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Impacts of Rail Transportation Projects on Urban Areas in Izmir-Turkey

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***Abstract*—**With the development of technology, the growing trend of fast and safe passenger transport, air pollution, traffic congestion, increase in problems such as the increasing population and the high cost of private vehicle usage made many cities around the world with a population of more or less, start to build rail systems as a means of urban transport in order to ensure the economic and environmental sustainability and more efficient use of land in the city. The implementation phase of rail systems costs much more than other public transport systems. However, social and economic returns in the long term made these systems the most popular investment tool for planned and developing cities.

In our country, the purpose, goals and policies of transportation plans are away from integrity, and the problems are not clearly detected. Also, not defined and incomplete assessment of transportation systems and insufficient financial analysis are the most important cause of failure. Rail systems and other transportation systems to be addressed as a whole is seen as the main factor in increasing efficiency in applications that are not integrated yet in our country to come to this point has led to the problem.

***Keywords*—**Urban Transportation Projects, Urban Light Rail Systems, Urbanization, Izmir**.**

I. Introduction

URBAN sprawl and the polarization are the most crucial result of the taking long distances in a short period of time. High transportation costs and long travel time, which were the most important factors that determines the position of urban settlement for many years, had become unavailable by the application of high-speed rail systems and citizens have had an increased tendency to choose lands in rural where land costs are lower than in the city centre.

The land selection outside of the city had caused expansion of the urban areas and urban sprawl. In addition, since the mid-20th century in the cities of Europe and the United States high-speed rail systems increased the suburban settlements around the cities. Therefore, metro is an issue that should be considered in environmental impacts because metro is supposed to be sustainable in every field but these systems had caused many problems such as uneven development, sub-regions and polarization.

However, a metro system brings a dynamic process affecting land use and economic activities of the city center and the surrounding area. International connections that have been carried out the integration of these systems with other transport modes make the economic activity of the city faster and more reliable [1]. Together with the reduction of transportation costs they contributed to the development and growth of national and regional economy directly. In this way, the main policy of today's metropolises being the brand city have become much more possible for increasing in the economic competitiveness of the city by these systems.

Nevertheless, a comprehensive analysis of Metro system's return on a city and the need is also very important to discuss in order to use of the country's resources in a sustainable manner due to the high costs of the investment phase. The high speed rail systems have an important role on the articulation of the city to global networks so it is a crucial issue how and where to apply them in the planning stage. Because, increase in the expected benefit while cost increases of require the most effective way of implementation.

II. Rail Transportation Applications in Developed, Developing Countries and Turkey

When the developed countries started their high-speed rail system applications, they have had already appropriate infrastructure and integrated rail system network with the city. Over time, these systems have become a method of solving traffic congestion in the most efficient way [2]. At the same time they could achieve positive results, the developed countries can better integrate systems. Developed countries not only have investments on high-speed systems, but also they enriched their rail networks by investing tram lines and light rail systems.

On the other, in developing countries not having effective urban planning studies has experienced problems in the transition of rail system and the rail system applications could not manage to carry out the expected performance because of the uncontrolled land use problems and unplanned development [3]. Besides, due to the direct impact of the redirection of urban development, these systems leads to a much more dangerous consequences, unplanned development that is already adding new ones.

Today, high demand for use of private vehicles, public transport with wheeled vehicles and informal public transportation are the indicators of the failure in developing countries with rail systems [4]. There are economic reasons and unplanned development behind this failure. All the rail system investments are carried out very large numbers. In addition, unplanned development already existing without any investment in infrastructure makes this work even more cost-effective. For this reason, developing countries experiencing

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more difficulty in during the implementation phase rather than developed countries that already have rail networks and infrastructure plans [5].

As we have seen, the most important part of the success of efficient resource use in very cost-effective rail system applications. These investments can be successful if requirements of the city are determined effectively by analysing the dynamics of the city. However, you should not change direction in the implementation phase of the proposed project should not be overlooked [6].

The growing population of cities, labour and the increase of traveling problems depending on the number of private vehicles in traffic has brought rail networks investments on the agenda. [7]. In our country, suburban lines began to practice in the second half of the 19th century, and the first tunnel was built in 1874. Then, especially Istanbul, Ankara, Konya, Izmir, Bursa, Kayseri cities started to implement rail systems. However, applications were made in a different manner in each city. So far, in our country, cannot be said the rail system projects based on a comprehensive plan. Our cities could not get an effective benefit from these investments because of the lower number of passenger demand than system had offered and Choosing inaccurate location due to the physical and economic thresholds [8].

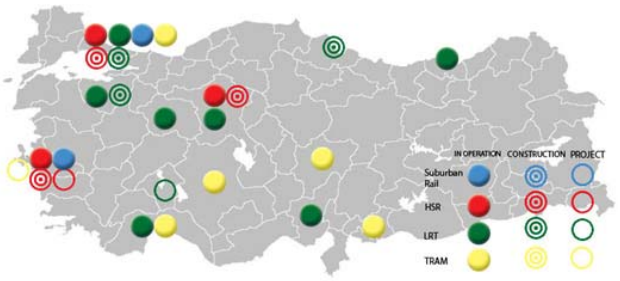

Fig. 1 Stages of rail projects in Turkey [1]

Rail transportation line which built on an aisle with a large number of passenger demand could not carry passengers as needed because of the inadequate infrastructure features and the inefficient frequency trip number [9]. In our country, having population of over 1 million the urban area is considered as the most important criterion for the decisions of rail system. Whereas effective planning of rail investments, which should be determined according to structure and requirements of the city's, in early stages is the most important reason for success. In addition, 449th article of The 9th Development Plan brought limitation and tram and light rail systems applications are restricted in our country [10].

III. Evaluation of Rail System Practices in Izmir

İzmir-Aydın the Turkey's first suburban rail line built in 1856. Later additions have been made Buca and Gaziemir corridor. The tram lines which had been operated between Konak– Göztepe, Konak– Karşıyaka and Halkapınar- Kordon had become the most preferable transportation type of the city. However, this tram lines have not reached up to now, removed in 1954 [11]. In the meantime, countries of the world having achieved speed rail system investments but in İzmir the Transportation Study came up with a new rail projects eventually in 1992 (Fig. 2).

According to this study, Bornova- Üçyol (construction began in 1994) 11.6 km long section was opened for operation in 2000 as the first phase of the rail system projects [9] (Fig. 3). In March of 2012, this system was put into operation by adding two more stops.

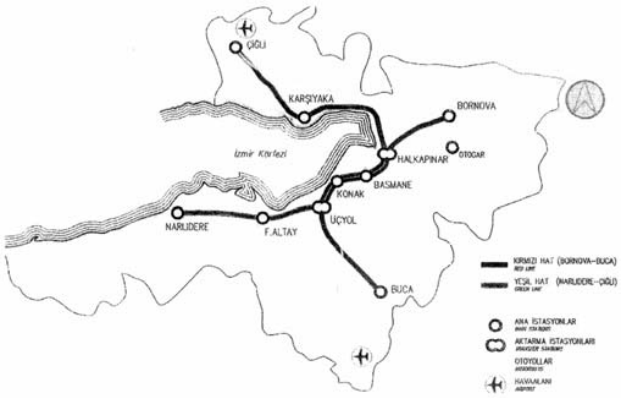

Fig. 2 According to Transportation Study in 1992 İzmir Metro Lines [1]

In addition, IZBAN was planned as a new rail system on the TCDD railway line along the Aliaga- Menderes corridor by increasing the capacity of that line instead of the metro line which had been thought to extend to Çigli according to the same courses of Study (Fig. 3). Opened in 2010, IZBAN rail system is 80 km long, and consists of two main sections as Aliaga- Alsancak- Halkapinar (north) and Halkapinar- Alsancak- Cumaovası (south) axis [12].

Fig. 3 Izmir Metro Applied and Construction Phases

According to Izmir Transportation Master Plan approved in 2009, the second stage of the light rail system Üçyol- F. Altay

extension should be completed by the year 2010 but it is still under construction. Although 3rd phase Bus Terminal, 4th phase Narlıdere and 5th phase DEU Tınaztepe extensions were planned to complete by 2015, their construction have not started yet (Fig. 4). According to the same plan, the extension and the connection of suburban lines with surrounding cities were envisaged. [13]. In addition, the plan includes double- and single-line tramway projects which were envisaged for the various areas of the city (Fig. 4).

As today's the projects were examined, only obtaining the need for rail system on the number of daily passenger in Transportation Master Plan report constitutes the most important point of the deficiency of study. Besides, the transportation model used must show much more detail as city grows. Otherwise, transportation networks remain far from reflecting the truth, and consist of a schematic model [14]. Not taken into consideration of the pull factor of the stations on residential and commercial functions in the studies make ruin the dynamics of the city over time be possible.

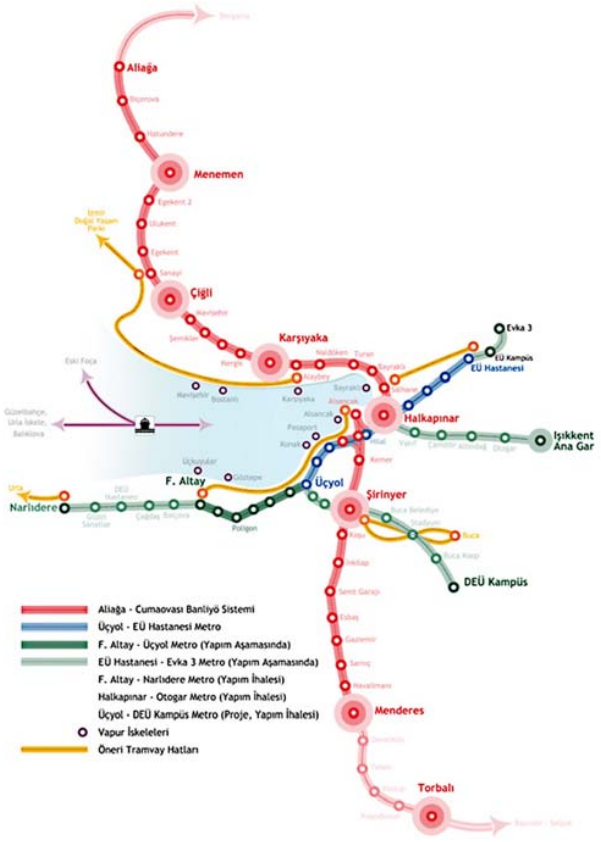

Fig. 4 Izmir Rail System Network [2]

It is known that, positioning of rail systems on the linear line as much as possible greatly reduce the cost of investment. However, the extension of system to the Bornova Merkez station was planned. This will lead to the unnecessarily increases in the cost and prevent the possibility of expansion to the north of the line [15]. Besides, bifurcation of main line is seen on many points is an attempt that prevents the effective use capacity of the system [16].

Finally, the studies of tram line additions, which were proposed in order to meet the need of rail system in the local centres where densely populated an inappropriate for light rail systems, were carried out, but the travel demands was calculated. Although they are more cost-effective than the other rail systems, tram lines also require fairly large investment. Despite this, offers a very limited passenger capacity.

IV. Impacts of Rail Transportation Projects on Urban Areas in Izmir

A. Fist Rail System Projects in Izmir

In this section, the space of the city of Izmir from past projects, how it had been affected by applied rail system projects will be examined. In the late 19th century, the opening of the Izmir- Aydın railway to use had made Izmir enter a new urban transformation process. The first effects of rail systems on the city have been observed in the beginning of 20th century [17]. Tram lines make accessing from greater distances to the city's business centre easier, so that, the city have begun to spread to the north east and south west and sprawled settlements formed in the Bornova, Buca, Karşıyaka regions.

TABLE I
Technical Features of Izmir Metro

Total Line Length	11,6 km.
Station Number	10
Travel Time	16 min 23 sec
Maximum Speed	80 km/h
Operation Hours	06:00-24:00
Peak Hour	07:00-09:00 and 16:30-18:30
Max. Passenger Capacity	1.700.000 passenger/day
Peak Hour Capacity	45,000 passenger/day
Feasible Capacity	400,000 y passenger/day

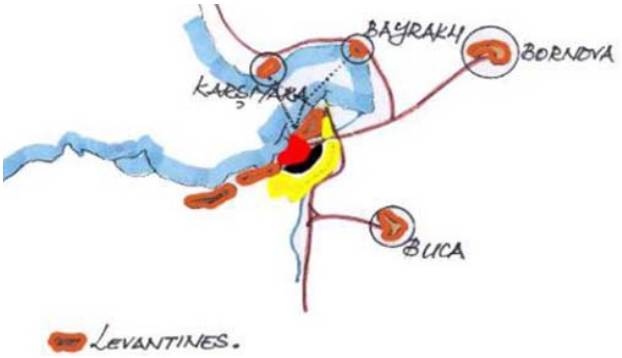

Fig. 5 Izmir's first Outside Settlements [3]

City's transport corridor has a direct impact on the development corridor of the city of Izmir. Also it increased

viability of existing commercial districts and led to the creation of new settlements [18].

TABLE II
TECHNICAL FEATURES OF IZBAN

Total Line Length	80 km
Station Number	31
Travel Time	98 min
Maximum Speed	140 km/h
Operation Hours	05:10-01:00
Peak Hour	07:00-09:00 and 16:30-18:30
Max. Passenger Capacity	550.000 passenger/day

A. Evaluation of Izmir Rail Transportation Projects on Number of Passengers in 21st Century

Today, there are two urban rail systems in Izmir named IZBAN and Izmir Metro which are applied and on-going development. İzmir Metro was opened to service in 2000 and IZBAN was opened in 2010. Both systems are based on the city's existing rail network. For this reason, currently it is not expected the systems to be caused a significant change in the form of the city after the city's first railway network, which has a direct impact on the emergence of the form the city [19].

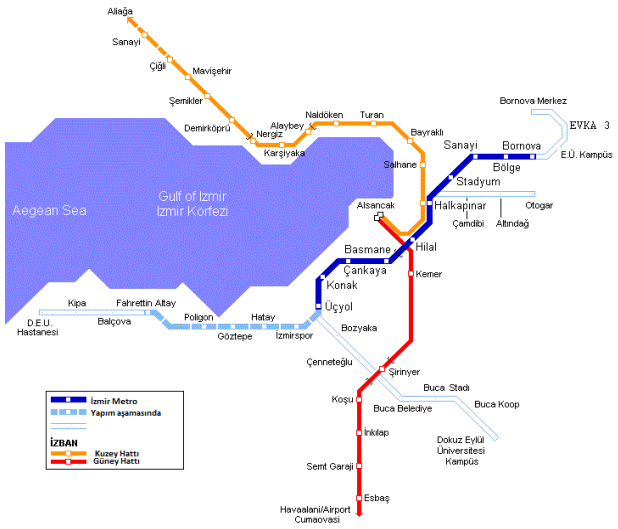

Fig. 6 Izmir Urban Rail System Network [4]

Length of 11.6 km of rail system operated by the İzmir Metro Inc. and located in the city centre has been serving the land use features of the central city. It has light rail system features according to technical aspects, route limitations and amounts of people carried. However, IZBAN established transport connection with the city centre and surrounding counties so that it will be true if IZBAN named as a suburban rail in considering the location and the passenger capacity of it (Table I).

According to data from Izmir Metropolitan Municipality of Izmir Transportation Master Plan report, daily travel demands of İzmir city is divided into the Central City and Urban Areas. The total number travels which is calculated 3,808,909 in 2008 is expected to increase to 7,128,847 by the target year (2030) of the plan with the increase of the urban population. (Table III, Fig. 7).

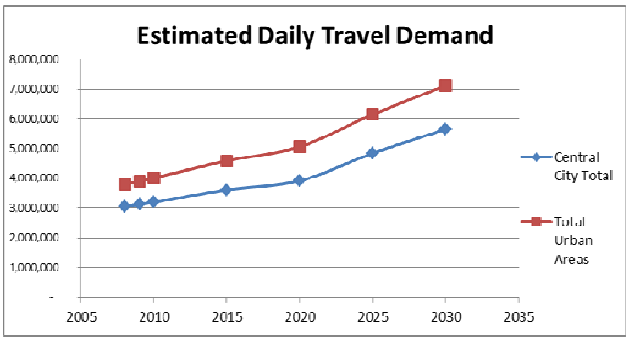

Fig. 7 Estimated Daily Travel Demand [6]

Estimates for the number of daily passenger rail systems in the public transport systems in urban rail systems show that a small portion of the demand for travel could be met. For example, in 2008 it was calculated that İzmir Metro will meet 2.97 % of the Izmir's need for travel when it was operated alone. Until 2030 there will be steadily increasing coverage ratio in travel demand but İzmir Metro planned to be completed in 2030 with all the stages expected to meet only 6.86% of whole travel demand. Although İZBAN opened in 2010 has much larger area coverage and capacity than İzmir Metro, it was calculated that it will meet 5.6 of the travel demand in its first year and only 8.21% of travel demand by the 2030 (Fig. 8).

If the data obtained from Izmir Metro Inc. and the annual service reports of Izmir Metropolitan Municipality is compared, it is obvious that the real number of passengers of İzmir Metro is not close estimates. The number of 112,974 passengers which is expected for 2008 could not be reached until 2012. In 2010 the coverage ratio of total travel demand realized as 2.57%, although it was estimated as 3.38%.

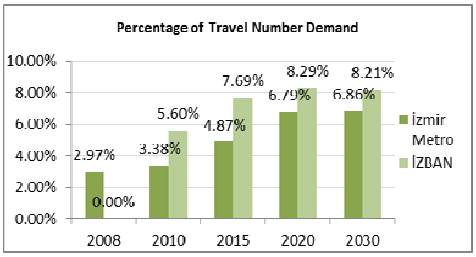

Fig. 8 Estimated Daily Travel Demand for Rail System [6]

TABLE IV
ESTIMATED RAIL SYSTEM TRAVEL PER DAY

Year	2008		2010		2015	
	Number of passengers	%	Number of passengers	%	Number of passengers	%
İzmir Metro	112,974	2.97	135,875	3.38	223,917	4.87
İZBAN	-	0.00	225,034	5.60	353,550	7.69
Total Number of Travel	3,808,909		4,017,274		4.594.773	

In addition, IZBAN operated in last 4 month of 2010 year did not meet the expected coverage ratio of 5.6%. In 2012 Rate it managed to reach approximately 3.22%. In this case, we are able to make the inference of that they are located on inappropriate corridor and they could not get enough passengers in their current route due to the unmet values of Transportation Master Plan's which are even insufficient.

B. Evaluation of Izmir Rail Transportation Projects on Number of Passengers in 21st Century

In this section, spatial changes in stations and surroundings of İzmir Metro will be examined based on the satellite images of 1989 and 2010 years. In the intervening 21-year period is enough to observe the change of urban space and to determine the contribution of Izmir Metro to these changes.

Fig. 9 Comparison of Üçyol Station

TABLE V
IZMIR METRO PASSENGER GROWTH RATES

	2004	2012	Growth Rate
ÜÇYOL	6,948,743	5,645,606	23.08%
KONAK	8,635,552	4,079,230	111.70%
ÇANKAYA	6,245,356	3,615,213	72.75%
BASMANE	2,889,957	1,168,528	147.32%
HİLAL	391,563	269,171	45.47%
HALKAPINAR	3,717,827	809,439	359.31%
STADYUM	3,139,478	1,643,063	91.07%
SANAYİ	892,118	567,121	57.31%
BÖLGE	2,550,309	1,656,909	53.92%
BORNOVA	9,393,953	5,629,498	66.87%

If the satellite images are examined, there is not a significant change in physical structure of Üçyol region after the construction and operation of Izmir Metro station due to the intense urban fabric in its surrounding. This residential structure which is already compact did not chance. In addition, when the distribution of the number of passengers according to stations has been analyzed, the distribution of passengers in 2004 has the highest ratio (22.51%), however in 2012 this ratio declined up to 14.41%. Although there is increase of over 50% and even over 100% in the other stations, this ratio has been calculated as 23% in Üçyol Station (Fig. 9).

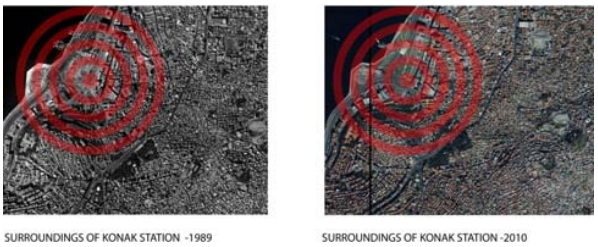

Fig. 10 Comparison of Konak Station

The Konak region which addressing the administrative centre and the historic centre of the city does not have much spatial changes around the station from 1989 until 2010 except from the open space and recreation arrangements. However, from 2004 until 2012 the number of passengers has increased by 111% (Fig. 10). In addition, being the only station integrated with the sea transportation system increases the importance of it.

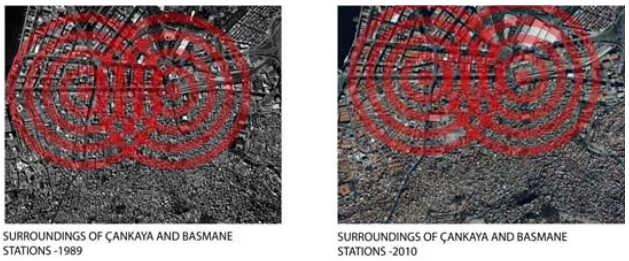

Fig. 11 Comparison of Çankaya and Basmane Stations

Fig. 12 Comparison of Hilal Station

Hilal Station has less intensive use of the land than the other stations, according to this situation; it has least number

of passengers (Fig. 11, Fig. 12). At the same time the rate of being used gradually decreases. While rate of the number of passengers used this station in 2004 was 1.07%, it dropped to 0.81% in 2012. However, according to the Master Plan of İzmir (2030), the surrounding of the Hilal Station is determined as Central Business District and 2nd and 3rd grade of centres.

Fig. 13 Comparison of Halkapınar Station

Halkapınar Station which became a comprehensive transfer station after opening of İZBAN in 2010 has increased its number of passenger by 359.31% (Fig. 13). According to İzmir Master Plan, surrounding of the Halkapınar Station has determined as CBD and Sports Area.

Fig. 14 Comparison of Stadium-Station

The number of passengers of Stadium-Station has increased by 91% from 2004 until 2012. However, there is a not significant spatial change around it (Fig. 14). According to İzmir Master Plan, surrounding of the Stadium and Sanayi Stations has determined as CBD, Sports Area and Regional Recreation Area. In this case, it is expected to increase the number of passengers of these stations which will serve to recreation areas instead of non-use industrial areas.

Fig. 15 Comparison of Sanayi-Station

Fig. 16 Comparison of Bölge Station

Compared to satellite images of 1989 and 2010 there is an increase in the density of planned residential areas around Bölge Station. It serves Education areas around it. Besides, the Regional Recreation Area planned in İzmir Master Plan will affect the usage of this station (Fig. 15- 16).

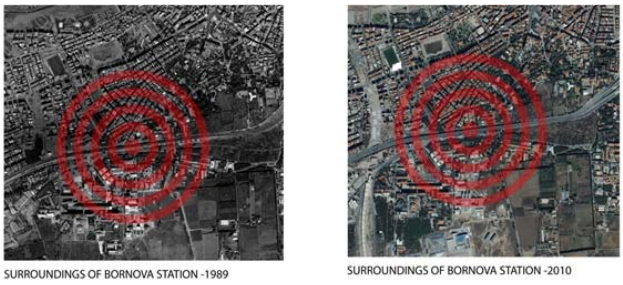

Fig. 17 Comparison of Bornova Station

In particular Bornova Station serving the areas of Education and Housing has an increase in the number of passengers by 67% due to increase in the density of housing areas in Manavkuyu and Atatürk Neighbourhood (Fig. 17). Looking at the residential area around the station is seen that mostly transportation projects had been realized.

According to the survey conducted by İzmir Metro Inc in 2001, the accessibility area of the metro is determined as 800 meters. Non-use urban areas in 800-meter walking area are most important factors of the diminution in the number of passenger. It is observed that there is higher numbers of passengers if the stations are located in dense residential, education and working areas.

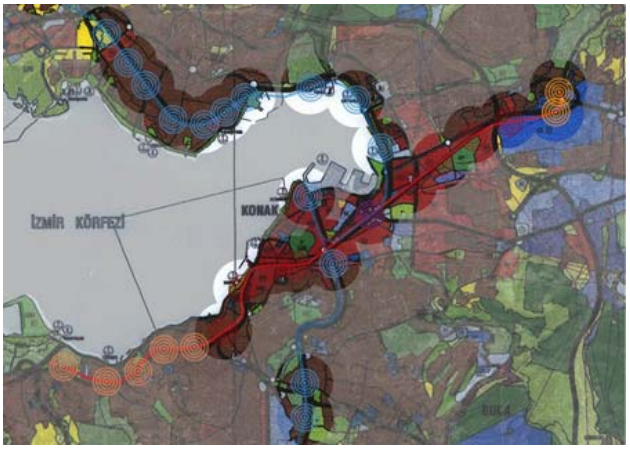

Fig. 18 Master Plan around the IZBAN and Izmir Metro

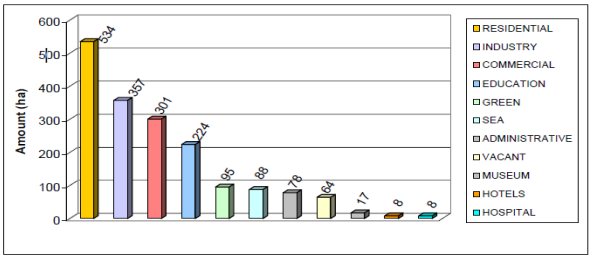

Fig. 19 Distribution of Land Use in the Domain of Izmir Metro [5]

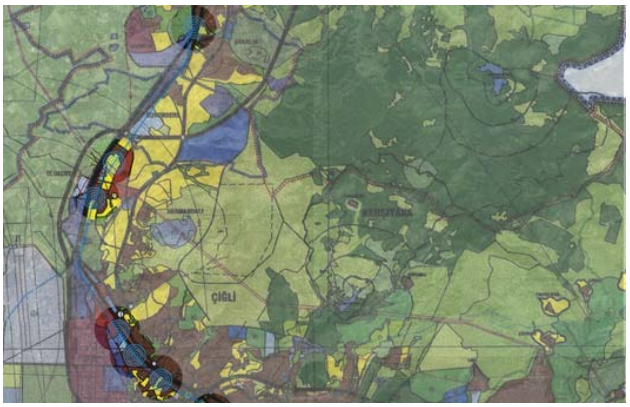

Fig. 20 Northern axis surroundings Master Plan IZBAN

IZBAN realizes connection of the central city and the surrounding settlements as well as the airport and the city centre. It has less frequent stops than the Izmir Metro. However, IZBAN has further service to urban development areas than Izmir Metro. In addition, it combines the residential areas and the working areas on the northern axis such as Atatürk Organized Industrial Zone (Fig. 18, Fig. 20).

In order to reach the expected passenger capacity of rail systems, they must be correctly connected in residential areas. As can be seen above visuals, rail systems domains include relatively small amount of residential areas in Izmir. It is understood that there is a weak link with other public transportation systems owing to low number of passenger. In the same way rail systems did not integrated with the pedestrian axles and cycle paths which should cover whole city.

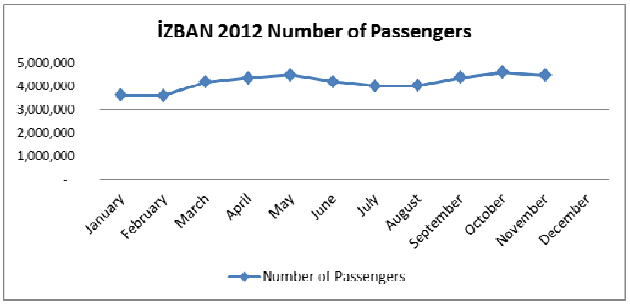

Fig. 21 IZBAN 2012 Number of Passengers [4]

If the passengers number of IZBAN and İzmir Metro has examined, the decline in the number of passengers in the months of July-August and January-February could be explained by the 17 per cent of trip rate between Home and Education which is obtained from the survey results (Fig. 21, Fig. 22).

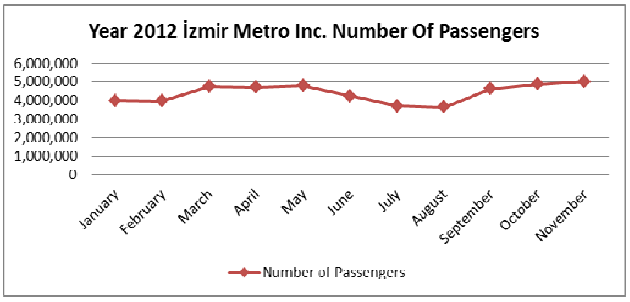

Fig. 22 Year 2012 İzmir Metro Inc. Number of Passengers [7]

V. Conclusion

The development of rail transportation systems, transportation planning work is one of the most important tools that allow the realization of these goals. For this purpose, being planning studies kept away from political pressures and the units involved in the study to avoid being in different applications is great importance.

In the study, it is clear that the system defined as Izmir Metro is actually a light rail system because there is a significant difference between Izmir Metro and metro systems. It is expected that there will be an increase in the share of rail transport systems in urban transportation systems as a result of the 5.5 km extension of İzmir Metro to Üçkuyular and a new light rail system (IZBAN) opened in Izmir. Especially, opening of Üçyol-Üçkuyular line will be resulted in effective usage of İzmir Light Rail System line which carries much less number of passengers than other rail systems currently. With this result, the demand for daily passenger 75 000 passengers / day from 130 000 passengers / day is expected to rise. In the

future by the addition of especially the bus terminal line and Narlıdere and Buca corridors to the system the demand will increase even more, and the transportation problem in Izmir will substantially be solved by implementing integrated fast and safe public transport system.

Based on these results recommendations are:

- Urban transport master plans should be revised and updated according to changing economic and social structures of city, decisions must be taken quick the application
- Short-term problems should be solved in the way that does not contradict with the main plan, and they should not violate the long-term proposals of solutions.
- The integration of the current transport system and the rail system must be well thought. The goal should be to get the most out of the system.
- Should not be the estimates less than the possible values used in the planning stage. Forward-looking projections should be performed using adequate data and appropriate methods.
- Long-term plans should be handled in stages, the time schedule should be followed as much as possible.
- Development plans and transportation plans must match each other.

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