water Supply; Sewerage, Waste Management and Remediation Activities
F	Construction
G	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles
H	Transportation and Storage
I	Accommodation and Food Service Activities
J	Information and Communication
K	Financial and Insurance Activities
L	Real Estate Activities
M	Professional, Scientific and Technical Activities
N	Administrative and Support Service Activities
O	Public Administration and Defence; Compulsory Social Security
P	Education
Q	Human Health and Social Work Activities
R	Arts, Entertainment and Recreation
S	Other Service Activities
T	Activities of Households as Employers; Undifferentiated Goods and Services Producing Activities of Households for Own Use
U	Activities of Extraterritorial Organisations and Bodies

Figure 5. Statistical Classification of Economic Activities in the European Community (Carre, 2008)

According to figüre 5 Code, A shows the agricultural sector business areas, codes B, C, D, E, F constitute the industrial sector business areas, and the rest are the codes for the workplaces in the service sector. The number of insured employees in each workplace was obtained from the Social Security Institution's (SGK) data. The 4-digit nace codes representing the business line were grouped according to the OECD and Eurostat classification of economic activities, and the information-intensive service sector evaluation was made. Moreover, population data were obtained from the address-based population registration system of the Turkish Statistical Institute (TUIK) in the form of district and neighborhood for the years 2009, 2014, and 2019.

4.4. Models

Two different models were used in this research. They are Mann-Whitney-U testsed for comparison to different non-parametric variables to find is there a difference in the dependent variable or not. It compares whether the distribution of the dependent variable is the same for the two groups and therefore from the same population.

Formula of Mann Whitney-U tese

$$I = \frac{N}{W} \frac{\sum_i \sum_j w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_i (x_i - \bar{x})}$$

where N is the number of spatial units indexed by i and j; x is the variable of interest; $\bar{x}$ is the mean of x; w_{ij} is a matrix of spatial weights where zero and W is the sum of all w_{ij}.

A posthoc compares the mean differences between groups that have been split into two "factors," where one factor is a "within-subjects" factor, and the other factor is a "between-subjects" factor. For example, post hoc is often used in studies where measured a dependent variable (e.g., "back pain" or "salary") over two or more

time points or when all subjects have undergone two or more conditions (i.e., where "time" or "conditions" are your "within-subjects" factor).

Formula of post hoc

$(Y_1 + Y_2)/2 = b_0 + b_1X + e$,……..…(1)

$(Y_1 - Y_2) = b_0 + b_1X + e$, ……(2)

Y1 is subjects' 2009 population or employment, Y2 is subjects' 2019 population or employment, X is the dichotomous between-subjects variable (IZBAN or Non-IZBAN neighborhood), and e refers to the residuals (the error) in the model.

CHAPTER 5

IZMIR REGIONAL RAILWAY SYSTEM

In this chapter, Izmir’s province's employment, population mobility, and change of urban transportation structure between the years will be mentioned. In addition, urban planning studies, the history, and the development of the IZBAN line will be evaluated with statistical data.

5.1. General Characteristics of Izmir City

Izmir is a city located in the Aegean Region in the west of Turkey and has a coast to the Aegean Sea. The province's territory lies between 37^{o} 45' and 39^{o} 15' north latitudes and 26^{o} 15' and 28^{o} 20' east longitudes. The province, which has a total area of 12,012 km2, has a length of approximately 200 km in the north-south direction and 180 km in the east-west direction. It is bordered by Balıkesir in the north of the city, Manisa in the east, and Aydın in the South. The town is surrounded by the Aegean Sea in the west (Izmir Governorship,2021). The location of Izmir province in Turkey is shown in figure 6.

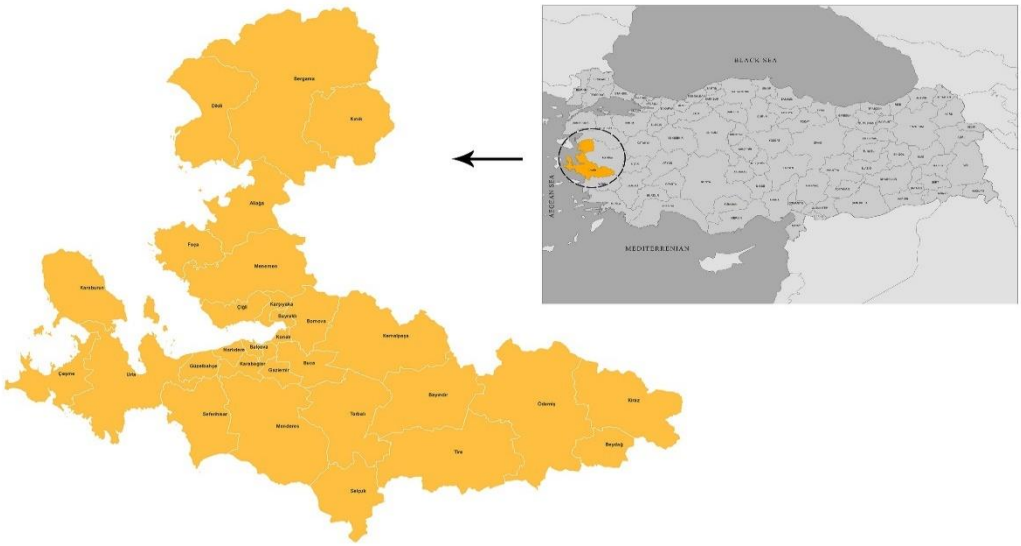

Figure 6. Location of Izmir in the Country

Located on important trade routes, the city has hosted many civilizations throughout history. During the Ottoman period, with the industrialization of Europe, port cities such as Thessaloniki, Istanbul, and Izmir gained importance, and investments from foreign countries began to be made in these cities. The emergence of the municipal institution in Izmir coincides with these periods (Izmir Metropolitan Municipality, 2021). The historical and geopolitical advantages of Izmir still make the city one of the more important economic cities. The city's per capita GDP (TL) value is 60,554, ranking 6th in Turkey (TUIK, 2020).

Izmir became a metropolitan municipality with the law numbered 5216 in 2004. As shown in figure 7, 11 districts cover the municipal borders; nine more districts were added to cover 20 districts. With the law numbered 6360, which entered into force in 2013, all districts in the whole city were connected to the metropolitan municipality.

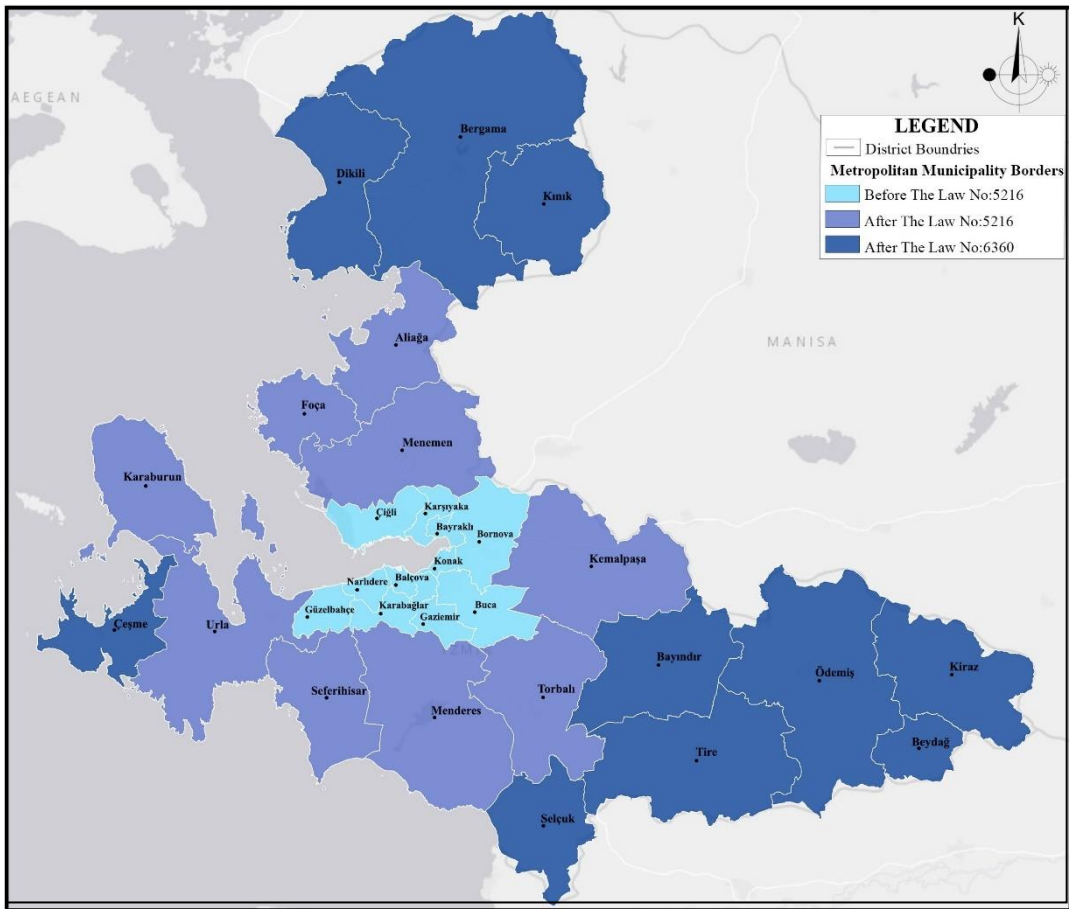

Figure 7. Change of Izmir Metropolitan Municipality Borders

5.2. Regional Classification of Izmir

For the analysis studies carried out in Izmir province, 30 districts owned by Izmir were divided into regions. These regions are divided into six concerning Şenbil et al. (2020) research: North, Kemalpaşa, metropolitan, south, southeast, and peninsula. Regions and districts covered by the regions are given in figure 8.

Regions

North Region: Bergama, Kınık, Dikili, Aliağa, Foça, Menemen

Metropolitan Region: Çiğli, Karşıyaka, Bornova, Bayraklı, Konak, Balçova, Narlıdere, Karabağlar, Buca, Gaziemir

Karşıyaka Region: Karşıyaka

South Region: Torbali, Menderes, Selcuk

Southeast Region: Bayındır, Tire, Ödemiş, Kiraz, Beydağ

Peninsula Region: Seferihisar, Güzelbahçe, Urla, Çeşme, Karaburun

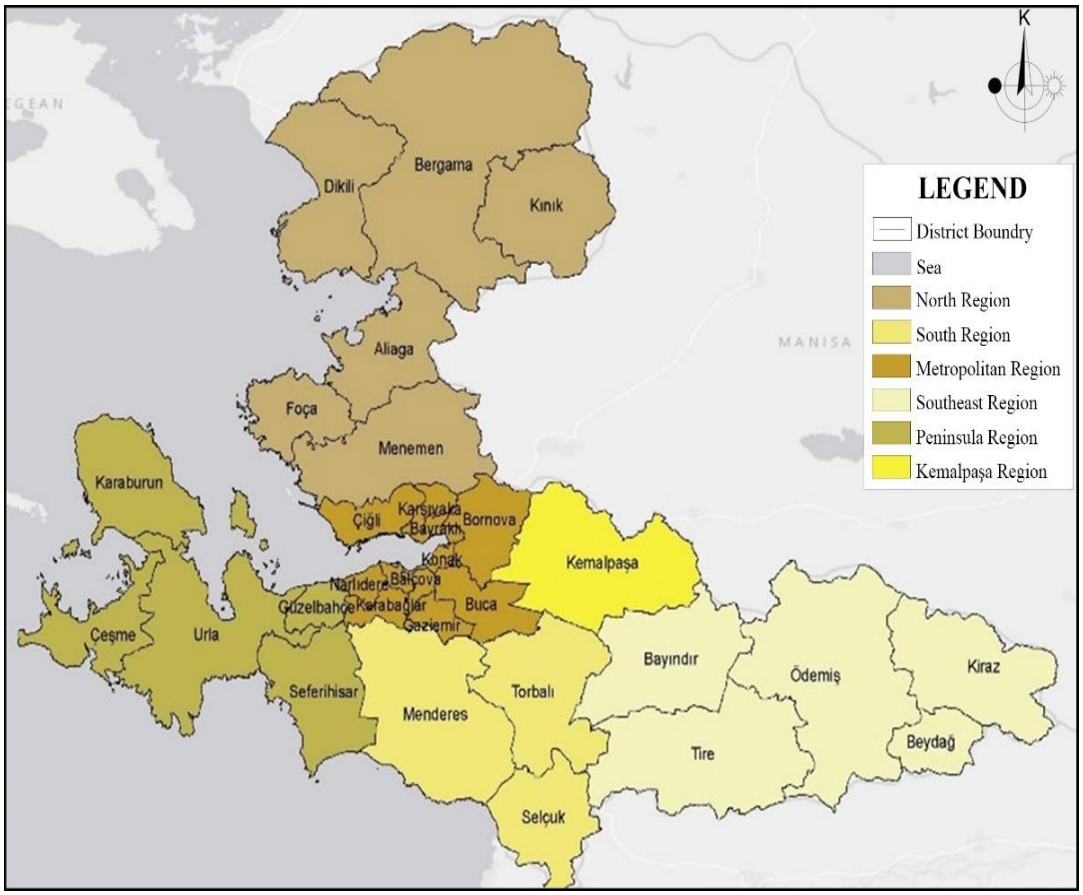

Figure 8. Regions of Izmir

Sub-Regions

The districts that fall under the influence of the IZBAN are shown in Figure 9. They are the districts which railway line passing through on them. In the analysis, three different zonings were made while evaluating the districts of IZBAN. These are;

1) North Sub-region: Aliağa, Menemen, Çiğli

2) Metropolitan Sub-region: Karşıyaka, Bayraklı, Bornova, Konak, Buca Karabağlar, Gaziemir

3) South Sub-region: Menderes, Torbali, Selcuk

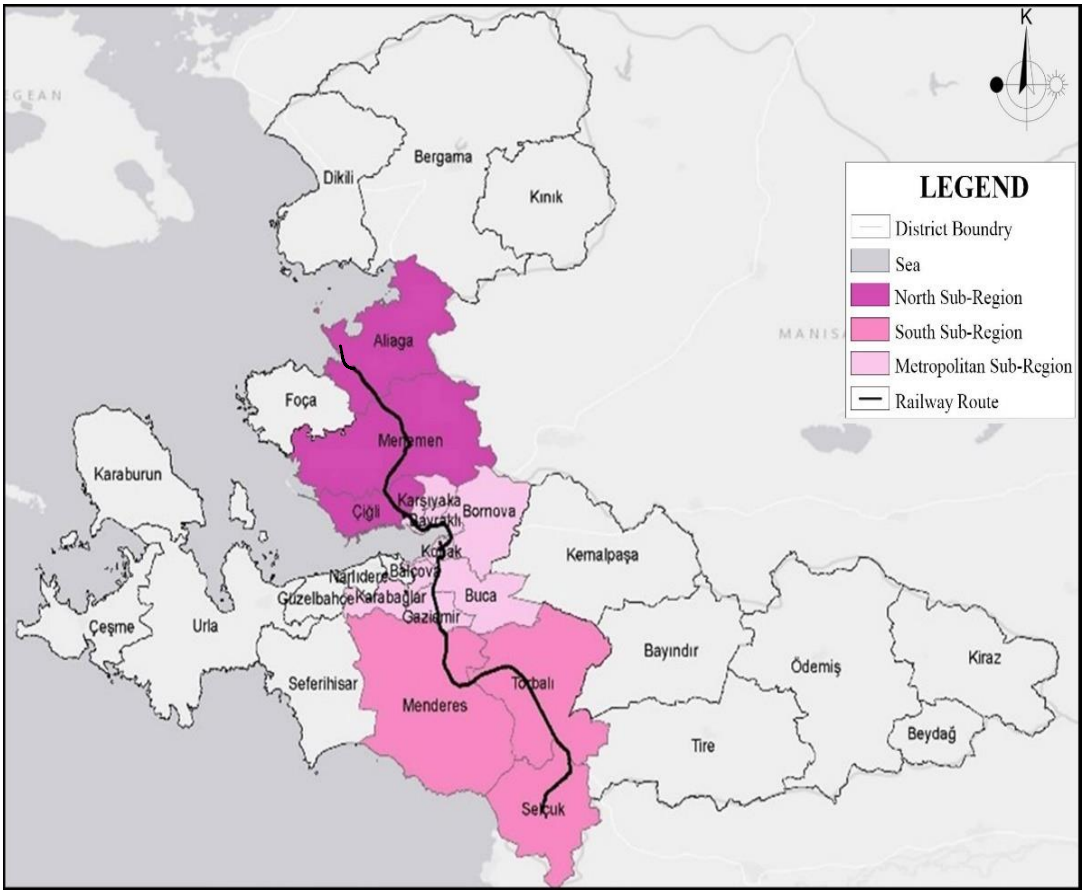

Figure 9. IZBAN Sub-Regions

5.3. Population of Izmir

Izmir province is the 3rd largest city after İstanbul and Ankara in terms of population size and population density (TUIK,2020). As of 2019, the total population of the city is 4,367,251. The urban population in 2020 is 4,394,694, with an average annual population increase of 0.63%. Turkey's average annual population growth is 1.6%, and Izmir remains below this average.

The analysis showing the population change between 2009 and 2019 and the distribution of the population within the city are given below. In this analysis, population change in the mentioned six regions of Izmir will also be taken into consideration.

5.3.1. The Population of Izmir in 2009

The total population of Izmir province in 2009 was 3,868,308. When the population distribution is examined from figure 10, it is observed that the population is below 50,000 in the peninsula and southeast regions. In the metropolitan area, excluding Narlıdere Çiğli and Balçova districts, it is seen that population is over 300,000.

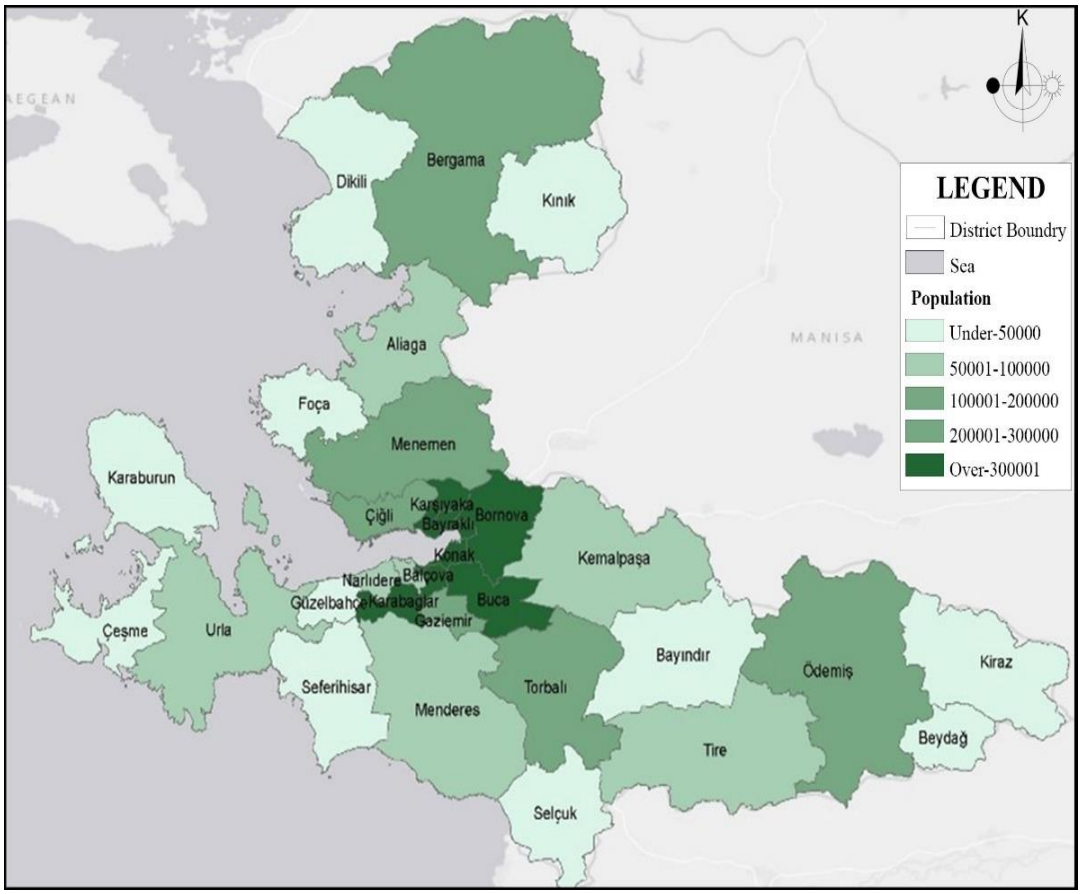

Figure 10. The Population of Izmir in 2009

36.7% of the district's population is up to 50,000. It has been observed that the districts with this population are mostly in the peninsula, southwest, and North regions. All the districts with a population of over 300,000 are in the metropolitan area and constitute 20% of all districts. Figure 11 shows that 70.2% of the Izmir

population is concentrated in the Metropolitan region. The region with the lowest population rate is Kemalpaşa with 2.3%.

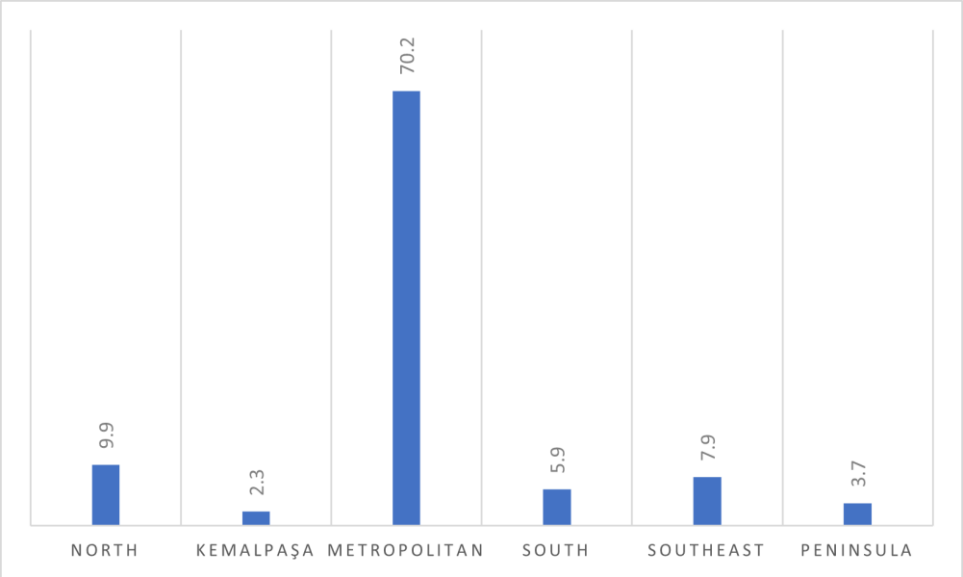

Figure 11. Regions of Izmir Population Share in 2009

5.3.2. The Population of Izmir in 2019

The population of Izmir in 2019 is 4,367,251. As shown from figure 12, created according to the population ranges, especially in the peninsula and southeast regions, the district's population remained below 100,000. While the districts with high population are concentrated in the Metropolitan region, Çiğli, Menemen, Kemalpaşa, and Torbalı districts around the Metropolitan region have witnessed a rapid population growth.

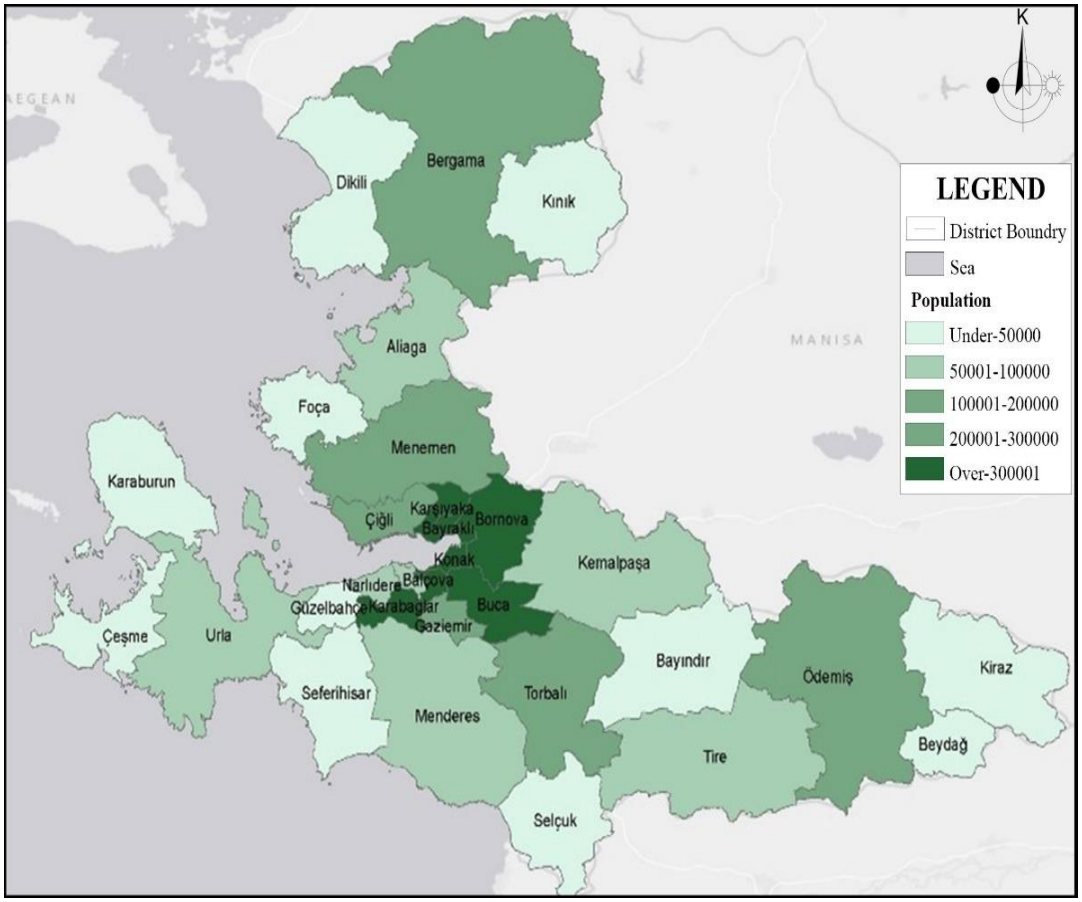

Figure 12. The Population of Izmir in 2019

Figure 13 shows the share of the population according to regions. The region with the highest ratio in the provincial population is the Metropolitan region, with 67.3%. The sub-region with the highest rate after the Metropolitan region was the North region with 11.1%. The region with the lowest population rate is the Kemalpasa region (2.5%).

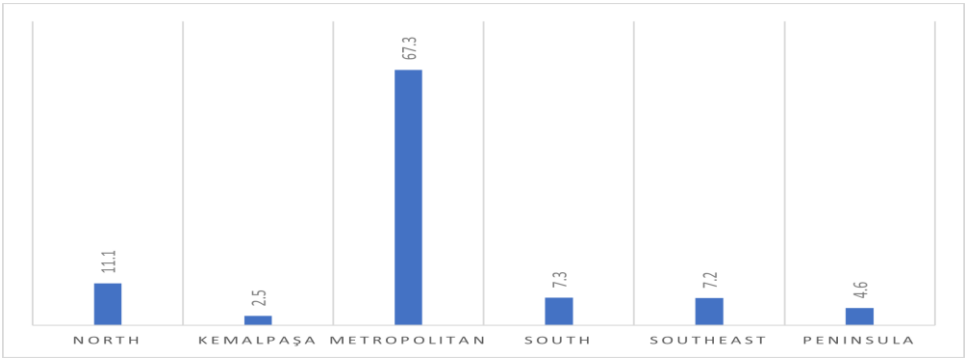

Figure 13. Regions of Izmir Population Share in 2019

5.3.3. Population Change in Izmir Province in 2009-2019

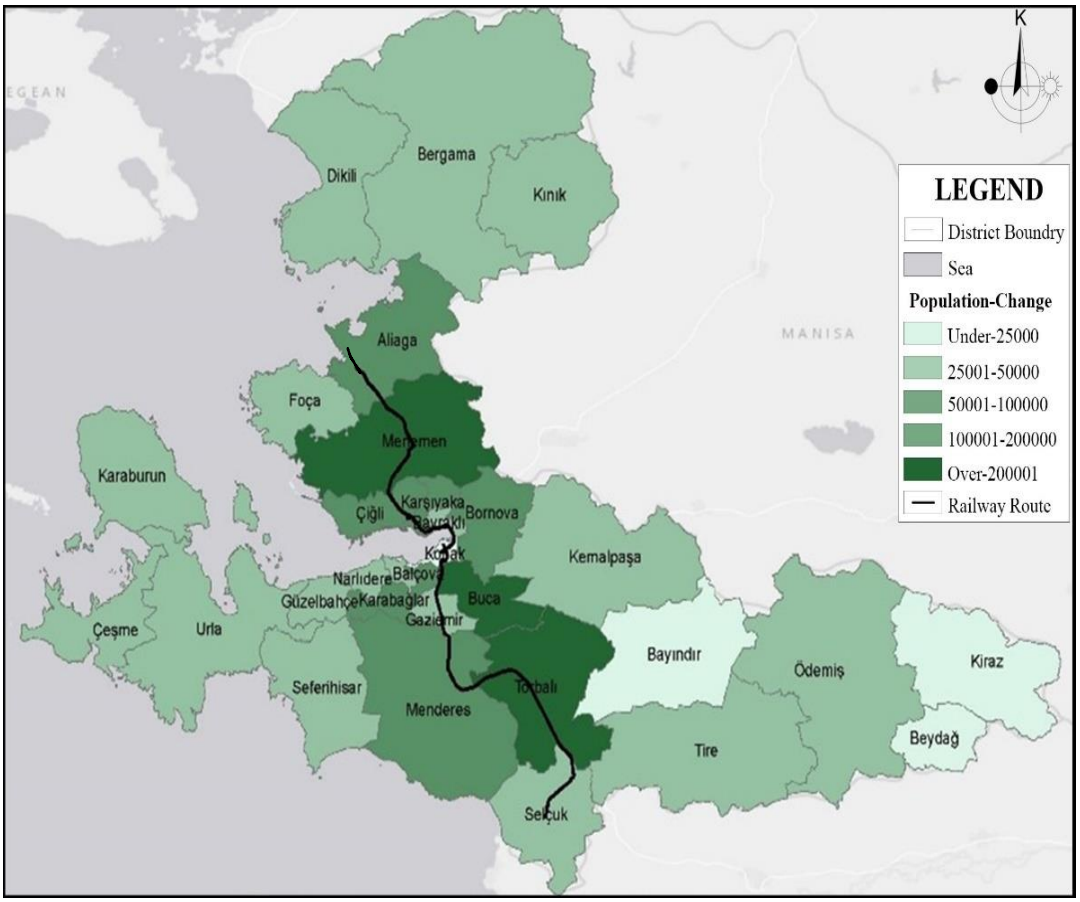

Figure 14. Population Change in Izmir Between 2009-2019

Between 2009 and 2019, the population of Izmir increased from 3,868,308 to 4,367,251, showing an increase of 12.9%. According to figure 15 created for the population change in Izmir, the population growth rate of 43.3% of the districts is over 20%. When the distribution of these districts is examined from figure 14, it is observed that the districts are concentrated in the north and south of the Metropolitan Region and the peninsula. In the Metropolitan region, it is seen that the population of Konak, which is accepted as the core of the center, has decreased.

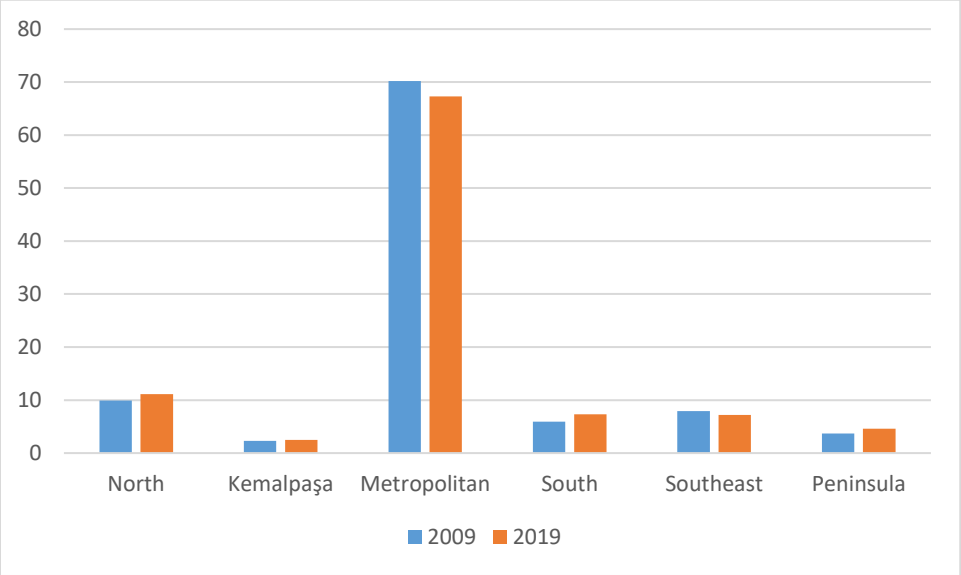

Figure 15. Regions of Izmir Populations in 2009 and 2019

In 10 years (2009-2019), the population ratio of the regions decreased from 70% to 67.3% in the Metropolitan region, and the population ratio of the southeast region fell from 7.9% to 7.2%. This rate has increased in other regions. The population increase in the north, south, and peninsula regions was over 25% within this period. Population growth in the metropolitan (8.2%) and southeastern sub-regions (2.7%) was lower than the overall population growth in the province (12.9%). The metropolitan area share in the population is gradually decreasing, and the population is decentralized to the north, south, and peninsula sub-regions.

5.4. Economic Structure of Izmir Province

To evaluate the city's employment change and sectoral dynamics, this section primarily examines the current economic structure of the city. In this section, the distribution of the gross domestic product in the city according to the sectors, foreign trade statistics, per capita income has been examined, and comparison within the country has been made. In addition to these, as of 2019, the areas where employment is concentrated and the business lines with the highest increase were determined.

According to the economic activity of 2019, according to the data of Gross domestic product by provinces by kind of economic activity, at current prices, 2019 which can be seen in figüre 16, Izmir's GDP as of 2019 is 263.2 million TL, and it is the third highest in Turkey. Sectorally, 69.6% of GDP is composed of the service sector, while 26.1% is the industry sector and 4.3% is the agricultural sector (TUIK, 2019). While the GDP per capita was 59,422 TL in 2018, it increased to 60,554 TL in 2019. Izmir is in sixth place in terms of GDP per capita in Turkey (TUIK, 2019).

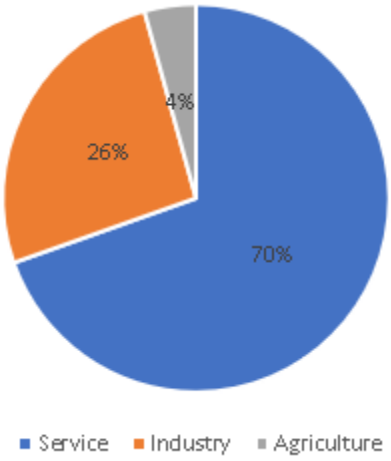

Figure 16. Izmir GDP Share by Sectors

5.4.1. Izmir Province Service Sector

The sector with the largest share in the Gross domestic product in Izmir is the service sector. According to the data obtained from the social security institution, the total employment in the service sector in Izmir in 2019 was 1,311,019 people. The service sector constitutes 74.5% of the total employment compared to the inner-provincial sectors.

The province has an important place in tourism due to its history and geographical location. There are many types of tourism in the province, such as coastal, cultural

and religious, congress or fair-related, winter, and thermal tourism (IZKA 2013). In addition, due to the high education level of the province (the rate for higher education graduates is %19.04), it is observed that the employment of qualified personnel has increased in services such as banking, insurance, technology development, and R&D (Izmir Governorship 2021).

The distribution of service sector employment by districts is shown in figüre 17 below. According to the map, it is seen that the IZBAN line serves districts that have more than 50,000 service sector employment.

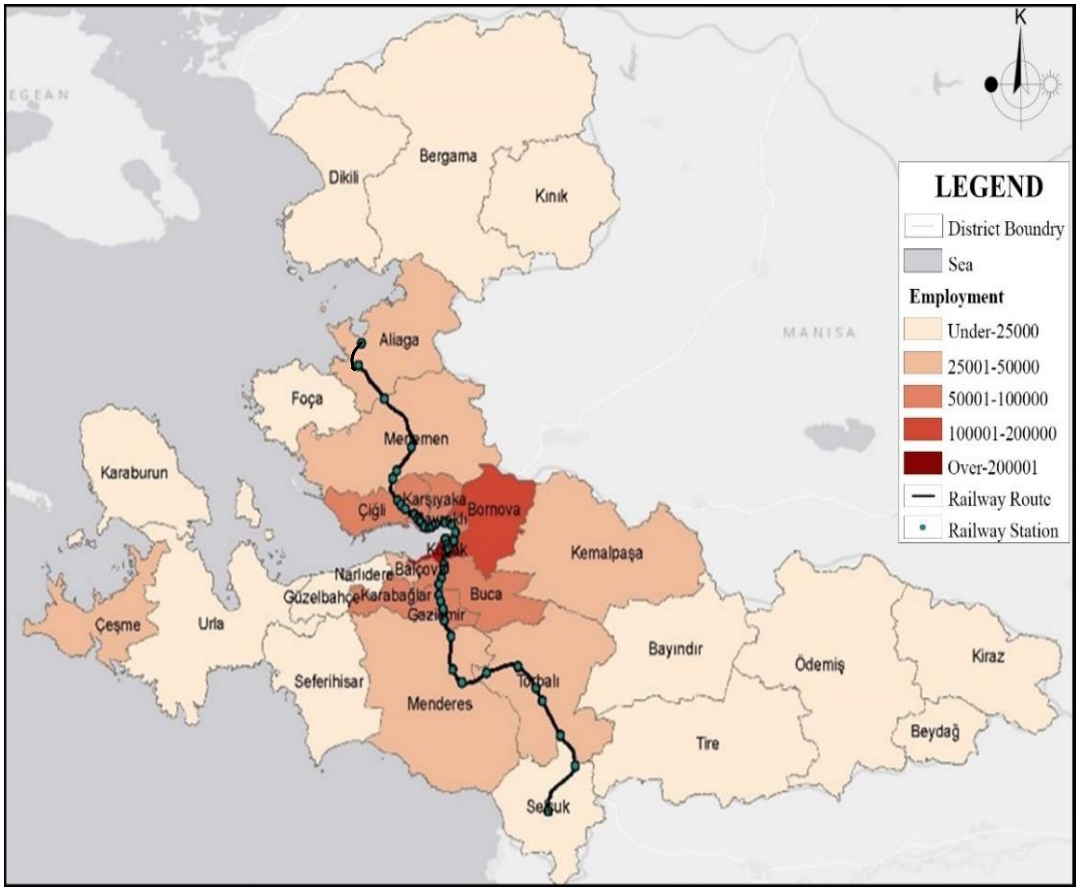

Figure 17. Izmir Service Sector Employment in 2019

According to figüre 18 below, which shows the increase in employment in the service sector in the 10-year period (2009-2019), it has been determined that the increase in employment in the service sector mainly occurs in the coastal districts

of the southwest region and along the IZBAN route starting from Aliağa, covering the metropolitan area and extending to Torbalı.

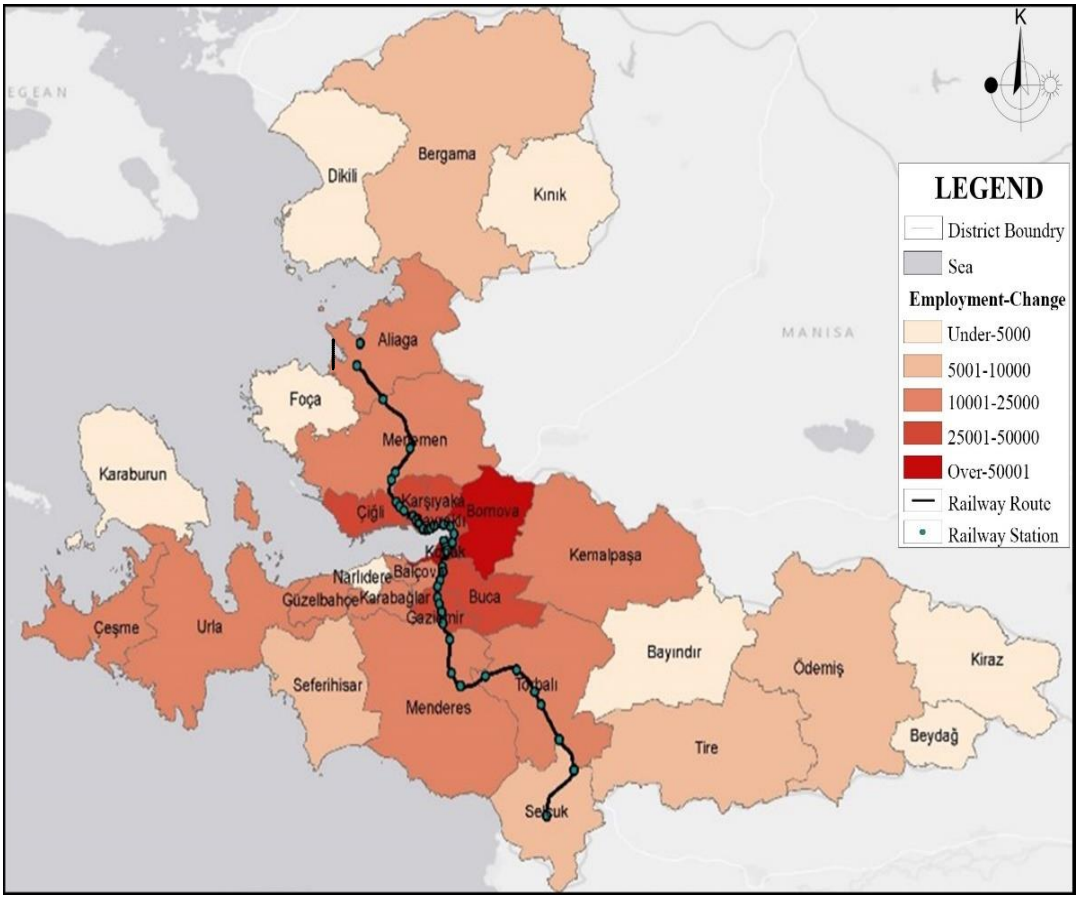

Figure 18. Service Sector Employment Change in Izmir Between 2009-2019

5.4.2. Izmir Province Industry Sector

Great progress has been made in the industry due to the fact that Izmir province has high transportation opportunities that provide access to raw materials and markets and has been on trade routes throughout history. There are 12 organized industrial zones and two free trade zones in the province. In addition to these, there is at least one industrial site in each district.

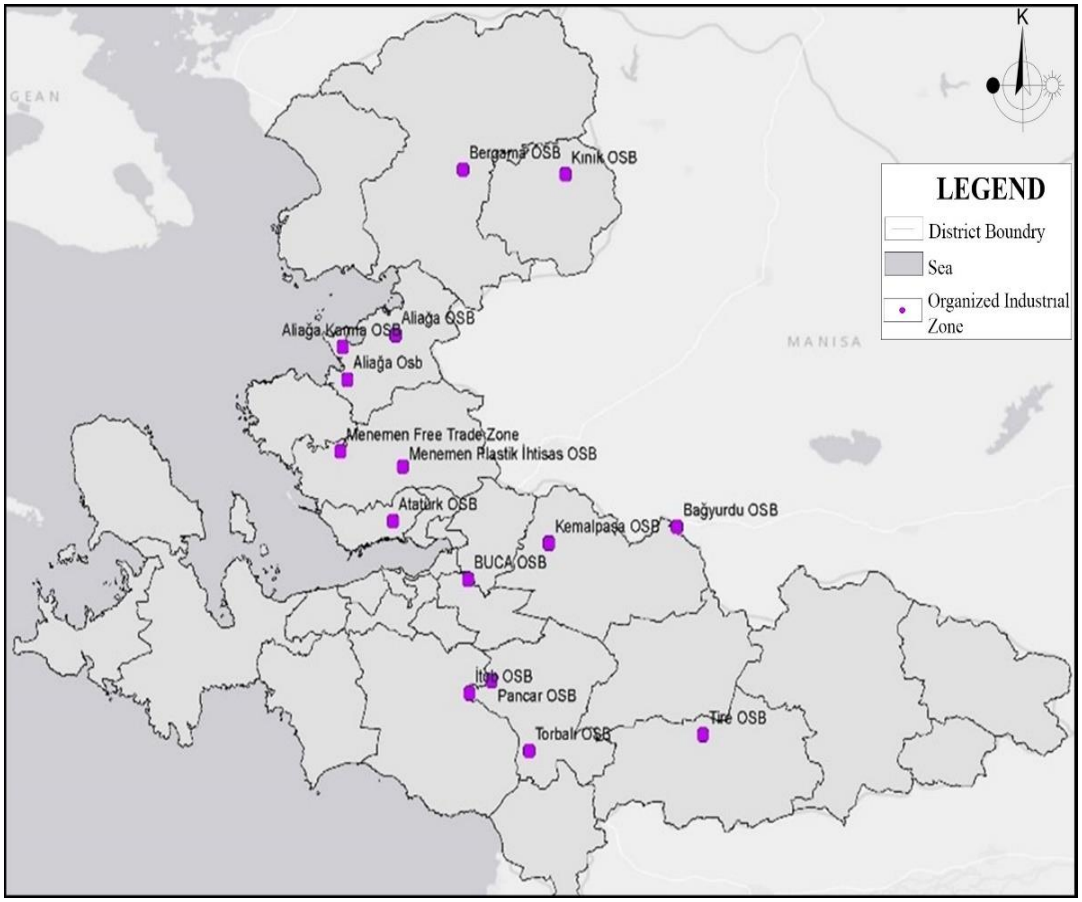

Figure 19. Organized Industrial Zone's of Izmir

As can be followed from figure 19, Aliağa, Bornova, Çiğli, Gaziemir, Kemalpaşa, Menderes, Menemen, and Torbalı districts in Izmir are the districts where industrial investments are concentrated. There are four technology zones in Izmir that provide industry and university cooperation in order to produce high-tech goods and services. These are Izmir Bilimpark Dokuz Eylül Technology Development Zone, Aegean Technopark Technology Development Zone, and Izmir Technology Development Zones (Istanbul Trade Office, 2019) 80% of the mentioned technology development and industrial zones are connected and the city center by the IZBAN railway system. The agro-based industry has developed in the city. Textile, apparel, food, liquor, beer, and tobacco feed industries are the most important business lines. Apart from these, iron-steel, petro-chemistry, automotive,

cement, shoes, fertilizer, agricultural machinery, and ceramic industries produce for domestic and foreign markets.

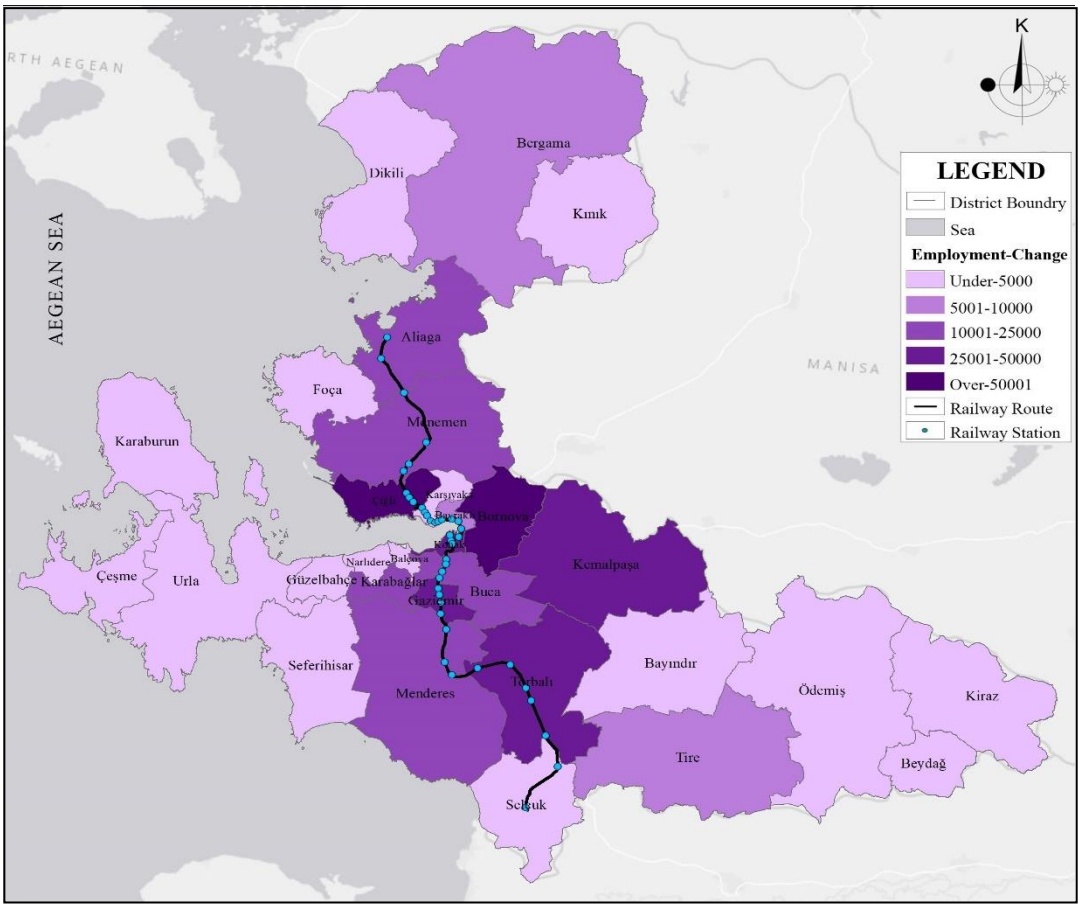

Figure 20. Industry Sector Employment in 2019

Industrial sector employment constitutes 24.5% of all employment as of 2019. According to figüre 20 it has been observed that industrial employment is below 5,000 people in the peninsula, southeast, and the extreme regions of the North region, and between 10,000-50,000 people in the north and South sub-regions served by the IZBAN line. Bornova and Çiğli districts, which have more than 50,000 industrial employment, are the districts with the highest employment.

The change in employment over ten years is shown in figüre 21 According to the map, while the district with the highest increase in industrial employment is Kemalpaşa (over 25,000 employment), the increase in industrial employment was over 10,000 in Aliağa in the north of the metropolitan area Gaziemir and also

Torbalı in the south. Districts with an industrial employment increase of more than 5,000 are also the districts located on the route of the IZBAN line. It has been observed that industrial employment has decreased in the coastal districts such as Karaburun and Çeşme, as well as in the metropolitan area, namely, Konak, Bayraklı, Karşıyaka, Balçova, and Narlıdere districts. It can be deduced from this that the industrial employment in the metropolitan area is decentralized to the Kemalpaşa district in the east and the districts served by the IZBAN line in the North and South.

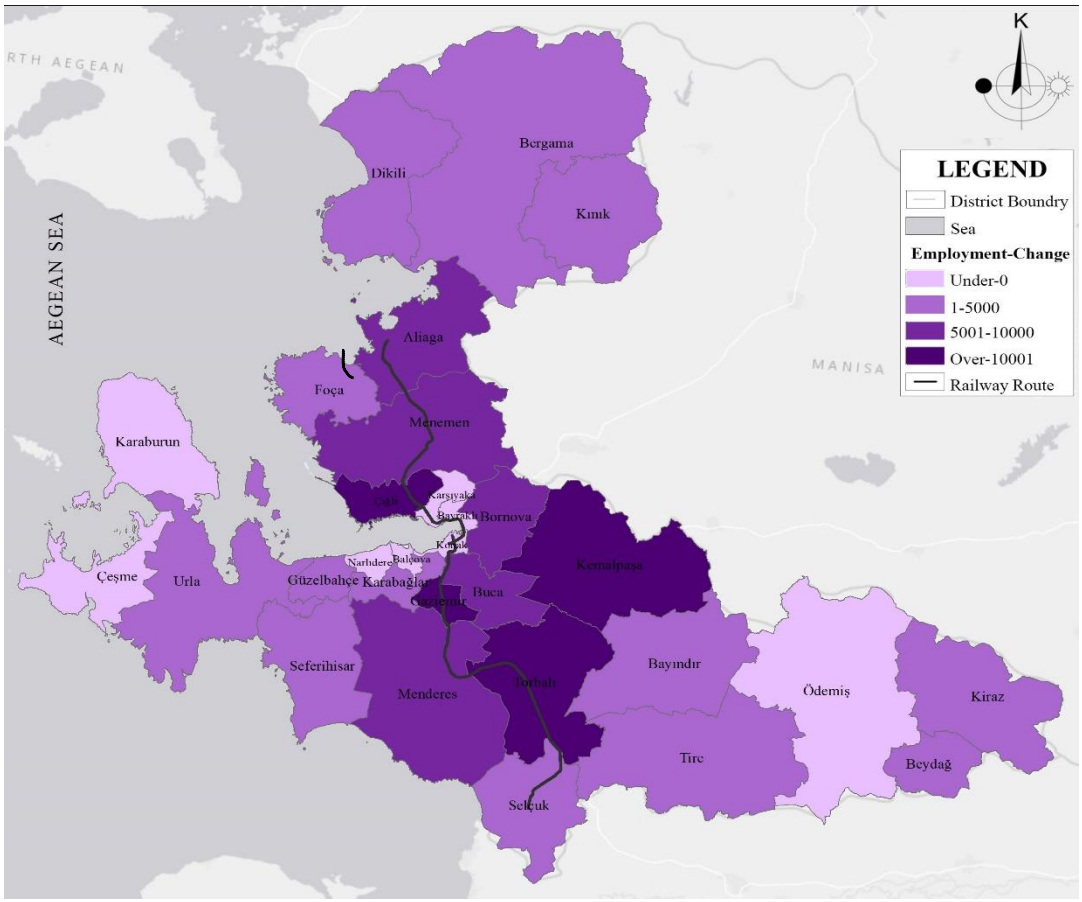

Figure 21. Industry Sector Employment Change in Izmir Between 2009-2019

5.4.3. Izmir Province Agriculture Sector Employment

Approximately 28.4% of Izmir's lands are agricultural areas. A total of 343 thousand hectares of agricultural land; 41.8% is field, 28.1% is olive, 11% is vegetable, 9.7% is fruit, and 3.6% is the vineyard. Izmir ranks first in the general production of Turkey with 30.9 % in ornamental plants production area, also ranking in the third place in vegetable production with 5.4%, in the 4th place in the fruit area with 4.4 %, and the olive area with 11.5%. Considering the total agricultural area sizes in Izmir; Bergama, Ödemiş, Torbalı, Bayındır Tire, Menderes and Menemen stand out. Crop production, animal production, and aquaculture production in Izmir; considering the production value and its share in total production, animal products have the highest percentage with 46.60%, followed by vegetable production with 42.36%, and a smaller share of aquaculture production with 11.04%. (IZTO, 2020).

When the agricultural sector employment in 2019 is examined, it is seen that the highest employment in agriculture is in Torbalı.

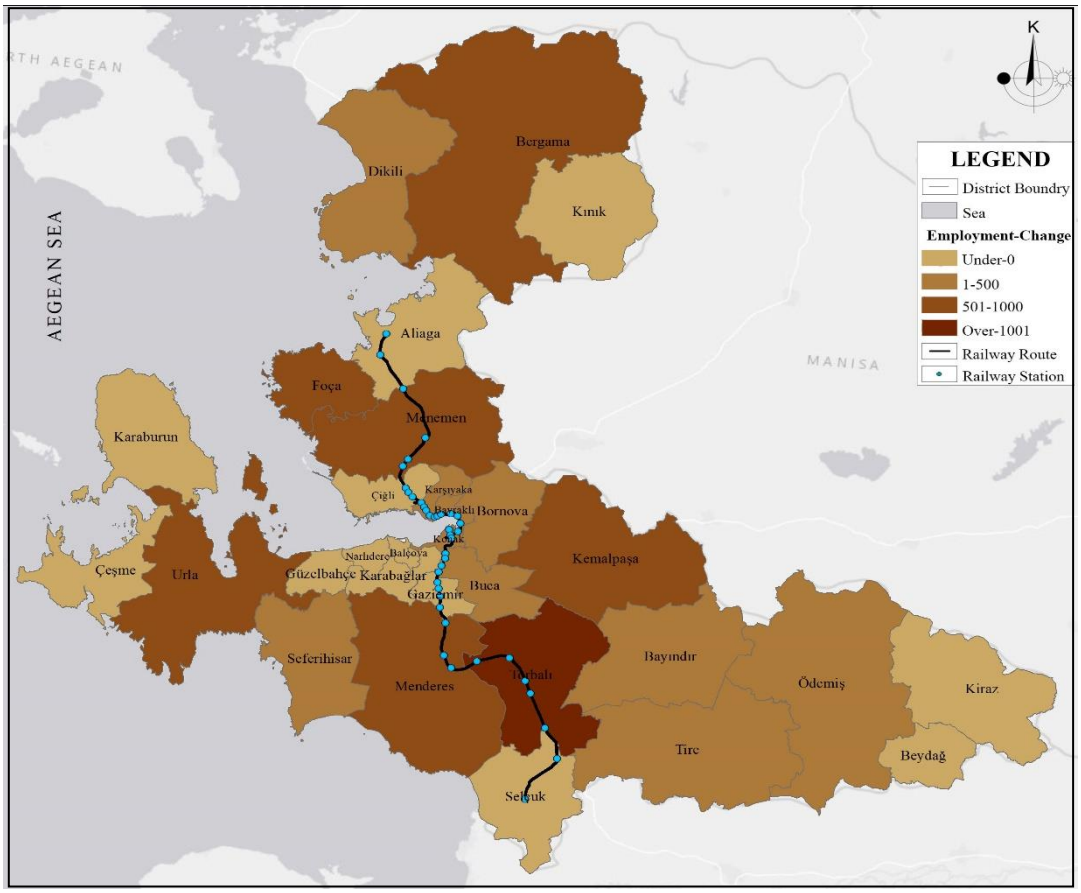

Figure 22. Agriculture Sector Employment Change in Izmir Between 2009-2019

In the 10-year period, agricultural employment increases, especially in the South region and the north most part of the city, and decreases in the Metropolitan region.

5.5. Place of Izmir in Country and Regional Transportation Lines

Izmir province is one of the provinces of Turkey that has four different modes of transportation (airway, highway, seaway, railway). There are two highways with a total length of 228 km connecting Izmir to other provinces within the city bordersrurubber. Along with these highways, there are four main highway axes.

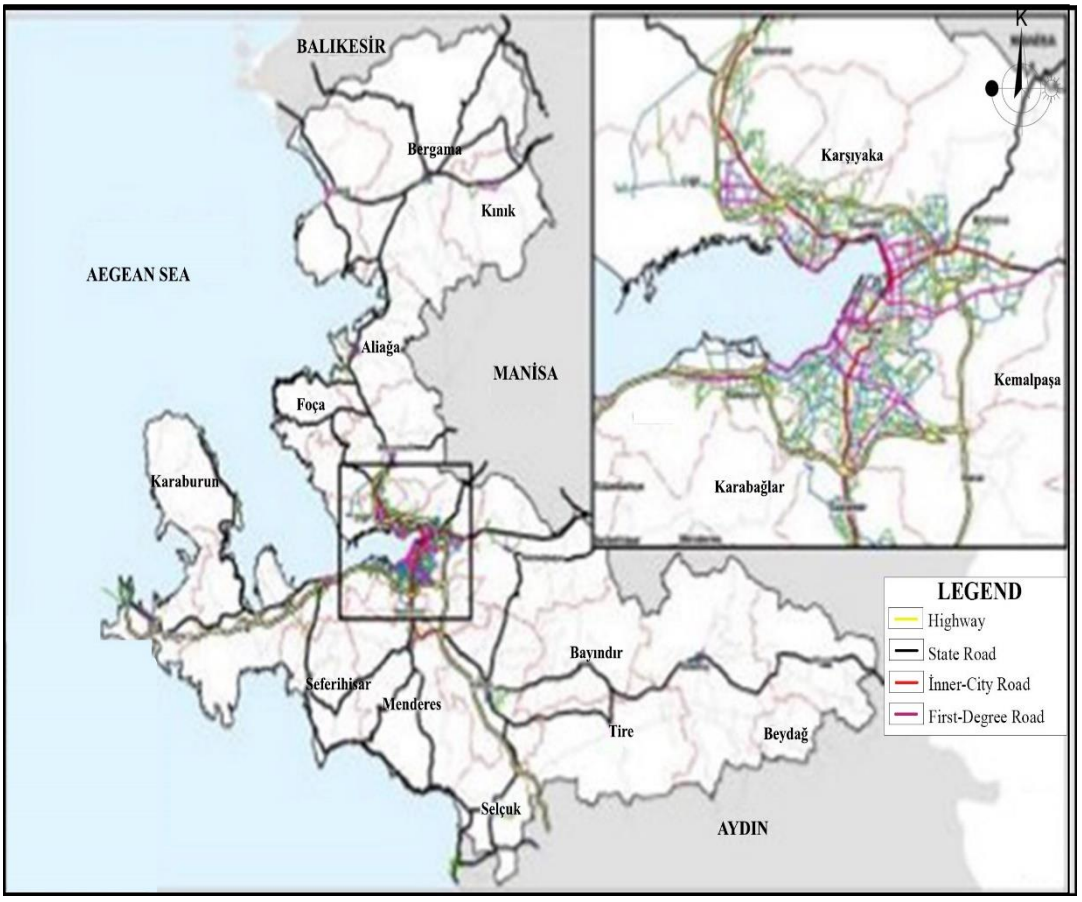

Figure 23. 2030 Izmir Transportation Master Plan (IMM, 2017)

Two important axes connect to the ring road in the city. One of these is the north-south direction Izmir-Aydin highway connecting the city to Aydın, and the other is the Izmir Çeşme highway, which provides highway access on the east-west axis of the city. When the state roads connecting the city to the districts and neighboring provinces are examined, two important lines are seen in the North-South direction.

There is the Aliağa-Menemen highway connecting the city to Manisa in the north, and the Torbalı-Selçuk highway connecting the city to Aydın in the South. On the east-west axis, important state roads, in the east Kemalpaşa, Turgutlu, Salihli roads, and in the west, Izmir-Çeşme and Izmir Karaburun roads serve for the highway access of the city. (Izmir Metropolitan Municipality, 2012).

One of the oldest railway lines in Turkey was established in Izmir in 1859. With this railway, it connects Izmir to Eskişehir, Ankara, Balıkesir Denizli and Isparta provinces. (Izmir Metropolitan Municipality, 2012). This railway, which provides the connection between the provinces, will also serve the suburban system of Izmir with the agreement between TCDD and Izmir Metropolitan Municipality in the following years. Along with railway and road transportation, there is also air transportation in the city. Adnan Menderes Airport, located between Gaziemir and Menderes and 18 km from the city center, was established in 1987. Access to the airport, which offers transfer opportunities by road and railway (IZBAN) within the city, is high.

Due to the fact that the city has a coast to the Aegean Sea, it has important ports serving in freight and passenger transportation. There are two ports in the city, which are important for export and import. As of 2020, Aliağa port ranks 3rd among ports in Turkey with the handling of approximately 60 million tons, while Izmir port ranks 13th with the handling of 8,3 million tons as of 2020 (Maritime Sector Report, 2021). Cruise passenger transportation is carried out at Çeşme, Alsancak, and Dikili ports.

5.6. Izmir Urban Transportation System

In this section, the urban transportation system of Izmir evaluated, and the effect of IZBAN on urban transportation examined. In Izmir, public transportation is carried out by means of transportation infrastructure, wheeled system, rail systems, seaway

system, minibus, taxi-dolmus, shuttle, and taxis. Also the integration of IZBAN with other modes of transportation is mentioned.

Eshot general directorate and İZULAS Inc. are the organizations that provide public transportation services in the city. While the general directorate of Eshot, which owns 1766 vehicles, provides the majority of rubber-tired transportation (ESHOT Annual Report 2020), İZULAS Inc. also contributes to urban transportation services with 300 buses. (IZULAS, 2020).

There are light rail systems, metro and suburban lines in the city. Izmir Metro INC. carries out light rail systems and the services of the metro, and the suburban line is carried out by IZBAN. While the IZBAN line serves the city in the north-south direction, light rail systems serve in the east-west direction, which is shown in figure 24. While the average number of passengers per day in the suburban line is 249,000, this number is 293,000 in light rail systems. (Izmir Metropolitan Municipality, 2017).

Figure 24. Izmir Railway Routes

IZDENIZ Inc. provides sea transportation in the city. Passenger transportation is carried out on 11 routes for sea transportation in Izmir. Some of these lines (Foça and Yassıcaada lines) serve periodically. In addition to passenger transportation, vehicle transportation is also carried out on the Bostanlı-Üçkuyular line. Sea transportation in the city is provided by a total of 24 vehicles, including 15 light passenger ships, one passenger ship, four car ferries, and four passenger engines (IZDENIZ, 2020).

The cable transportation system in the city is carried out via the Izmir cable car. The line, which was put into service in Balçova Dede Mountain in 1974, was closed for operation in 2007. In 2015, the cable car line was reopened and

continued its activities. There are 20 cabins in total, and 1,200 people are transported per hour.

There are 1,117 minibusses with M license plates in the city. These vehicles serve on 64 different routes with a total of 46 stops. The total number of daily trips is 17,831. While 135 taxis and minibusses serve on six routes in the city, these vehicles carry an average of 14,000 passengers per day (Izmir Metropolitan Municipality, 2017). The number of taxis serving in the city is 2,545, with an average of 5 vehicles working at one stop.

According to the data obtained from the Izmir Transportation Master Plan, a total of 5,882,387 trips are made in the city during the day based on the data for 2015 (Izmir Metropolitan Municipality, 2017). When the distribution of these journeys according to transportation types is examined, pedestrian journeys have the highest share with a rate of 37%. Public transport journeys follow with a rate of 28%. Private vehicle journeys have a share of 24%; shuttle trips have the lowest rate with 11%. When compared with Istanbul, it is seen that the share of public transportation in all journeys is 24.52% in Istanbul, and this rate is low compared to Izmir.

When the ratios of public transportation systems to types are evaluated, the highest share of municipal buses is 46.41%. Minibusses/dolmuses follow this number with 17.64%. Izmir Metro, the light rail system in the city, has a share of 13.96% in the total, while the share of IZBAN, which is a suburban system, is 11.49% (Izmir Metropolitan Municipality, 2017). In this context, it can be said that the passenger transportation in the city is mainly made by buses and minibusses, while the share of rail systems in the total is determined to be in the second and third places.

5.6.1. Mass Transportation Systems

With the metropolitan municipality law in the 2000s, the service area of the municipality expanded, and it became essential to strengthen the transportation of

the city center and the suburban regions, where daily transportation relations with this center are high. In establishing such a connection, not only the development of urban transportation was aimed, but it was also a goal to make Izmir a city region.

In order to provide access to this corridor in the South-North direction, a partnership agreement was signed between the central government and the local government in 2007, and the foundations of the Izmir Suburban Line (IZBAN) were laid. The institutions involved in the establishment of IZBAN are the Republic of Turkey State Railways (TCDD) in the central administration and the Izmir Metropolitan Municipality in the local administration. This project aims to provide a more modern, fast, and comfortable railway transportation that will serve the city and sub-regions by modernizing some parts of the line that is currently owned by TCDD and passing through Izmir. Thus, to solve the current transportation problems of Izmir and to increase urban accessibility. IZBAN line operation years ın 2010 are shown in figure 25. Three years after the agreement, the first test runs on the line were carried out between Alsancak and Cumaovası. In the same year, the line was extended to Çiğili. The line, which was extended from Çiğili to Aliağa in 2011, was extended from Cumaova to Tepeköy in the South in 2016, and a year later it was extended from Tepeköy to Selçuk in the same direction. By 2019, the line length has reached 136 km. One of the most significant benefits of this project is that it connects the North and South regions without being dependent on the center. In addition, IZBAN has created new trip demands in the city (Şenbil, 2018b).

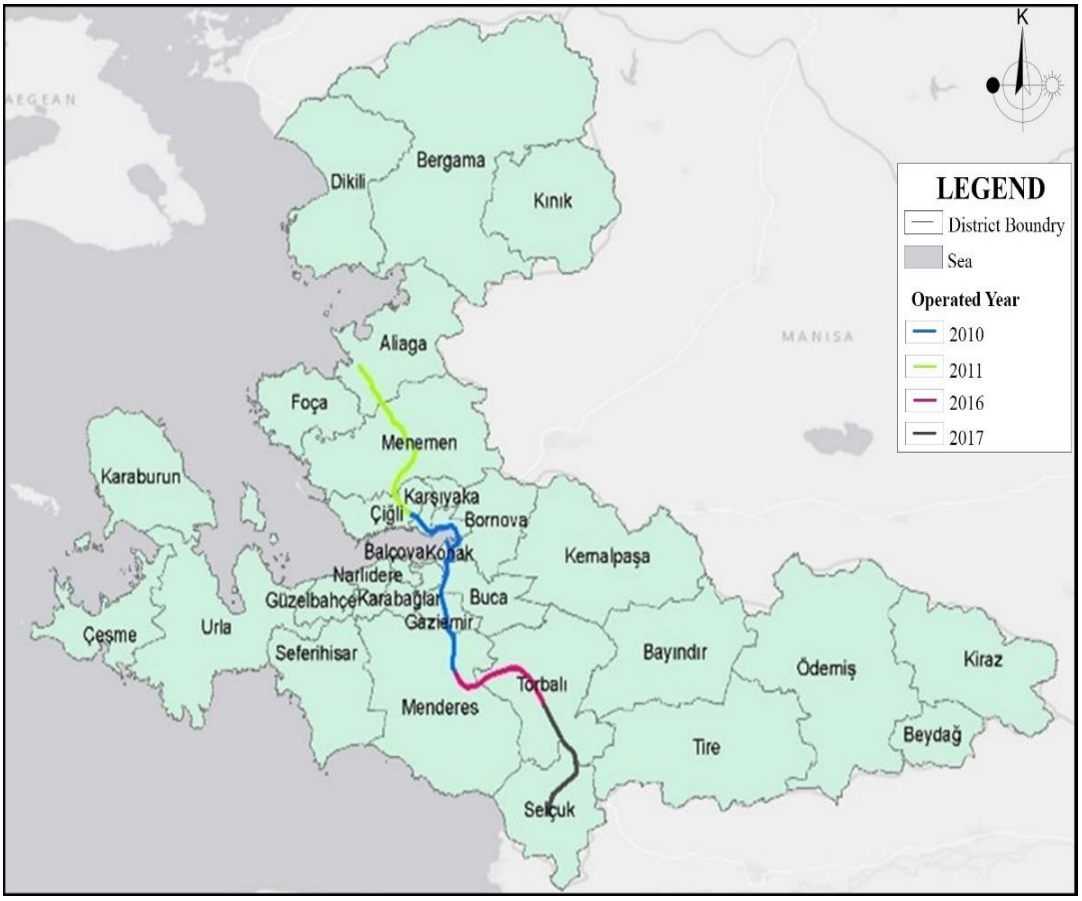

Figure 25. IZBAN Line Operation Years

It is named the north axis between Aliağa and Menemen, the central axis between Menemen and Cumaovası, and the south axis between Cumaovası-Tepeköy-Selçuk.Station zones provide integration of the IZBAN line with other transportation lines. Bus service is provided at many stations, access to the station has been increased, and the station's area of influence has spread to more expansive areas. Again, some stations in the city center are connected to both the tram and the metro. "Park and Ride" areas are created at many stations, allowing private car users to make modal shifts. In addition, with some stations of this line being close to the airport and port, integration into both air and sea transportation has been ensured. According to the 2030 plan, IZBAN, which will extend to Bergama with its north development, is planned to serve all districts except the peninsula and eastern districts (Tekeli, 2018).

5.6.2. IZBAN

Izmir Metropolitan Municipality of Izmir suburban rail and the Republic of Turkey State Railways (TCDD), a joint venture of the institution, was founded in 2005. The operation of the line depends on IZBAN INC.., which was established in 2007. Halkapınar-Cumaovası route, which is the first stage, was opened on 30 August 2010. A total of 80 million passengers have been transported in the 8-year period from August 2010, when the IZBAN line was put into use, until August 2018 (ESHOT General Directorate, 2018).

The South of the line was extended to Tepeköy, and the current line length reached 110 km, and the total number of stations reached 38. By 2018, the line was extended again in the south direction and reached Selçuk district. Finally, with the opening of the Belevi station in 2019, the line length has reached its current state, 136 km, and 41 stations. The line extension continues in 2018 with the extension of the line up to Bergama district in the north. With the continuation of this extension work, the total length of the line will be extended by 52 km, and eight more stations will be added (Izmir Metropolitan Municipality, 2020).

Currently, the IZBAN line serves up to Aliağa in the north of the city and to Selçuk district in the South. With the connection of the IZBAN line to the airport, it is among the country's most important public transportation systems. (IZTO, 2020). IZBAN line consists of 3 axes as north, south, and central axes. While the north axis is the line between Aliağa and Menemen stations, the central axis is between Menemen and Cumaovası. The south axis is the line between Cumaovası-Tepeköy-Selçuk. The three axes mentioned above will be used separately in this study, and comparative evaluations will be made.

IZBAN Passenger Statistics

The total number of trips on the IZBAN line between 2013 and 2018, shown in figure 26, reached approximately 473 million. Among the specified years, the highest suburban railway use was in 2017 with 93 million. While the use of

suburban lines increased between 2013 and 2017, in 2018, there was a decrease of approximately 14% in the trips made by the suburban line compared to the previous year.

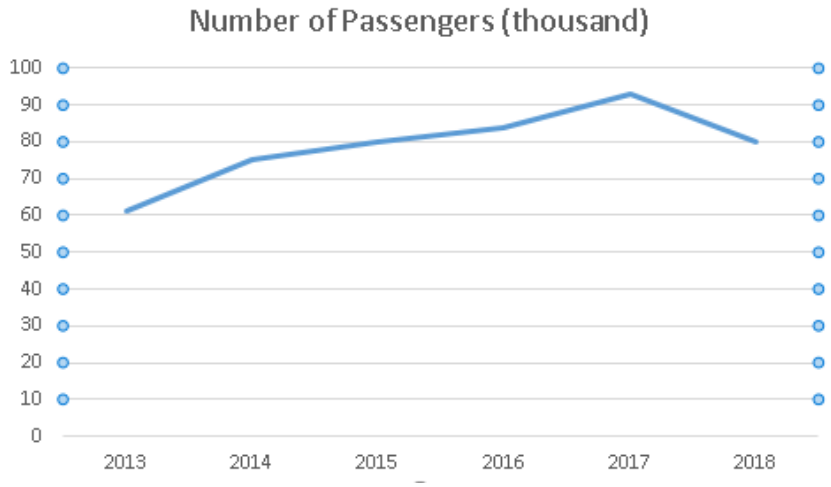

Figure 26. Number of Passengers Carried By IZBAN in Years (ESHOT Annual Report, 2008)

The total number of trips made by public transport in 2018 is 514 million. When the distribution of the number of passengers in public transport in Izmir province in 2018 is shown in figure 27, it is observed that the most common means of transportation in public transportation are municipal buses (47%). The Izmir suburban line is the third most widely used transportation type (16%) (ESHOT, 2018).

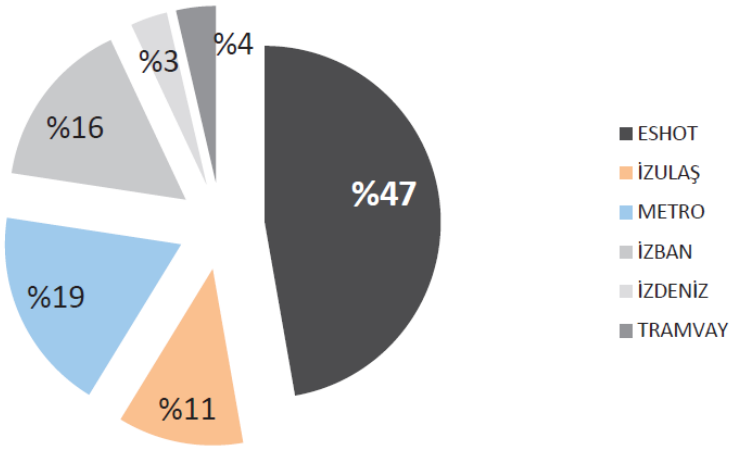

Figure 27. Public Transport Share by Modes (ESHOT Annual Report, 2008)

The passenger numbers of IZBAN stations on November 8, 2018, are shown in figure 28. When the number of daily passengers is examined, it is seen that the stations with the highest number of passengers are Halkapınar, Şirinyer, Alsancak, and Hilal stations in Konak and Buca districts in the metropolitan area center. One of the general properties of these stations is their high integration with other modes of transportation (bus, metro, tram, etc.), serving the city center. On the other hand, the average number of passengers at the district stations serving district centers in the North region is over 7,500. In the IZBAN South sub-region, station passengers are lower than in the North region.

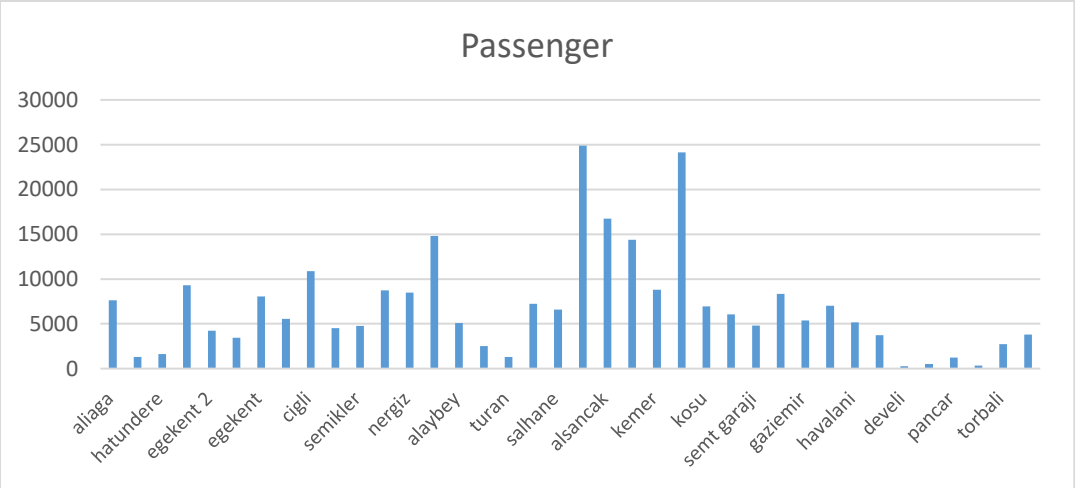

Figure 28. IZBAN Stations Number of Passengers in 2018 (Şenbil et al. 2020)

Concerning figure 28, created according to the journey numbers of the stations above, the number of passengers is homogeneously distributed between Şirinyer and Cumaovası stations in the south (5,000-10,000 people), while the number of passengers at the stations after Cumaovası remains below 2,500. In the north, it has been identified that the number of station passengers is concentrated, especially in the district centers (Çiğli, Menemen, Aliağa) and that there is a heterogeneous distribution at other stations.

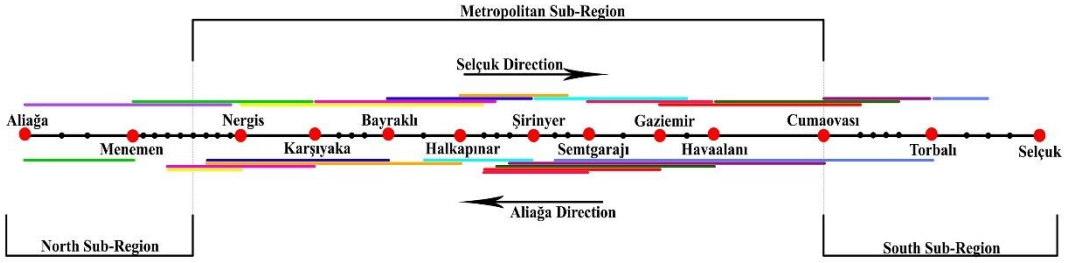

Figure 29. Based on the Number of Stations 85% of Passengers Travel Distance at the Morning Peak of İZBAN Stations Dated 8 November 2018 (Şenbil et al. forhcoming)

Izmir suburban system connects the city center and suburban areas, but also serves many stations that are closer to each other in the metropolitan area. In other words, it serves suburban areas, but also serves as urban transit in integration with other types of urban transportation. The system, which is integrated with the metro at Halkapınar station, is integrated with the tramway at Mavişehir and Alaybey stations. At Şirinyer station, it is integrated with the city bus system. The figure above shows the trip distance traveled by 85% of passengers using IZBAN stations on November 8, 2018 at 29. For example, 85% of those who get on at Bayrakli station and travel towards Selcuk complete their trip to Şirinyer station. Those who go to Aliaga from the same station complete their trips after 8 stops. As can be seen from Figure 29, trips from the south subregion to Aliaga reach the metropolitan subregion, while trips from the north subregion to the Selcuk direction do not reach the metropolitan area and again trips take place in the north subregion. Again, the

travel distance in the metropolitan area does not reach the north or south subregion, their trips are completed within metropoliten subregion borders.

5.7. Upper Scale Plans Transportation Decisios for Izmir

By taking the plan made in 1973, the 1/25.000 scale metropolitan area land use plan revision was carried out in 1989, but as per the law enacted in 2002, the authority of the metropolitan municipalities to make 1/25.000 scale plans was limited, so the plan could not be implemented. After this period, four plans with a scale of 1/25.000 were prepared (Ministry of Environment and Urbanization, Spatial Planning General Management, 2021). These are, in order:

1. Tahtalı Territorial Development Plan
2. Seferihisar-Dilek Penissula Coastal Region Plan
3. Çeşme- Karaburun Territorial Development Plan
4. Izmir-Manisa region Territorial Development Plan

Izmir 1/25,000 Scale Master Development Plan in 2009

The primary purpose of the 1/25.000 scaled Master Development Plan Revision is to eliminate the problems created by the rapid and uncontrolled urbanization, fragmentary and sectoral planning in the city of Izmir and its surroundings. Furthermore, other objectives are to ensure the controlled development of urbanization and industrialization, make the developments sustainable, and prevent interventions that will disrupt the ecological balance.

The urban development goals of the plan are to confine the central city within the so-called in-pot area in the directions permitted by the approved plans. The second goal is to create a green belt, including the Gediz, Emiralem, Nif, and Tahtalı basins extending from west to east also merging with the Küçük Menderes basin. The third is to create a peripheral settlement belt, this time starting with Aliağa in the north, continuing with Kemalpaşa and Torbalı, and ending with Urla. The fourth is the creation of a second green belt that connects the Bakırçay basin in the north of Aliağa and the Büyük Menderes basin in the south of Selçuk. Thus, the

growth of both the central city and the peripheral settlements will be constrained among the grand green belts.

Development Decisions for Metropolitan Sub-Region

The region, including Konak, Karabağlar, Karşıyaka, Bayraklı, Bornova, Buca, Narlıdere, Balçova, Gaziemir, Çiğli and Menemen counties and rural areas within the boundaries of Izmir Metropolitan Municipality, is defined as the Merkezkent Sub-region. The 2030 target population has been accepted as 3,897,392 (68% of the urban population). Housing areas have not been increased due to insufficient social facilities and high population density. With the decentralization of the industry, it is foreseen that the surrounding residential areas will also be decentralized. If the population increase in the central city is higher than expected, it will be located primarily in the empty areas and then in the existing settlements in the periphery.

Development Decisions for North Sub-Region

This region, which covers all of Aliağa and Foça districts and is a part of Menemen district, has been defined as the North Urban Development Subregion. It has been emphasized that although it has rich agricultural lands due to being in the Gediz Basin, it is under a deadline of industrialization. Although the industrial and port developments put pressure on the population, it was thought that the population would be supplied both in this region and from the center with the Izmir Aliağa railway line to be established. In 2030, it is predicted that 8% of 482,639 people will be located in the north urban development sub-region.

Development Decisions for South Sub-Region:

This region, which consists of the transportation axes of the Izmir Urban Zone oriented to the south and southeast, and the Torbalı district and most of the Bayındır district located around it, and a part of the Menderes and Selçuk districts, has been defined as the South Urban Development subregion. It is observed that Torbalı, which is one of the settlements within the south urban development sub-

region, is detached from the central city but has been significantly affected by the city of Izmir with its functions and industrial developments. As a result of this influence, it is seen that the scattering tendency, which has developed by destroying the fertile agricultural areas on the Torbalı axis, exceeded the Torbalı center and caused an increase in the settlements along the highway on the Çaybaşı-Subaşı line. It is foreseen that the housing need that will arise resulting from the industrial development in the South Urban Development Sub-region will be met from the planned areas in Ayrancılar, Yazıbaşı, and Pancar settlements. The South Urban Development Sub-region settlements are also located in the Küçük Menderes Basin, and its economy is based on agriculture. It is predicted as one of the development axes of the industry due to its physical development, road, and railway connections, as well as the strengthening of transportation connections with the Aydın highway. In the 2030 target year, it is foreseen that 8% of 481,946 people would be located in the south urban development sub-region.

Urban Development Areas:

According to the existing zoning plans, no new development area decision has been made in settlements with larger development areas than the required area.

When the general decisions of the Izmir Master Development Plan Revision are studied, it is evident that new development areas have been arranged in this direction, especially since Izmir is located on the north axis of the industrial development. The fact that central investments, highway, and railway connections are programmed to strengthen the transportation connections of these areas also supports this development.

1/100.000 Scale Izmir-Manisa Territorial Development Plan

1/100,000 scale Territorial Development plan covering Izmir and Manisa provinces was approved on 23/06/2014. In this article, the railway decisions in the plan will be examined. While the railways providing intercity access with short connections within the province are shown in the plan, in addition to these, the rail system proposals existing and projected in Izmir were also transferred to the plan.

The plan includes railway connections between Izmir-Aydın, Izmir-Manisa-Balıkesir, Izmir-Manisa-Uşak, as well as railway connections between Izmir-Aliağa, Izmir-Bayindır-Ödemiş, Izmir-Bayindır-Tire, and Izmir-Kemalpaşa-Tire, which is in the project phase. Turgutlu railway connection is also shown in the plan. With the plan decisions, it was aimed to connect the existing line between Izmir and Aliağa to the north Çandarlı Aegean Port to raise it to metro standards, to connect the same line to Soma via Bergama, and to provide a connection to the line that provides railway access between Izmir and İstanbul. The railway proposal connection between Adnan Menderes Airport and Bergama, which attracts many tourists. On the other hand, it was aimed to facilitate access to the north Aegean Port by rail from different parts of the country (Ministry of Environment and Urbanization 2021).

It has been determined that the existing railway routes are generally used within the borders of the planning region for the high-speed train that is planned to be built between Ankara and Izmir. The high-speed train line under the project follows the Salihli-Turgutlu-Manisa axis from the north of Alaşehir and ends in Menemen. In this context, the high-speed train line was transferred to the plan with the high-speed train display, apart from the conventional railway line.

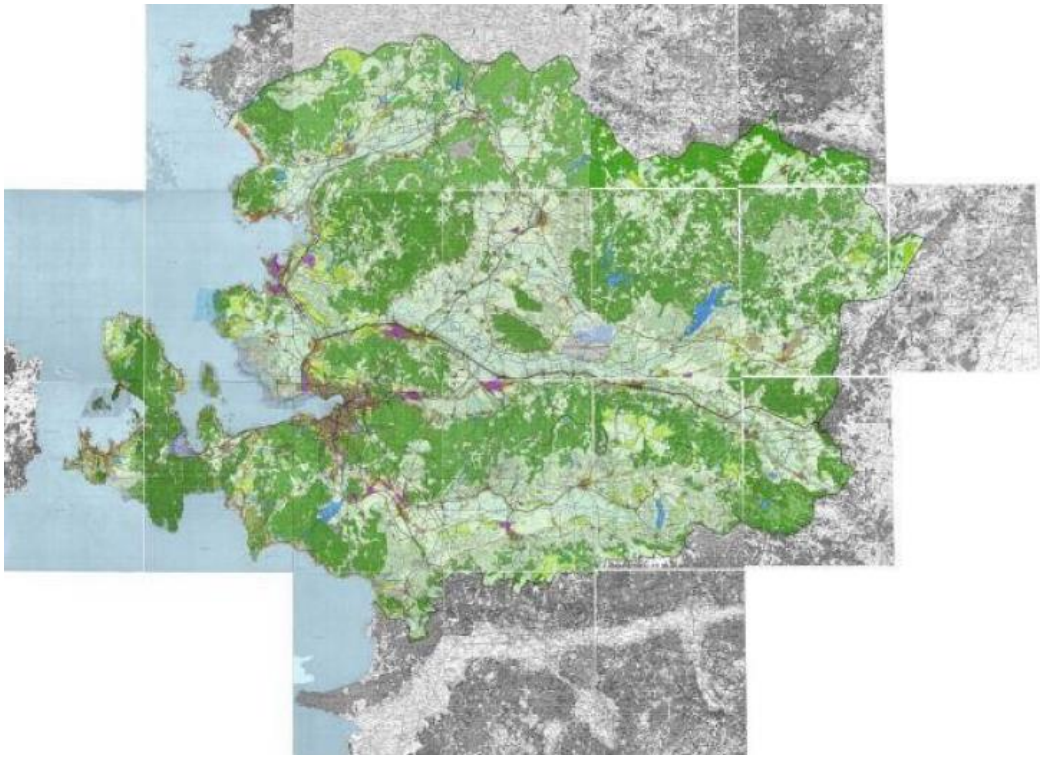

Figure 30. Izmir-Manisa Planning Region 1/100,000 Scale Environmental Plan (Ministry of Environment and Urbanization, 2021)

In addition to the existing metro line in Izmir, the light rail system and metro proposals planned by the Izmir Metropolitan Municipality are also included in the plan. In this context, the existing rail system line between Bornova and Hatay was extended to Izmir Institute of Technology in the west via Üçkuyular-Balçova-Güzelbahçe-Urla. In addition, the rail system branch that will provide the connection between Üçyol and Buca is also shown in the plan. The rail system line, which ends in front of the University Hospital in Bornova for today, to be extended over the Ege University Campus to the center of Bornova, is also included in the plan. Considering that the existing railway between Menderes and Aliağa will be transformed into a light rail system, with the completion of the rail system proposed in the plan, a rail system connection will be provided between the important residential areas in the north, south, east and west directions of Izmir, as well as the city center and working areas (TMMOB, 2020).

Izmir Transportation Master Plan (UPI) 2030

According to current trends, the current situation analysis was made in the plan prepared in 2017, and transportation decisions were taken for the 2030 projection year. In the plan, it has been determined as 6.2 million people as the 2030 population projection. It is predicted that the population will increase by 58% between the 2015-2030 periods. Despite the increase in population, vehicle ownership is expected to increase by 125% between 2015 and 2030. Again, in the plan, it is foreseen that the number of daily trips will increase by 75 % and reach 10.2 million from 5.8 million in the same period intervals. Suppose no transportation investment is made until 2030. In that case, it is estimated that the share of private vehicle transportation in all transportation modes will increase from 25% to 29%, and public transport will increase from 25% to 26.5%. The pedestrian trip is expected to decrease from 35% to 30%.

The plan also mentions high-speed train projects and the investments to be made in these areas by determining the direction of city development. The high-speed train projects mentioned in the plan are as follows. Izmir Ankara high-speed train project is planned to reduce the existing 824 km railway to 624 km and reduce the travel time from 14 hours to 3 hours and 30 minutes. The project's station, which aims to connect two metropolitan cities, is planned as Halkapınar, which is the intersection and transfer point of the railways. It is thought that connecting the high-speed train to the city from a single point will cause congestion around the planned station. For this reason, a high-speed train is planned from Menemen district to Manisa in the north. After Manisa, it is planned to connect to Ankara Izmir high-speed train (UPI, 2019).

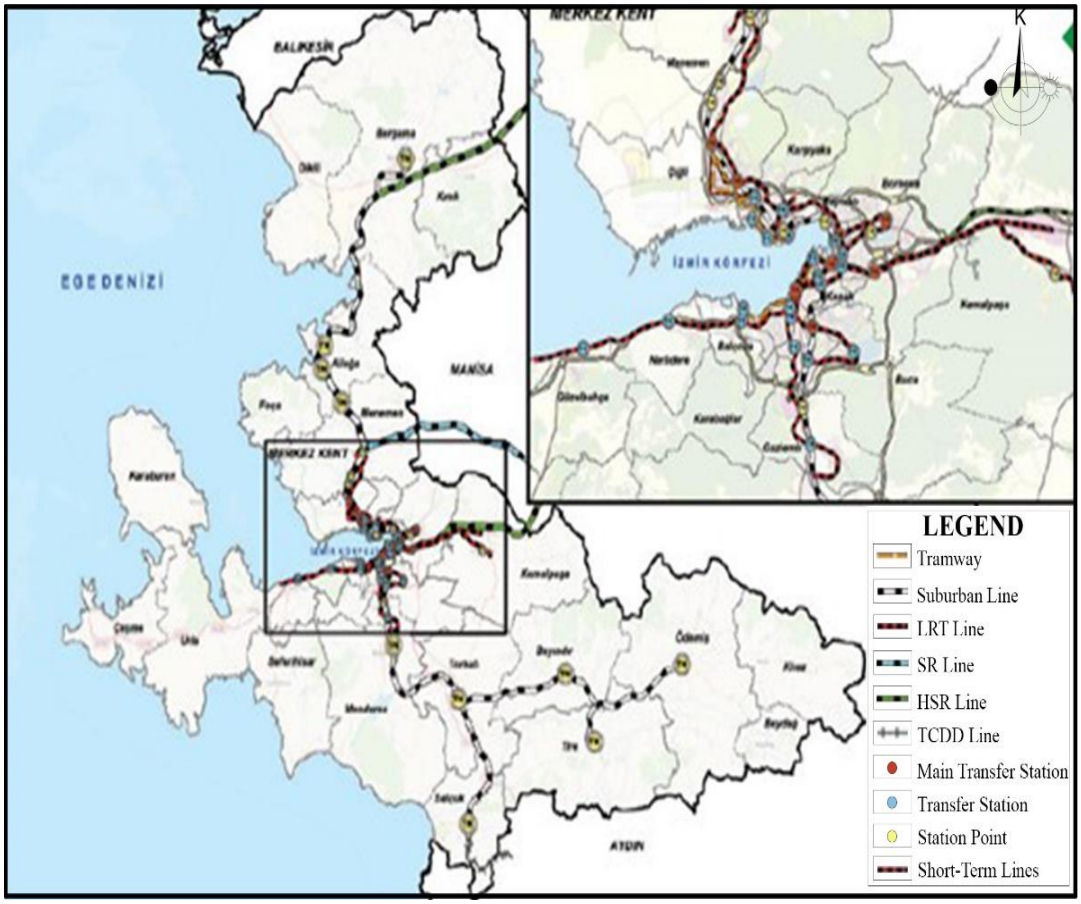

Figure 31. 2030 Izmir Transportation Master Plan Railway Lines (UPI,2019)

The Menemen-Bandırma line, which serves as the existing convectional line, is planned to be transformed into a high-speed train by making the necessary infrastructure works. While the urban railways were organized in the plan, the suggestions were arranged according to the city development expectations. It is predicted that the city will develop on the Karşıyaka, Çiğli and Menemen axis in the north. It is assumed that the study areas will be concentrated in Bornova and Kemalpaşa districts in the east. In the target year of 2030, it is planned to increase the length of the railway line to 664 km. In line with the development expectations, the proposed railways are concentrated north of the center and the west.

Evaluation of Recent Izmir Plans

When the recent Izmir plans are examined, it is accepted that decentralization occurs in the metropolitan area in the 1/25.000 scaled provincial master plan, but this is ignored in the population projection. The effect of IZBAN was evaluated especially in the North sub-re. It predicted that the industry would intensify in this region and that there would be a more detached development from the center in Baglı and its surroundings in the south. However, IZBAN serves not only in the north but also in the south. The effect of IZBAN on possible urban development in this region has not been evaluated. In addition, for 2030, the ratio of north and south in the total population has been reached in a 10-year period. The speed of decentralization from the center could not be measured. Although the industry is focused on in the North sub-region, the increase in the service sector in Aliağa in the north, Menderes, and Torbalı in the south has not been emphasized.

The 1/100,000 scale environmental plan is planned to extend the IZBAN line in the north to Bergama and in the south to Ödemiş in the east direction. While these developments in the north-south direction were planned, a high-speed train line was also planned from Güzelbahçe to Kemalpaşa, which passes through the center in the east-west direction. The pressure in the center will increase even more with the integration of all the main transportation lines of the city development in the central area and the connection of the Ankara-Izmir high-speed train line here. In the current situation, with the north-south development strengthened by the IZBAN line, the east-west development will take place with the high-speed train, and it will become more challenging to control the urban development.

Summary of the Chapter

The population of Izmir has increased rapidly over the 10-year period, especially in the north, south and peninsula regions. In Konak, which is the center of the metropolitan region, and in the Southeastern sub-region, the population growth rate remained below that of the province as a whole. Employment in Izmir province increased in the Aliağa, Menemen and Çiğli districts in the north and in Torbalı and

Menderes districts in the south over a 10-year period. In addition, employment increased in Bornova, Buca, Gaziemir, Karsiyaka and Kemalpaşa districts around Konak district in the metropolitan region. The employment growth rate is high in Cesme and Urla districts, which are the focus of tourism in the peninsula region. From here, the population and employment were decentralized from the metropolitan area core to both the metropolitan area wall and the north-south regions by inference. When the high-scale plans of Izmir province were examined, it was envisaged that urban development would take place from the metropolitan area to the north and south. It is envisaged that this development will take place within the areas they define as the green corridor. When the change in population and employment according to the subregions is examined, the regions with an increase coincide with the IZBAN impact area. In order to measure the complementary effect of suburban railway on urban development, an analysis was carried out at the level of the neighborhoods around the station in the following section.

CHAPTER 6

POPULATION AND EMPLOYMENT ANALYSIS OF IZBAN, NON-IZBAN NEIGHBORHOODS

In the chapter above, the employment and population analysis at the province level were made, and the development and statistical evaluation of IZBAN were made. In addition, Izmir province's upper-scale plans, the city's urban development, transportation decisions, and IZBAN decisions are stated. This chapter mostly concentrates on district which IZBAN passing through and the IZBAN's impact area which named as IZBAN neighborhood. These subregions are Aliağa, Menemen, Çiğli in the north, Karşıyaka, Bayraklı, Bornova, Konak, Buca Karabağlar in the metropolitan, Gaziemir and Menderes, Torbalı and Selçuk in the south.

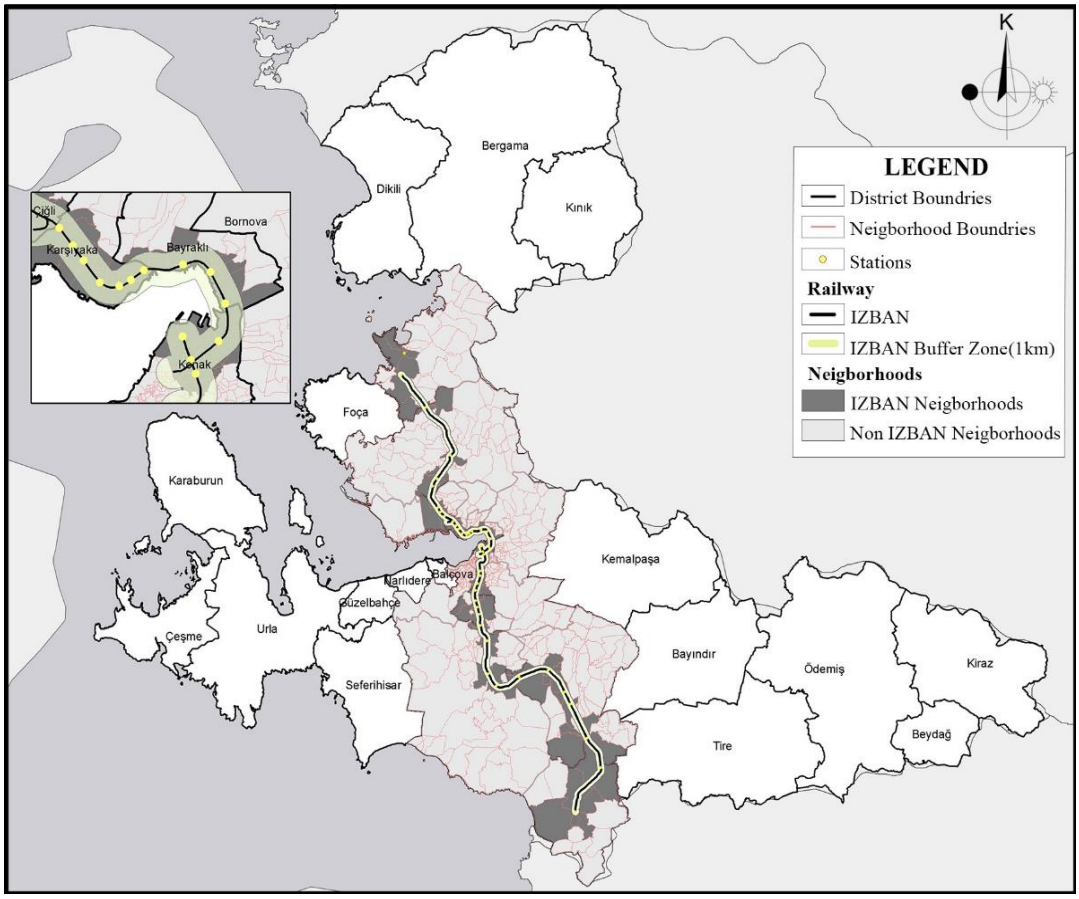

Figure 32. IZBAN and Non-IZBAN Neighborhoods

IZBAN districts are shown on the above figure 32. There are a total of 579 neighborhoods in IZBAN districts, of which 150 are IZBAN neighborhoods, and 429 are non-IZBAN neighborhoods. 60% of Izban neighborhoods are located in the Metropolitan region, 23.4% in the North region and 16.6% in the South region. The district with the highest number of IZBAN Neighborhood is Konak, while the district with the lowest is Karabağlar.

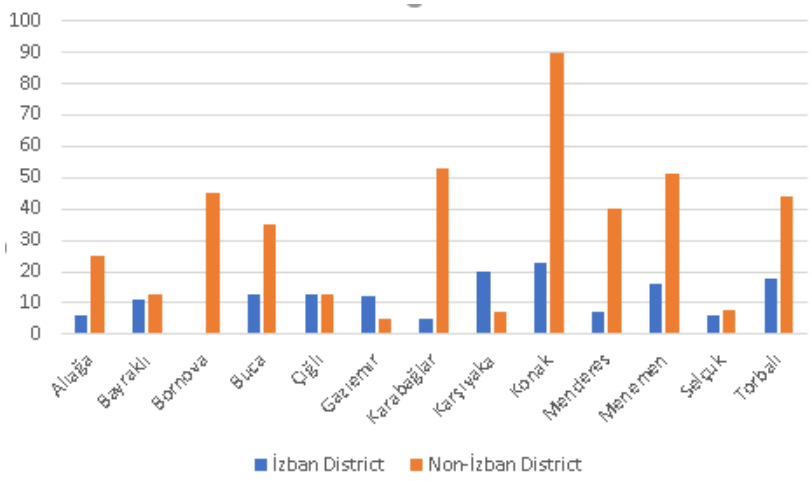

Figure 33. IZBAN and Non-IZBAN Number of Neighborhood

6.1. IZBAN District's Neighborhood Population Analysis

The neighborhoods located in the 13 districts served by the IZBAN line were evaluated separately as IZBAN and non-IZBAN neighborhoods and the general population change in these neighborhoods was examined.

6.1.1. Non- IZBAN Neighborhood Populatıon Change

Non-IZBAN neighborhoods which are at the sub-regions analyzed. When the 2009 and 2019 populations of non-IZBAN neighborhoods asses in figure 34 it is seen that the population of non-IZBAN neighborhoods has increased in districts except Karabağlar and Selçuk.

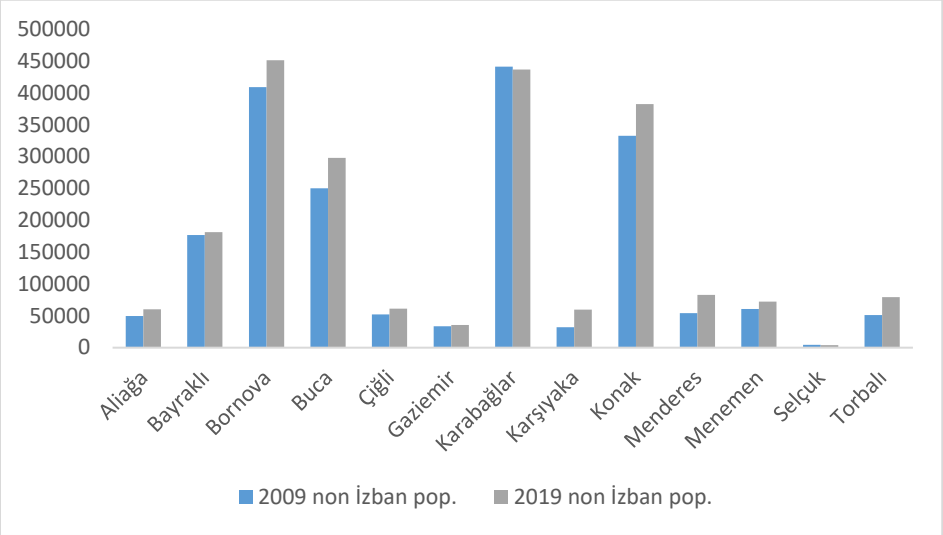

Figure 34. Non-IZBAN Neighborhood 2009 and 2019 Population

According to the table 1 the average population in the non-IZBAN neighborhoods of sub-regions within the IZBAN influence area was 4,540 in 2009, it increased 4,911 in 2019.

Table 1. Non-IZBAN Neighborhood Population Descriptive Statistics

Population (Years)	*N*	*Maximum*	*Mean*	*Std. Deviation*
2009	429	41179	4540.65	5729.547
2019	429	37334	4911.57	6231.148
Valid N (listwise)	429			

6.1.2. IZBAN Neighborhoods Population Change

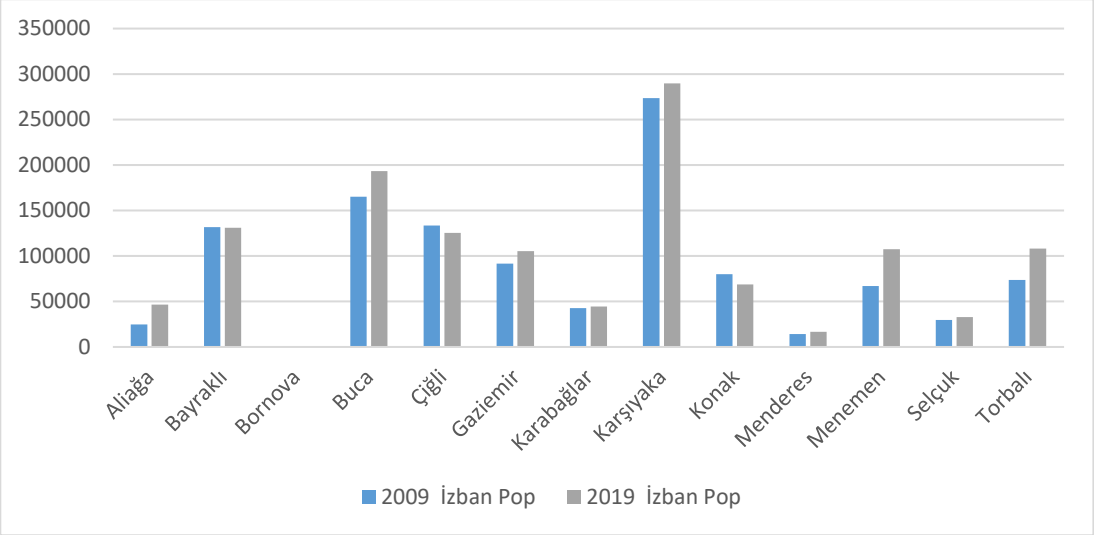

Figure 35. IZBAN Neighborhood 2009 and 2019 Population

While the average population of IZBAN districts was 7,517 in 2009, it increased by %12.7 in 2019 and the average neighborhood population reached 8,468. As figüre 35 illustrate only in Çiğli and Konak's IZBAN neighborhoods lose their populations. The total population in Konak decrease between the years 2009 to 2019, that's why the population lose in IZBAN neighborhood is also expected. However there increase in Çiğli's total population, the IZBAN neighborhood's population of it decreases.

Table 2. IZBAN Neighborhood Population Descriptive Statistics

Population (Year)	*N*	*Maximum*	*Mean*	*Std. Deviation*
2009	150	41066	7517.15	6901.428
2019	150	38403	8468.36	7514.012
Valid N (listwise)	150			

The Mann-Whitney U test was applied to measure whether there was a significant difference in population change in IZBAN and non-IZBAN neighborhoods in the sub-regions over a 10-year period. With this method, it has been tested whether the

population increase in IZBAN neighborhoods is higher than in non-IZBAN neighborhoods.

H0: There is no significant differentiation in terms of population change in IZBAN and non-IZBAN areas.

H1: There is a significantly higher in terms of population change in IZBAN and non-IZBAN areas.

Table 3. Descriptive Statistics of Sub-Regions Population Change (IZBAN, Non-IZBAN Neighborhood).

	N	*Mean*	*Median*
IZBAN Neighborhood	150	951	92
Non-IZBAN Neighborhood	429	599	13

According to the descriptive statistical data from table 3 IZBAN and non-IZBAN neighborhoods, the population increased 58.7% more in IZBAN neighborhoods than in Non-IZBAN neighborhoods.

Table 4. Test Statistics of Sub-Regions Population Change (IZBAN, Non-IZBAN Neighborhood).

Mann-Whitney U	*Wilcoxon W*	*Z*	*Asymp. Sig. (2-tailed)*
29143.5	121378.5	-1.79	0.085

To evaluate the the difference between IZBAN and non-IZBAN neighborhood population change was tested using Mann-Whitney U test. The test revealed not significance differences in population change of IZBAN neighborhood (Median=92, n=150) and non IZBAN neighborhood (Median=13, n=429), *U*= 29143.5, z=-1.179 p= .086 r= .05 As a result we can not reject the H_0 hypothesis which emphasize there is not a significance difference between IZBAN and Non-IZBAN neighborhood for population change.

6.2. IZBAN Neighborhoods Employment Change

IZBAN increase the accessibility between North South sub-regions to city center. It's also created a chance to firms access more costumers and low-paid workers. Firms get to drop on other firms and increase their competitiveness. Thus, station areas become an attraction location for the investors. With the investments around the station, there is an expectation for the employment increase in IZBAN neighborhoods. Thanks to these advances, is there a difference between IZBAN and non-IZBAN neighborhoods in terms of employment tested.

H0: There is no significant difference in terms of employment change in IZBAN and non-IZBAN areas.

H1: There is a clear divergence in terms of employment change in IZBAN and non-IZBAN areas.

Table 5. Descriptive Statistics of Sub-Regions Employment Change (IZBAN, Non-IZBAN Neighborhood).

	N	*Mean*	*Median*
IZBAN Neighborhood	150	1,828	735
Non-IZBAN Neighborhood	429	628	121

According to the descriptive statistical data from table 5 IZBAN and non-IZBAN neighborhoods, employment increased 191% more in IZBAN neighborhoods than in Non-IZBAN neighborhoods. It is observed that the increase in employment is especially concentrated more in the neighborhoods within the station's influence area.

Table 6. Test Statistics of Sub-Regions Employment Change (IZBAN, Non-IZBAN Neighborhood).

Mann-Whitney U	*Wilcoxon W*	*Z*	*Asymp. Sig. (2-tailed)*
20089	112,324	-6.853	.00

To evaluate the the difference between IZBAN and non-IZBAN neighborhood employment change was tested using Mann-Whitney U test. The test revealed significance differences in employment change of IZBAN neighborhood (Median=735, n=150) and non IZBAN neighborhood (Median=121, n=429) , *U*= 20089, z=-6.853 p=.001 r=.27 As a result we can reject the H_0 hypothesis which emphasize there is a significance difference between IZBAN and Non- IZBAN neighborhood for employment change. As indicators of employment change shows that the mean employment change of IZBAN neighborhoods higher than the non-IZBAN neighborhoods, the increase of employment is higher in IZBAN from non-IZBAN neighborhood.

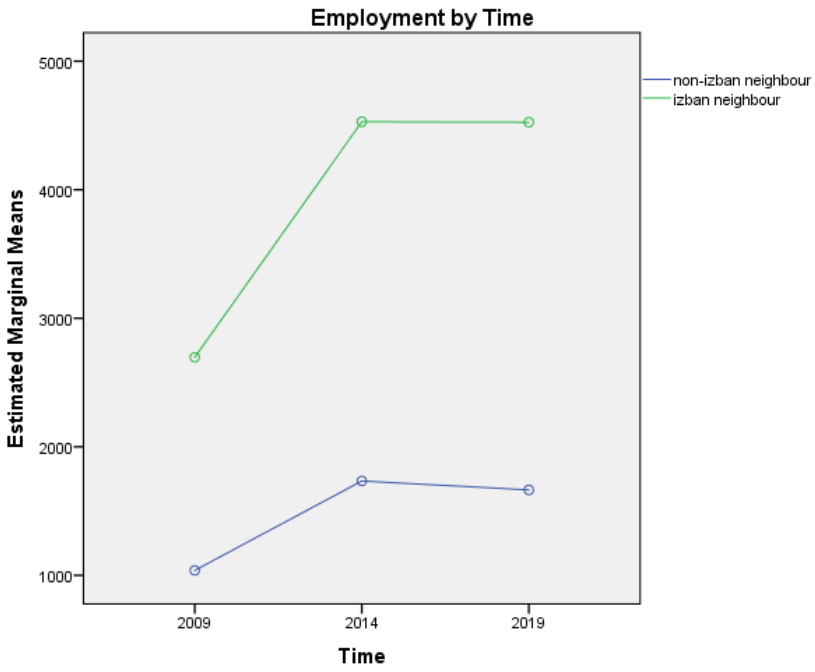

Figure 36. IZBAN, non-IZBAN Estimated Marginal Means of Employment by Time

As can be seen in the figüre 36, there was a large increase in estimated marginal means in IZBAN neighborhoods between 2009 and 2014, while this increase was less in non-IZBAN neighborhoods. Between 2014-2019, while the estimated marginal means did not change in IZBAN districts, a decrease was observed in

non-IZBAN districts. It has been observed that between 2009 and 2019, the employment increased in non-IZBAN neighborhoods, but decreased after 2014. In IZBAN neighborhoods, it was observed that the employment increased in 2009-2014 reached a balance between 2014-2019. It can be deduced from here that the railway investment facilitates stability around the station in the long term.

6.3. Sectoral Employment Change of IZBAN and Non-IZBAN Neighborhood

In this part, the differentiation of average employment by years in agriculture, industry and service sectors in IZBAN and non-IZBAN neighborhoods has been examined. Thus, it has been revealed which sectors are more affected by railway transportation. It increases the values of the properties around the station. With the increasing property values, choosing a location around the station becomes disadvantageous for sectors that carry out production activities in large areas such as agriculture and industry. On the contrary, the service sector shows more interest in the station environment as it can operate in smaller areas and face-to-face communication is more important than other sectors. For this reason, the selection of the location of service sector has more importance among the service sectors. With the light of the information above, it is expected that there will be no significant differentiation about the employment in IZBAN and non-IZBAN neighborhoods in the agriculture and industry sector, and there will be significant differentiation in the service sector.

Hypothesis: While the employment change in the service sector differs in IZBAN and non-IZBAN neighborhoods, the employment change in the industry and agriculture sectors do not differ.

Service Sector Employment Distribution Differentiation in IZBAN and Non-IZBAN Neighborhoods

Mixed-Design ANOVA method was applied to measure whether the distribution of employment in the service sector differs in IZBAN and non-IZBAN

neighborhoods. While IZBAN and non-IZBAN neighborhoods were determined as independent variables in the analysis, the dependent variables were determined as the number of service sector employees in 2009, 2014 and 2019. A two way 2 (Neighborhood: IZBAN or non-IZBAN) x 3 (Number of Service sector Employment: the year 2009,2014 or 2019) mixed ANOVA with repeated measures on the employmentloyment in neighborhood.

Table 7. Service Sector Employment Descriptive Statistics

Service Sector Employment (Year)	*IZBAN_neig*	*Mean*	*Std. Deviation*	*N*
2009	Non-IZBAN Neighborhood	728.93	2642.609	427
	IZBAN neighborhood	1831.63	4262.801	150
2014	Non-IZBAN neighborhood	1282.09	4112.406	427
	IZBAN Neighborhood	3309.88	5895.547	150
2019	Non-IZBAN Neighborhood	1237.38	3853.573	427
	IZBAN neighborhood	3452.07	5705.676	150

As can be seen in the descriptive table table 7, the average employment in the service sector neighborhood has increased for both IZBAN and non-IZBAN neighborhoods.

Table 8. Mauchly's Test of Sphericity for Service Sector Employment

						Epsilon[b]	
Within Subjects Effect	*Mauchly's W*	*Approx. Chi-Square*	*df*	*Sig.*	*Greenhouse-Geisser*	*Huynh-Feldt*	*Lower-bound*
Time	.733	178.089	2	.000	.789	.793	.5

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

Mauchly's test shows that the assumption of sphericity had been violated, $\chi 2(5) = 178$, $p = .001$, therefore degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .79$). The results show that there is significant effect of which location of neighborhood (IZBAN or Non-IZBAN) on the number of service sector employement, $F(1.59, 907) = 27.24$, $p = .001$. These results indicate that, neighborhood which are near railway station have significantly more service sector employment than the non-IZBAN neighborhood.

Table 9. Distribution of Service Sector Employment Multivariate Test

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Time	Sphericity Assumed	3,21E+8	2	1,60E+8	111,029	,000	,162	222,058	1,000
	Greenhouse-Geisser	3,21E+8	1,579	2,03E+8	111,029	,000	,162	175,298	1,000
	Huynh-Feldt	3,21E+8	1,585	2,02E+8	111,029	,000	,162	176,005	1,000
	Lower-bound	3,21E+8	1,000	3,21E+8	111,029	,000	,162	111,029	1,000
Time * izban_neig	Sphericity Assumed	7,87E+7	2	3,94E+7	27,247	,000	,045	54,495	1,000
	Greenhouse-Geisser	7,87E+7	1,579	4,99E+7	27,247	,000	,045	43,020	1,000
	Huynh-Feldt	7,87E+7	1,585	4,97E+7	27,247	,000	,045	43,193	1,000
	Lower-bound	7,87E+7	1,000	7,87E+7	27,247	,000	,045	27,247	,999
Error(Time)	Sphericity Assumed	1,66E+9	1150	1444392					
	Greenhouse-Geisser	1,66E+9	907,840	1829674					
	Huynh-Feldt	1,66E+9	911,500	1822326					
	Lower-bound	1,66E+9	575,000	2888783					

According to the graph figure 37, which shows the distribution of the average employment of the service sector in IZBAN and non-IZBAN districts, the average service sector employment in IZBAN districts in 2009 is higher than in non-IZBAN districts. Between 2009 and 2014, the increase in the average employmentloyment in the service sector in IZBAN neighborhoods was sharp compared to non-IZBAN neighborhoods. Between 2014 and 2019, while the average number of service sector employment in non-IZBAN neighborhoods decreased, an increase was observed in IZBAN neighborhoods.

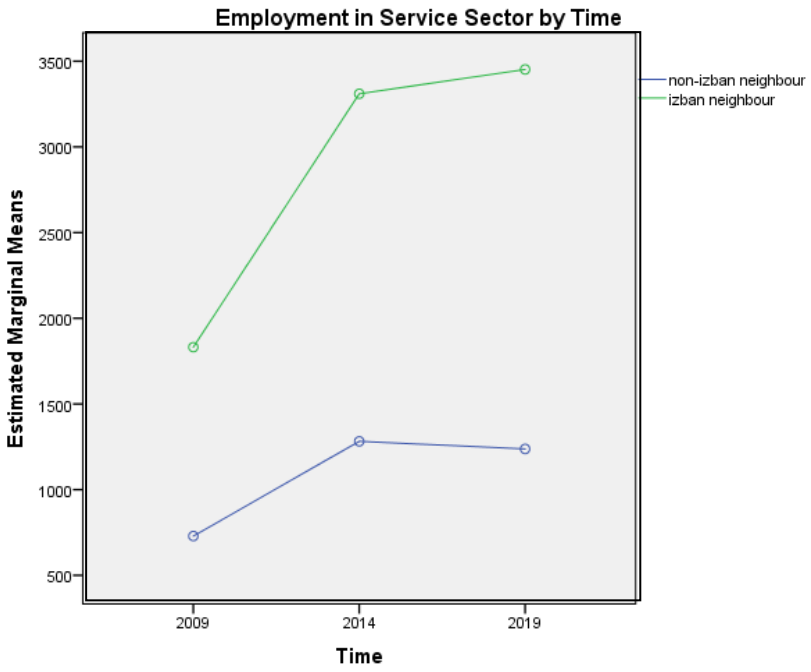

Figure 37. IZBAN-Non IZBAN Estimated Marginal Means of Service Sector Employment by Time

Industrial Sector Employment Distribution Differentiation in IZBAN and Non-IZBAN neighborhoods

The average employment of IZBAN and non-IZBAN neighborhoods between 2009-2014 and 2019 is shown in the table below. According to the table, the average employment showed the same trend for both groups (IZBAN and non-IZBAN neighborhoods). While the average employmentloyment increased for both groups between 2009-2014, the average employment value decreased slightly between 2014-2019.

Table 10. Industry Sector Employment Descriptive Statistics

Industry Sector Employment (Year)	*IZBAN_neig*	*Mean*	*Std. Deviation*	*N*
2009	Non-IZBAN Neighborhood	312.07	1001.975	427
	IZBAN neighborhood	846.87	2589.217	150
	Non-IZBAN Neighborhood	451.10	1591.173	577
2014	IZBAN neighborhood	449.68	1516.725	427
	Non-IZBAN Neighborhood	1192.36	4237.463	150
	IZBAN neighborhood	642.75	2540.190	577
2019	Non-IZBAN Neighborhood	423.72	1556.787	427
	IZBAN neighborhood	1048.08	4328.252	150
	Non-IZBAN Neighborhood	586.03	2591.068	577

Mauchly's test shows that the assumption of sphericity had been violated, $\chi 2(5) = .336$, $p = .001$, therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .60$). The results show that there is not a significant effect of which location of neighborhood (IZBAN or Non-IZBAN) on the number of industry sector employement, $F(1.2, 691)= 2.36$, $p = .119$. These results indicate that neighborhood which are near railway station have not significantly more industry sector employment than the non-IZBAN neighborhood.

Table 11. Mauchly's Test of Sphericity for Industry Sector Employment

Within Subjects Effect	*Mauchly's W*	*Approx. Chi-Square*	*df*	*Sig.*	*Epsilon[b]* *Greenhouse-Geisser*	*Huynh-Feldt*	*Lower-bound*
Time	.336	626.067	2	.000	.601	.603	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

Table 12. Distribution of Industry Sector Employment Multivariate Test

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Time	Sphericity Assumed	1,33E+7	2	6664770	13,044	,000	,022	26,088	,997
	Greenhouse-Geisser	1,33E+7	1,202	1,11E+7	13,044	,000	,022	15,678	,972
	Huynh-Feldt	1,33E+7	1,205	1,11E+7	13,044	,000	,022	15,720	,972
	Lower-bound	1,33E+7	1,000	1,33E+7	13,044	,000	,022	13,044	,950
Time * izban_neig	Sphericity Assumed	2414049	2	1207025	2,362	,095	,004	4,725	,479
	Greenhouse-Geisser	2414049	1,202	2008515	2,362	,119	,004	2,839	,367
	Huynh-Feldt	2414049	1,205	2003147	2,362	,119	,004	2,847	,368
	Lower-bound	2414049	1,000	2414049	2,362	,125	,004	2,362	,335
Error(Time)	Sphericity Assumed	5,88E+8	1150	510946,3					
	Greenhouse-Geisser	5,88E+8	691,097	850225,9					
	Huynh-Feldt	5,88E+8	692,949	847953,2					
	Lower-bound	5,88E+8	575,000	1021893					

As can be seen in the chart below, although the average number of industrial sector employment is higher in IZBAN districts, there has not been a significant difference between the average employment values over the years mentioned.

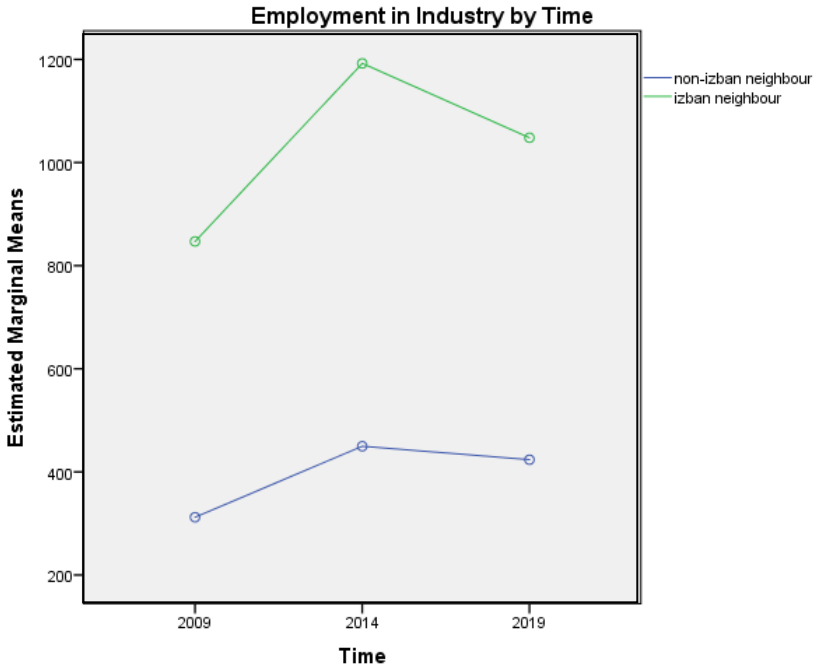

Figure 38. IZBAN-Non IZBAN Estimated Marginal Means of Industry Sector Employment by Time

Agricultural Sector Employment Distribution Differentiation in IZBAN and Non-IZBAN Neighborhoods

As can be seen from the descriptive statistics table below, the change in the average employmentloyment in the agricultural sector of IZBAN and non-IZBAN areas showed a similar trend. While there was a significant increase between 2009 and 2014, the average agricultural employment change between 2014 and 2019 was at a low level.

Table 13. Agriculture Sector Employment Descriptive Statistics

Agriculture sector employment	*IZBAN_neig*	*Mean*	*Std. Deviation*	*N*
2009	Non-IZBAN Neighborhood	3.62	13.302	426
	IZBAN neighborhood	18.22	83.259	148
	Non-IZBAN Neighborhood	7.39	44.164	574
2014	IZBAN neighborhood	10.33	55.725	426

	Non-IZBAN Neighborhood	26.78	77.932	148
	IZBAN neighborhood	14.57	62.556	574
2019	Non-IZBAN Neighborhood	11.06	52.979	426
	IZBAN neighborhood	25.26	70.038	148
	Total	14.72	58.128	574

Mauchly's test shows that the assumption of sphericity had been violated, $\chi 2(5) = .458$, $p = .001$, therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .65$). The results show that there is not a significant effect of which location of neighborhood (IZBAN or Non-IZBAN) on the number of industry sector employement, $F(1.3, 743)= .125$, $p = .789$. These results indicate that neighborhood which are near railway station have not significantly more agriculture sector employment than the non-IZBAN neighborhood.

Table 14. Mauchly's Test of Sphericity for Agriculture Sector Employment

					Epsilon[b]		
Within Subjects Effect	*Mauchly's W*	*Approx. Chi-Square*	*df*	*Sig.*	*Greenhouse-Geisser*	*Huynh-Feldt*	*Lower-bound*
Time	.458	446.380	2	.000	.648	.650	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

Table 15. distribition of Agriculture Sector Employment Multivariate Test

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Time	Sphericity Assumed	16224,09	2	8112,043	6,377	,002	,011	12,754	,902
	Greenhouse-Geisser	16224,09	1,297	12511,99	6,377	,007	,011	8,269	,789
	Huynh-Feldt	16224,09	1,301	12473,64	6,377	,007	,011	8,294	,790
	Lower-bound	16224,09	1,000	16224,09	6,377	,012	,011	6,377	,713
Time * izban_neig	Sphericity Assumed	318,347	2	159,173	,125	,882	,000	,250	,069
	Greenhouse-Geisser	318,347	1,297	245,509	,125	,789	,000	,162	,066
	Huynh-Feldt	318,347	1,301	244,756	,125	,790	,000	,163	,066
	Lower-bound	318,347	1,000	318,347	,125	,724	,000	,125	,064
Error(Time)	Sphericity Assumed	1455274	1144	1272,092					
	Greenhouse-Geisser	1455274	741,703	1962,071					
	Huynh-Feldt	1455274	743,983	1956,058					
	Lower-bound	1455274	572,000	2544,185					

In the figure 39 of agricultural sector average employment below, it is seen that employment increased in both neighborhood types between 2009 and 2014 decreased in IZBAN areas and increased in non-IZBAN neighborhoods between 2014-2019, albeit at a low level.

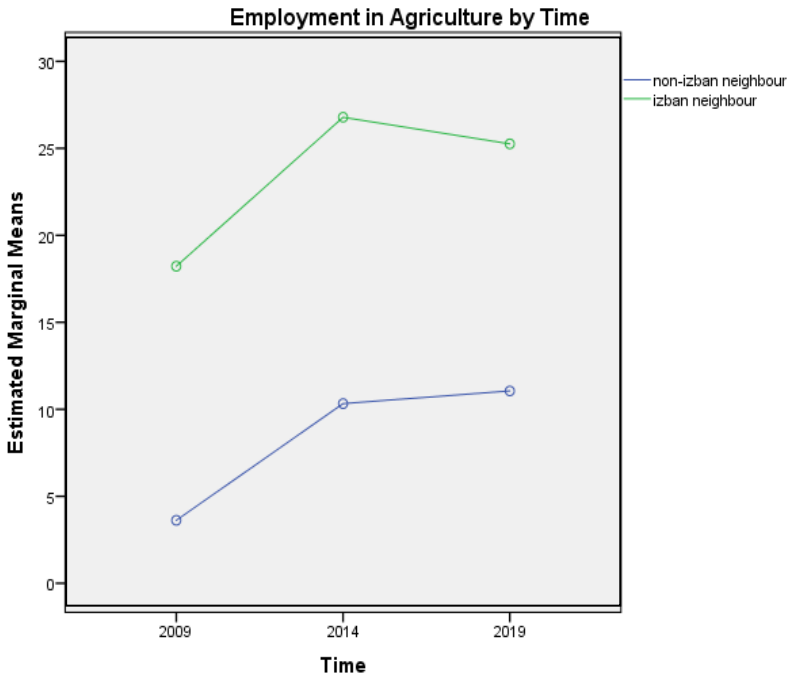

Figure 39. IZBAN-Non IZBAN Estimated Marginal Means of Agriculture Sector Employment by Time

6.4. Employment Differentiation by Distance

Railway investments increase accessibility around the station and create an attraction point for residences and workplaces. With this attraction effect which was created around the railway, it causes transit oriented development with intense and mixed uses. As the distance to the station increases, the access to the station decreases and the advantages of the station become lost. Therefore, depending on the distance to the station, the location decisions of the workplaces also change. In this section, the employment number of the neighborhoods at a distance of 1000 m, between 1000 and 2000 m and more than 2000 m from the IZBAN station, which is the study area, was examined and it was measured whether the employment around the station differed depending on the distance. The change in employment in the neighborhoods depending on the distance to the station was examined as the period before the establishment of IZBAN (2009) and the following period (2019), and the results were evaluated.

H0: Employment does not change depending on the distance to the station.
H1: Employment changes depending on the distance to the station.

Table 15. Descriptives for Distance Neighbourhood to Station 2009

					95% Confidence Interval for Mean			
	N	*Mean*	*Std. Deviation*	*Std. Error*	*Lower Bound*	*Upper Bound*	*Minimum*	*Maximum*
outside	311	787.18	2089.137	118.464	554.08	1020.27	0	18970
1000 m	150	2696.65	5876.789	479.838	1748.48	3644.81	0	47471
1000-2000 m	118	1699.97	5404.324	497.508	714.69	2685.26	0	50784
Total	579	1467.89	4219.964	175.376	1123.43	1812.34	0	50784

The table above shows the average employment numbers of neighborhoods grouped by distance in 2009. As can be seen, while the average number of employment is 2696 in the neighborhoods that are 1000 m from the station, it is 1699 in the neighborhoods that are 1000-2000 m away, and 787 in the

neighborhoods that are higher than 2000m. It can be said that while the distance from here increases, the average number of employment in the neighborhoods decreases. However, it is not a sufficient indicator to measure whether the average employment distribution in the neighborhoods differs significantly. For this reason, One Way Anova With Post-Hoc results were also examined.

Table 16. Multiple Comparison of Employment 2009

(I) Distance Group	(J) IZBAN_Distance	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Outside	1000 m	-1909.470*	412.463	.000	-2899.79	-919.15
	1000-2000 m	-912.798	448.609	.127	-1989.90	164.31
1000 m	outside	1909.470*	412.463	.000	919.15	2899.79
	1000-2000 m	996.672	510.553	.154	-229.16	2222.51

*. The mean difference is significant at the 0.05 level.

Post hoc comparisons test indicated that the mean score for the 1000m distance to station condition (M = 2696, SD = 5876) was significantly different than the over 2000m distance to station condition (M = 787, SD = 2089). However, the1000m-2000 distance to station condition (M = 1699, SD = 5404) did not significantly differ from the 1000 m and over 2000 m conditions.

In the period before Izban (2009), the employment of the neighborhoods within the station's influence area (1000 m) and the places with a distance of more than 2000 m to the station differ. However, employment does not differ between these neighborhoods and the neighborhoods located between 1000-2000m. While examining the employment change based on the distance to the station in 2019, the focus has been on the differentiation between the neighborhoods at a distance of 1000m and the neighborhoods at a distance of 1000-2000m.

Table 17. Descrictives for Distance to Station 2019

	N	*Mean*	*Std. Deviation*
1000 m	150	4525.07	7928.292
1000-2000 m	118	2695.85	7558.794
outside	311	1272.95	3082.958
Total	579	2405.45	5894.081

According to the table 18, the neighborhoods that are 1000m away from the station have approximately 2 times more employment than the neighborhoods that are 1000-2000m away from the station, and approximately 4 times more than the neighborhoods that are more than 2000 m away.

Table 18. Multiple Comparisons for Distance to Station 2019

Bonferroni

(I) Distance_Group	*(J) IZBAN_Distance*	*Mean Difference (I-J)*	*Std. Error*	*Sig.*	*95% Confidence Interval*	
					Lower Bound	*Upper Bound*
outside	1000 m	-3252.118*	570.896	.000	-4622.84	-1881.40
	1000-2000 m	-1422.899	620.926	.067	-2913.74	67.94
1000 m	outside	3252.118*	570.896	.000	1881.40	4622.84
	1000-2000 m	1829.219*	706.664	.030	132.52	3525.92

*. The mean difference is significant at the 0.05 level.

Post hoc comparisons test for the year 2019 indicated that the mean score for the 1000m distance to station condition (M = 4525, SD = 7928) was significantly different than the over 2000m distance to station condition (M = 1272, SD = 3082). Mean score for the 1000m distance to station condition (M = 4525, SD = 7928) was also significantly different than the 1000-2000 distance to station condition (M = 2695, SD = 7558). However, the 1000-2000 m distance to station condition (did not significantly differ from the over 2000 m conditions."

By inferring from this, employment concentrated in the area with a radius of 2000 m before the establishment of IZBAN was concentrated at a distance of 1000 m around the station with the establishment of IZBAN, and it was seen that the increase in employment occurred mainly in this region.

6.5. Sub-Regions Urban Development

The impact of railway investments may also vary in sub-regions with different development dynamics. Planned transportation investments are an important tool for achieving targeted urban development. In this section, the urban development in the sub-regions of İzmir has been evaluated with population and employment indicators, and it has been tested whether there is any differentiation in terms of population and employment change in the neighborhoods in the IZBAN impact area and the Non- IZBAN neighborhoods by operating the IZBAN system.

6.5.1. Urban Development Dynamics of Metropolitan Sub-region

Metropolitan Sub-region consists of 7 districts in total, namely Karşıyaka, Bayraklı, Bornova, Konak, Buca Karabağlar and Gaziemir. While examining the urban development of the Metropolitan sub-region, population and employment dynamics were taken into account. As of 2019, the population of the sub-region is 2,593,546, making up 59.4% of the population of Izmir. The number of employees is 1,118,092 as of 2019, and it constitutes 57% of the total employment in the province.

When the population change of the sub-region in the period of 10 years (2009-2019) is examined, while the total population of the sub-region was 2,417,984 in 2009, it reached 2,593,546 in 2019 and increased by 7.2% and was lower than the general population growth in the province (13.6%). While its share in the population was 62.5%, in 2019, this rate decreased to 59.4%. In this process, while the population of Konak and Bayraklı districts in the center of the region

decreased, it was observed that the population increased in Bornova and Karşıyaka in the eastern periphery of the region, and in Buca and Gaziemir districts in the south periphery. Therefore, it has been deduced that there is a population mobility from the center to the periphery within the Metropolitan sub-region itself.

While examining the regional employment change, the number of employees and how the employment changes in terms of sectors are analyzed. In 2009, the total number of employees for the sub-region was 669,889 people, and in 2019, it reached 1,004,864 people and increased by 50%. In the same period, the total employment increase in the province was 63.2%, and the employment increase in the sub-region was lower than the general employment increase. As can be seen from the chart below, there was an increase of 64.8% in the service sector in the district, while an increase of only 23% was observed in the industrial sector.

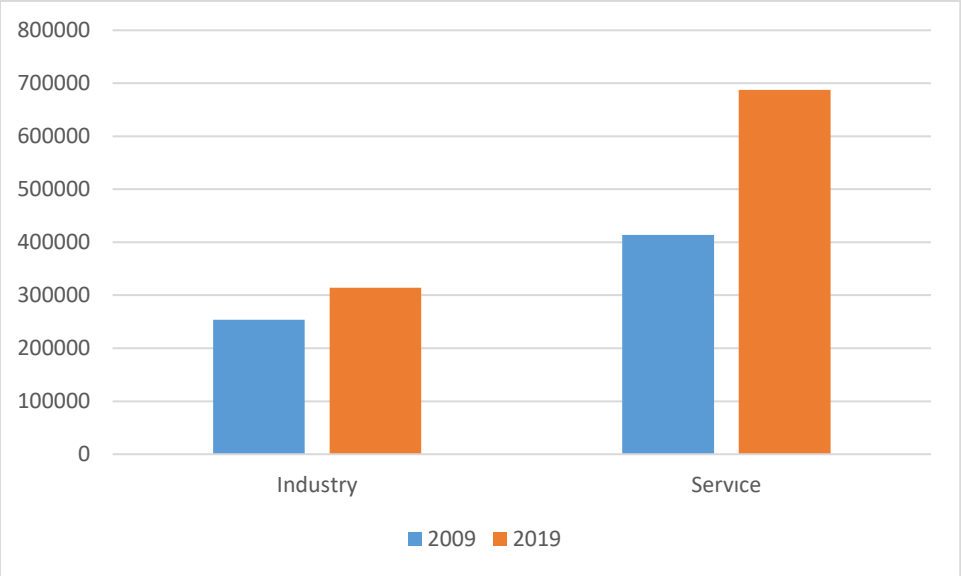

Figure 40. Metropolitan Sub-region Service and Industry Sector 2009 and 2019 Employment

Thus, it can be deduced from figüre 40 that the population and employment growth in the IZBAN Metropolitan sub-region was lower than the increase in the province. Employment growth remained below the overall employment growth in the city. It is seen that the increase in employment in the city is not concentrated in the

metropolitan area, but is more homogeneously distributed to other regions in the 10-year period. When the sectoral employment transformation is analyzed, the increase in employment in industry and agriculture was lower than the increase in industry and agriculture throughout the province. The regional service sector employment increase rate is higher than the provincial service employment increase rate (64.8% and 56.8%, respectively).

Comparison of Metropolitan Sub-region's IZBAN and Non-IZBAN Neighborhood in Terms of Employment and Population Change

The Mann-WhitneyU test was applied to measure whether there is a significant difference in population and employment changes in IZBAN and non-IZBAN neighborhoods in the Metropolitan sub-region within 10 years. With this method, it has been tested whether the population and employment increase in IZBAN neighborhoods is higher than in non-IZBAN neighborhoods.

H0: There is no significant differentiation in terms of population change in IZBAN and non-IZBAN areas in the Metropolitan sub-region.
H1: There is a significant differentiation in terms of population change in IZBAN and non-IZBAN areas in the Metropolitan sub-region.

Table 19. Descriptive Statistics of Metropolitan Sub-Region Population Change (IZBAN, Non-IZBAN Neighborhood).

	N	*Mean*	*Median*
IZBAN Neighborhood	84	575.7	-122.50
Non-IZBAN Neighborhood	248	677	-10.50

In total, there are 332 neighborhoods in the Metropolitan sub-region. While 84 of these neighborhoods are IZBAN neighborhoods, 248 of them are non-IZBAN neighborhoods. According to the descriptive statistics above, while the population increased by an average of 677 people in non-IZBAN neighborhoods over 10 years, this value was lower in IZBAN neighborhoods (575.7).

Table 20. Test statistics of Metropolitan Sub-Region Population Change (IZBAN, Non-IZBAN Neighborhood).

Mann-Whitney U	*Wilcoxon W*	*Z*	*Asymp. Sig. (2-tailed)*
10082,5	13652.5	-0.44	0.66

To evaluate the the difference between IZBAN and non-IZBAN neighborhood population change in Metropolitan sub-region was tested using Mann-Whitney U test. The test revealed there was not significance differences in population change of IZBAN neighborhood (Median=-122.5, n=84), and non IZBAN neighborhood (Median=-10.5, n=248), U= 10082.5, z=-.44 p= .086 r= 0.024 As a result we can not reject the H_0 hypothesis which emphasize there is not a significance difference between IZBAN and Non- IZBAN neighborhood in Metropolitan sub-region for population change.

Table 21. Descriptive Statistics of Metropolitan Sub-Region Employment Change (IZBAN, Non-IZBAN Neighborhood).

	N	*Mean*	*Median*
IZBAN Neighborhood	84	1,839	837
Non-IZBAN Neighborhood	248	760	157

According to the descriptive statistics in table 22, while employment increased by 760 people on average in non-IZBAN neighborhoods over ten years, this value increased by 1,839 people in IZBAN neighborhoods. Average employment increase in Izban neighborhoods was 141% higher than in non-Izban neighborhoods.

Table 22. Metropolitan Sub-Region Employment Change (IZBAN, Non-IZBAN Neighborhood).

Mann-Whitney U	*Wilcoxon W*	*Z*	*Asymp. Sig. (2-tailed)*
6688	37,564	-4.903	.00

To evaluate the the difference between IZBAN and non-IZBAN neighborhood employment change in Metropolitan sub-region was tested using Mann-Whitney U test. The test revealed significance differences in employment change of IZBAN neighborhood (Median= 837, n=84), and non IZBAN neighborhood (Median=157, n=248) *U*= 6688, z=-4.903 p= .000 r=.23 As a result we can reject the H_0 and admit H_1 hypothesis which emphasize there is a significance difference between IZBAN and Non- IZBAN neighborhood in Metropolitan sub-region for employment change.

6.5.2. Urban Development Dynamics of North and South Sub-region

The evaluation has been made through the population and employment change, which is one of the urban development dynamics , in the North and South subregions where IZBAN has increased accessibility with the metropolitan area. Additionally, the population and employment change around the IZBAN stations were compared with the areas outside the İZBAN impact area, and how it enhanced the developments was demonstrated.

Urban Development Dynamics of North Sub-region

North sub-region consists of three districts, namely Aliağa, Menemen and Çiğli. While examining the urban development of North sub-region, population and employment dynamics were taken into consideration. As of 2019, the population of the region is 495,066 people, making up 11.3% of the population of Izmir. The number of employees is 258,706 as of 2019, and it constitutes 14.7% of the total employment in the province.

When the population change of the sub-region in the period of 10 years (2009-2019) is examined, while the total population of the sub-region was 346,013 in 2009, it reached 495,066 in 2019 and increased by 43% and was much higher than

the general population growth in the province (13.6%). While its share in the population was 8.9%, this rate increased to 11.3% in 2019.

While examining the regional employment change, the number of employees and how the employment changes in terms of sectors are analyzed. In 2009, the employees of the region was 133,800 and in 2019, the number of employees reached 258,756 and increased by 93.3%. In the same period, the total employment increase in the province was 63.2%, and the employment increase in the region was higher than the general employment increase. As can be seen from the chart below, there has been an increase of 127% in the service sector and 56% in the industry sector in the district.

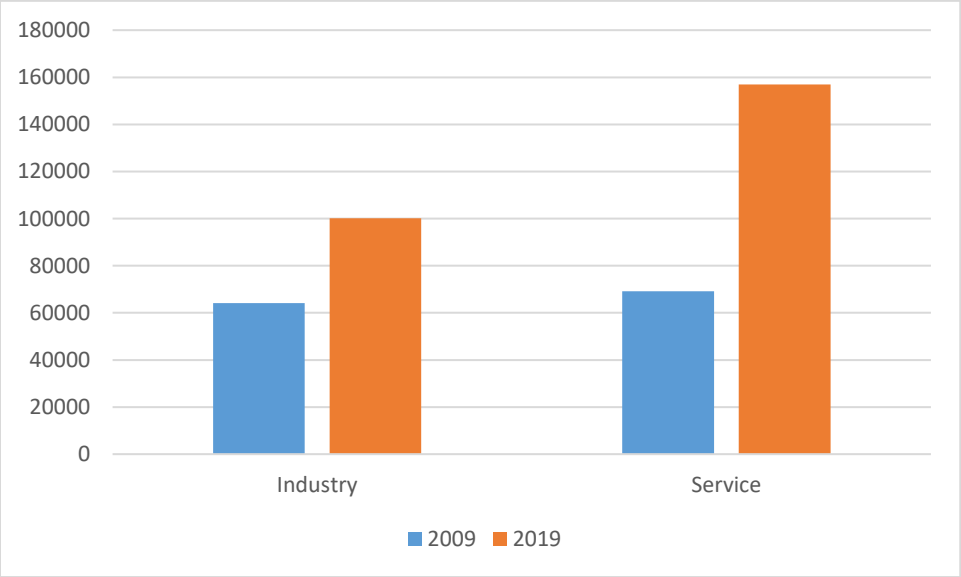

Figure 41. North Sub-region Service and Industry Sector 2009 and 2019 Employment

It can be deduced from figüre 41 that the population and employment increase in the North sub-region was higher than the increase in the province. The rapid increase in population and employment in the region has increased urbanization in this region. The increase in employment in Aliağa OIZ Menemen Plastik OSB and Atatürk OSB regions is one of the most important reasons for the increase in employment in the industrial sector. Apart from the industrial sector, especially

those working in the industry choosing housing around the industry has increased the population in this 10-year period. The employment rate in the service sector, which increased due to the population growth, was also much higher than the increase in the service sector employment rate throughout the province.It was measured whether the population and employment change differed in the North sub-region IZBAN and non-IZBAN neighborhoods, whether the population and employment clustered around the station or spread to the neighborhoods. Accordingly, two basic hypotheses were tested for population and employment.

H0: There is no significant differentiation in terms of population change in IZBAN and non-IZBAN areas in the North sub-region.

H1: There is a significant differentiation in terms of population change in IZBAN and non-IZBAN areas in the North sub-region.

Table 23. Descriptive Statistics of North Sub-Region Population Change (IZBAN, Non-IZBAN Neighborhood).

	N	*Mean*	*Median*
IZBAN Neighborhood	35	1556	1755
Non-IZBAN Neighborhood	89	368	13

According to the descriptive statistics in table 24, while the population in non-IZBAN neighborhoods increased by an average of 368 people in the ten-year period, this value increased by 1556 people in IZBAN neighborhoods. Average employment increase in Izban neighborhoods was 322% higher than in non-Izban neighborhoods. Population growth was mostly realized in IZBAN neighborhoods.

Table 24. Test statistics of North Sub-Region Population Change (IZBAN, Non-IZBAN Neighborhood).

Mann-Whitney U	*Wilcoxon W*	*Z*	*Asymp. Sig. (2-tailed)*
974	4979	-3.23	.001

To evaluate the the difference between IZBAN and non-IZBAN neighborhood population change in North sub-region was tested using Mann-Whitney U test. The test revealed significance differences in population change of IZBAN neighborhood (Median= 1755, n=35), and non IZBAN neighborhood (Median=13, n=89) *U*= 974, z=-3.23 p= .001 r= .29 As a result we can reject the H_0 and admit H_1 hypothesis which emphasize there is a significance difference between IZBAN and Non- IZBAN neighborhood in North sub-region for population change.

H0: There is no significant differentiation in terms of employment change in IZBAN and non-IZBAN areas in the North sub-region.

H1: There is a clear differentiation in terms of employment change in IZBAN and non-IZBAN areas in the North sub-region.

Table 25. Descriptive Statistics of North Sub-Region Employment Change (IZBAN, Non-IZBAN Neighborhood).

	N	*Mean*	*Median*
IZBAN Neighborhood	35	2260	864
Non-IZBAN Neighborhood	89	436	90

Table 26. Test Statistics of North Sub-Region Employment Change (IZBAN, Non-IZBAN Neighborhood).

Mann-Whitney U	*Wilcoxon W*	*Z*	*Asymp. Sig. (2-tailed)*
731	4736	-4.59	.00

To evaluate the the difference between IZBAN and non-IZBAN neighborhood employment change in North sub-region was tested using Mann-Whitney U test. The test revealed significance differences in employment change of IZBAN neighborhood (Median= 864, n=35), and non IZBAN neighborhood (Median=90, n=89) *U*= 731, z=-4.59 p= .001 r= .41 As a result we can reject the H_0 and admit H_1 hypothesis which emphasize there is a significance difference between IZBAN and Non- IZBAN neighborhood in north sub-region for employment change.

Urban Development Dynamics of South Sub-region

South sub-region consists of three districts in total, which are Menderes, Torbalı and Selçuk districts. As of 2019, the population of the region is 319,855, making up 7.3% of the population of Izmir. The number of employees is 155,750 as of 2019, and it constitutes 8.8% of the total employment in the province.

When the population shift of the region in the period of 10 years (2009-2019) is examined, while the total population of the region was 228,575 in 2009, it reached 319,855 in 2019 and increased by 40% and was much higher than the population growth in the province (13.6%). While its share in the population was 5.9%, this rate increased to 7.3% in 2019.

While examining the sub-region employment change, the number of employees and how the employment changes in terms of sectors are analyzed. In 2009, the total number of employees in the region was 84,304, and in 2019, it reached 155,750 and increased by 84.7%. In the same period, the total employment increase in the province was 63.2%, and the employment increase in the region was higher than the general employment increase. As can be seen from the chart below, there has been an increase of 84% in the service sector and 80% in the industrial sector in the district.

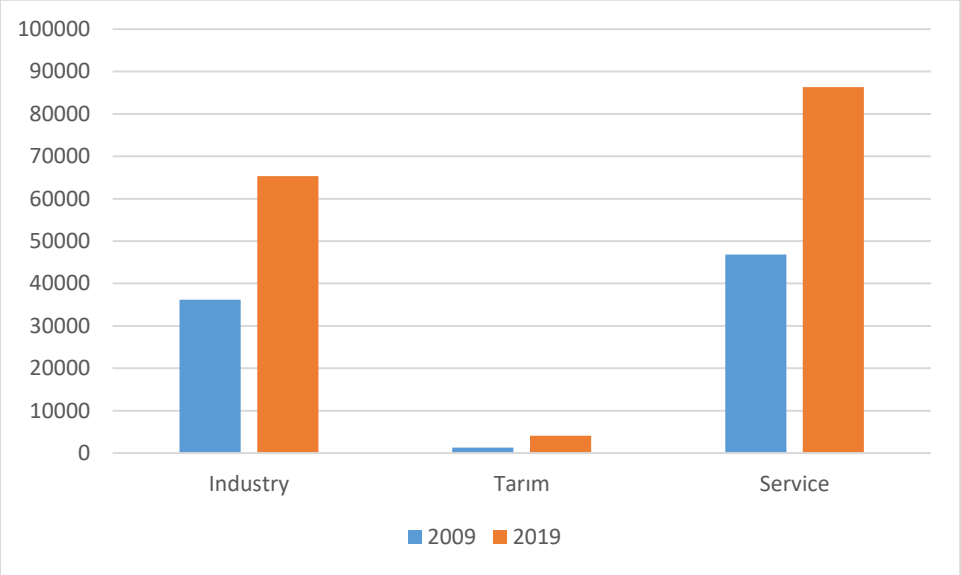

Figure 42. South Sub-region Service and Industry Sector 2009 and 2019 Employment

Therefore, it can be deduced from figüre 42 that the population and employment increase in the South sub-region was higher than the overall increase in the province. The rapid increase in population and employment in the region has enhanced urbanization in this region. The increase in employment in Pancar OIZ, Itob OIZ and Esbaş free trade zones in the region is one of the most important reasons for the increase in employment in the industrial sector. Although the increase in the industrial sector was higher than the Northsub-region, the employment increase in the service sector was not as high as that of the North sub-region. One of the main reasons for this is that this line is at a shorter distance to the metropolitan area than the North sub-region, along with its opening occurring in later periods. Due to the fact that the Torbalı Selçuk line started to be used in 2017, its impact in Selçuk district has not been fully measured yet.

It was measured whether the population and employment change differed in the South subregion IZBAN and non-IZBAN neighborhoods, whether the population and employment clustered around the station or spread to the neighborhoods. Accordingly, two basic hypotheses were tested for population and employment.

H0: There is no significant differentiation in terms of population change in IZBAN and non-IZBAN areas in the South sub-region.

H1: There is a clear differentiation in terms of population change in IZBAN and non-IZBAN areas in the South sub-region.

Table 27. Descriptive Statistics of South Sub-Region Population Change (IZBAN, Non-IZBAN Neighborhood).

	N	*Mean*	*Median*
IZBAN Neighborhood	31	1284	206
Non-IZBAN Neighborhood	92	612	38

According to the descriptive statistics above, while the population increased by 612 people on average in non-IZBAN neighborhoods over the ten-year period, this value increased by 1284 people in IZBAN neighborhoods. Average population growth in Izban neighborhoods was 109% higher than in non-Izban neighborhoods.

Table 28. Test Statistics of South Sub-Region Population Change (IZBAN, Non-IZBAN Neighborhood).

Mann-Whitney U	*Wilcoxon W*	*Z*	*Asymp. Sig. (2-tailed)*
1082	5360	-2.004	.045

To evaluate the the difference between IZBAN and non-IZBAN neighborhood population change in South sub-region was tested using Mann-Whitney U test. The test revealed significance differences in employment change of IZBAN neighborhood (Median= 206, n=31), and non IZBAN neighborhood (Median=38, n=92) U= 1082, z=-2.004 p= .045 r= .18 As a result we can reject the H_0 and admit H_1 hypothesis which emphasize there is a significance difference between IZBAN and Non- IZBAN neighborhood in South sub-region for population change.

H0: There is no significant difference in terms of employment change in IZBAN and non-IZBAN areas in the South sub-region.

H1: There is a clear divergence in terms of employment change in IZBAN and non-IZBAN areas in the South sub-region.

Table 29. Descriptive Statistics of South Sub-Region Employment Change (IZBAN, Non-IZBAN Neighborhood).

	N	*Mean*	*Median*
IZBAN Neighborhood	31	859	314
Non-IZBAN Neighborhood	92	448	69

According to the descriptive statistics in table 30, while employment increased by 448 people on average in non-IZBAN neighborhoods over ten years, this figure increased by 859 people in IZBAN neighborhoods. Average employment increase in Izban neighborhoods was 91.7% higher than in non-Izban neighborhoods. The increase in employment was mostly realized in IZBAN neighborhoods.

Table 30. Test Statistics of South Sub-Region Employment Change (IZBAN, Non-IZBAN Neighborhood).

Mann-Whitney U	*Wilcoxon W*	*Z*	*Asymp. Sig. (2-tailed)*
1059	5337	-2.138	.033

To evaluate the the difference between IZBAN and non-IZBAN neighborhood employment change in South sub-region was tested using Mann-Whitney U test. The test revealed significance differences in employment change of IZBAN neighborhood (Median= 864, n=35), and non IZBAN neighborhood (Median=314, n=31) *U*= 5337, z=-2.138 p= .033 r= .19 As a result we can reject the H_0 and admit H_1 hypothesis which emphasize there is a significance difference between IZBAN and Non- IZBAN neighborhood in South sub-region for employment change.

Summary of the Chapter

When the change in the population of IZBAN and non-IZBAN neighborhoods over a 10-year period was examined in the north, south and metropolitan subregions, it was found that there was no statistically significant difference in the neighborhood populations. When the sub-regions were examined separately, there was a statistically significant difference in population growth in IZBAN and non-IZBAN neighborhoods in the north and south. IZBAN neighborhoods increased by 332% in the northern subregion and by 102% more in the southern subregion than non-IZBAN neighborhoods. In the metropolitan subregion, there was not a statistically significant differentation between the specified neighborhoods. Employment increased by 191% more in IZBAN neighborhoods than in non-IZBAN neighborhoods and there was a statistically significant differentiation. By inferring from this, IZBAN neighborhoods became the attraction point of employment especially in the metropolitan area, while in the north and south sub-regions there were places where both the population and employment were clustered. Sectors give different response to transportation investments. Although the change in service sector employment in IZBAN and non-IZBAN neighborhoods is statistically higher than in IZBAN neighborhoods, the increase in industrial and agricultural sector employment does not have a statistically significant differentiation in IZBAN and non-IZBAN neighborhoods. While examining the spatial effect of the suburban system around the station, in 2009 employment clustered in neighborhoods that are 2000 m away from the station. In 2019 the employment clustered in 1000 m distance neighborhood and there occur an significant differentiaition between 1000m neighborhood and 1000m-2000m neighborhood.

CHAPTER 7

CONCLUSION

A Summary of Thesis

Railway investments have many spatial, economic, and demographic effects on the city. The current urban development trends in İzmir and how the IZBAN system affects this development as a complementary factor have been the subject of the research. In the research, it has also been examined what kind of urban development the near-term plans aim at and how the IZBAN system supports this development in this direction. The effects of the IZBAN system were evaluated in 13 districts with stations at the regional scale. At a lower scale, the station in these 13 districts was compared with the neighborhoods within the impact area and the neighborhoods outside the impact area.

At the beginning, the historical development of the railway and its changing role in transportation in this process are explained. Along with the development process in the world, the development process in Turkey has also been examined. In the second part, the effect of railway investments on the form of the city, its effect on the population change around the station and its spatial effects and its effect on urbanization are explained. According to the research, with the realization of railway investments, accessibility increases and the increase in access opportunities also affects factors such as location selection and land use characteristics. With the railway investments, the population density around the station is increasing, thus transforming the dispersed population in the regions with urban sprawl into a more centered structure. Thus, both the effect of urban sprawl is reduced and decentralization takes place from CBD areas to sub-centers, thereby relieving urbanization pressures on the CBD. In addition to the effect of the railway on urban development, its economic effects were also investigated. The economic impacts are generally evaluated on the basis of economic growth and changes in property

values around the station. It has been explained that one of the factors affecting productivity in terms of economic growth is transportation and it exerts a driving force on other factors affecting productivity. At the same time, it is explained with case studies that railway investment increases per capita income in regions.

Although the change in property values around the station differs according to the socio-economic status of the station surroundings, it generally causes an increase in property values around the station. For this reason, it has been stated that residential or industrial areas around the station have been transformed into service sector firms. Along with the impact of the railway on economic development and urbanization, its environmental effects are also emphasized. The fact that the carbon emission of the railway is lower than other modes of transportation has been explained and that the railway has less impact on the environment than other types of transportation. As a result of these researches, it has been revealed that railway investment increases accessibility, and stimulate the urban growth.

In the fifth chapter, the historical development of Izmir, which is the study area, and its position in the country are briefly mentioned. The change of population years between 2009 and 2019 inspected. To establish the relationship between railway investments and urban development, the current economic structure of the city has been examined under the headings of agriculture, industry and service sector. The development and statistical data of the Izmir suburban line, which is the subject of the study, are explained. In addition, recent Izmir's strategic plan, environmental plan and transportation master plans of Izmir have been examined in line with urban development and transportation decisions. Railway decisions, which are the subject of the plans, are also examined.

Analyzes and evaluations were made in the previous chapter. With the first analysis, the North, South and Metropolitan subregions were evaluated together and the population and employment changes that took place in these regions over a 10-year period were focused on. In addition, it was determined whether there is a significant difference in the population and employment changes of IZBAN and

non-IZBAN neighborhoods in this region. In another analysis, it was tested mainly in which sector employment differs in IZBAN and non-IZBAN neighborhoods.. Whether employment differs depending on the distance from the station, and if it does, in which direction (increasing and decreasing) it differs is analyzed in 2 different periods. Urban development trends in the connection of North, South and Metropolitan subregions have been studied. It measured whether there is a difference between IZBAN neighborhoods and other neighborhoods in these regions in terms of population and employment change.

Reflection of the Findings

Railway investments became a tool to for supporting and directing urban development. When the recent upper-scale plans of Izmir province were examined, planners was aimed to reduce the pressure of Metropolitan area with the way of redirecting the development in the south and north region of the city. The fact that large investments, especially in organized industrial zones, are planned in these regions is an indication of this decentralization process. The IZBAN railway system, which was launched in 2011, also combines the North and South regions with the metropolitan area, supports this urban development. The role of IZBAN in this urban development process of Izmir has been the subject of research. The effect of Izban on urban development was measured through changes in population and employment dynamics.

In the population and employment analyses conducted in Izmir, the areas where the increase is high coincide with the north, metropolitan and south sub-regions where the IZBAN line passes. Peninsula subregion which have the important tourism centers have the highest employment change rate in the 10-year period. Within a period of 10 years, the proportion of the Metropolitan area in the overall population of the province has decreased from 59.4% to 57%, and its share in total employment has decreased from 59,4% to 56%. Population and employment have been decentralized from the metropolitan area. While industrial employment in particular increased by only 23% in the metropolitan area, it remained below the

industrial employment increase in the province. However, employment average in the service industry is above provincial average. In other words, while the population and employment in the metropolitan area are decentralized, employment also experienced a sectoral transformation. Primary and secondary sectors such as metropolitan industry and agriculture have been replaced by the service sector.

When the population and employment change in the sub-regions served by the IZBAN railway line is examined, the population in the North and South sub-regions increased by more than 40% and this increase was much higher than the general population growth (16.5%) of the province of Izmir. While the increase in employment was 93.3% in the north, it increased by 84% in the south, which was again well above the provincial average. The common features of these two sub-regions are that large industrial investments such as Itob OSB, Atatürk OSB and Aliağa OSB are located in this region. While Aliağa and Atatürk OSB were established in the North sub-region in the 1990s, large industrial zones such as İTOB OSB and Pancar OSB in the North sub-region are the regions established after 2003. Population growth has taken place with the people employed in the north making the long-term housing location selection in this region. In the period after 2009, employment in the service sector, which serves this population, increased by 127%. In the same region, the increase in industrial employment was 56%. In the south, employment in the service and industry sectors increased in a balanced way (84%, 80%, respectively).

During the examination of the relationship between the IZBAN system and urban development in the sub-regions, especially IZBAN neighborhoods and non-IZBAN neighborhoods were compared. In the Metropolitan sub-region, the average population growth of non-IZBAN districts was 17% higher than that of IZBAN districts. In the statistical analysis, it was concluded that there was no significant change in the population in IZBAN and non-IZBAN areas in the Metropolitan sub-region. However, in the same time period (2009-2019), the employment increase in IZBAN neighborhoods was 142% higher than the employment increase in non-

IZBAN neighborhoods. Statistically, the employment increase in IZBAN neighborhoods was higher than in non-IZBAN neighborhoods. Here, it is observed that especially the residential areas around the station have turned into commercial areas with the increase in access and land value. This development can be explained by the fact that IZBAN, while serving the suburban area, is integrated with other modes of transportation in the city and becomes a "node" created by this integration. In the North and South sub-regions, IZBAN neighborhoods are statistically significantly higher than non-IZBAN neighborhoods in terms of both employment and population growth, pointing out that the station areas create attraction zones for both population and employment in the sub-regions. According to the analysis of the employment change according to the distance from the station, there was a differentiation in employment in 2009 between the neighborhoods with a distance of 1000m to 2000m from the station. In 2019, employment change started to differ in neighborhoods that are 1000 m from the station and between 1000 and 2000 meters. In other words, it has been revealed that employment is more concentrated at a distance of 1000 meters from the station.

As a result, IZBAN neighborhoods were differentiated in other neighborhoods in a structure that supports the decentralization trend in the population and increase in employment in the Metropolitan sub-region, while decentralization was concentrated in the IZBAN neighborhoods in the North and south. In line with these findings, it can be stated that IZBAN supports the existing urban development as a complementary factor.

The location selection or relocation decisions of the economic sectors differ from each other. Because the area size needed by these sectors, the way of accessing raw materials or customers differs. Sectors such as agriculture and industry are sectors that provide a lower density of labor in larger areas compared to the service sector. It is more difficult to respond to an external factor (for example, railway investment). In this study, it has been seen that the IZBAN system does not affect the location selection of agriculture and industry, but it causes centralization in the

service sector around the station. Service sector is more responsive to suburban railway investment than other sectors.

Limitations of the Study

Close to 2% of the data has been eliminated due to reasons such as irregular registration of the data obtained and incorrect entry of address information. Again, incomplete data was collected due to the fact that there are a lot of agricultural families working unregistered in the social security institution agricultural employment data. Although the change in population and employment is one of the most basic indicators of urban development, the inability to access social and spatial data has been one of the limits of this research.

It will not be enough to evaluate the changes and developments that have occurred in IZBAN neighborhoods at a lower scale only by the influence of the railway station. The inability to access data on changes occurring in the social, cultural and spatial structure of these neighborhoods is also one of the limitations of the study.

Recommendation for Future Research

In this study, although the station influence area is limited to the neighborhood boundaries, employment and workplace can be determined as one of the factors in determining the station influence area with more reliable data. While focusing on the number of workplaces and employment in the research, if the accommodation areas can be determined, it can be measured how railway investments affect commute trip distances. Using NACE codes specific to CBD, it can be measured whether there is a change in business lines around the station. While determining the railway impact area, its integration with other transportation modes and accessibility criteria can be determined. Thus, the railway access area and impact area shall be increased and a more reliable research can be done.

Although the railway is more environmentally friendly than other types of transportation, researches can getting their attention in that direction alternative transportation activities such as walking, which are non-motorized transportation

vehicles that cause less health and environmental pollution, will be among the best alternatives today.

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