

## **The effects of urban rail transportation projects on urban areas: Case study of Izmir**

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### **ABSTRACT**

Starting in the late nineteenth century rail network expansion activities in large cities of developed countries has been in trouble because of the energy crisis in the 1970s, but the rail system works in the 1990s accelerated the concepts of environmental and economic sustainability, and is still continuing today. In the 1970s urban rail systems, previously only applied to highly populated cities, started to be implemented in low-populated urban areas. Despite efforts to accelerate rail system in the 1990s in developed countries, many developing countries had not have rail networks. In countries which had been studying on rail system networks, along with the acceleration of urban development, due to the lack of transportation plans, inadequate or incorrect implementation of the plans or changing actions in the implementation phase applied advanced rail system has not reached capacity or expected.

In Turkey, the purpose, goals and policies of transport 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. Compared to other transport systems, rail systems require more efficient use of the investment because of the high investment costs, so that implementation of these systems without deviating from the main policies and objectives, efficient use of financial resources has become crucial for the correct orientation of the investment. One of the most important factors in the provision of effective use of rail systems is locating in the right corridor. Provided, however, to meet the expected passenger capacity in terms of investment is very important to achieve the objective. In this study, located in the city of Izmir, Bornova-Üçyol Metro line and Aliağa-Menderes Urban Light Rail System and light rail

systems in the coming years and the projected capacity of recommendation after analyzing tried to reveal the effects of urban space.

## INTRODUCTION

In Turkey, due to misapplication rail systems have emerged that the capacity of the rail systems, which was calculated according to the population of the city, cannot capture the expected number of passengers. For this range of passenger capacity, light rail systems were inadequate and metro rail systems do not contain a sufficient demand so that alternative concepts emerged such as fast tram, semi-underground or pre-underground and they were seen as the savior for the developing countries. Afford the long-term, these systems failed to meet public expectations. They caused an increase in the use of private vehicles and have not lessened the intensity of the wheel systems which were not fully installed with the rail systems. Increasing of air pollution and traffic congestion which has become today the main problems of these cities continued as a result of unrealized expectations of the implementation of rail systems [1].

In the phase of investment for these systems, high costs and the expected level of capacity requires more careful planning stage, because rail system investments contain a substantial amount of the country's resources and highest level of benefit for these systems should be obtained in order to reach economically sustainable investments. Therefore, the need of rail systems for which city, for which time interval, for which capacity, for which thresholds should be carefully examined and then needed to be discussed. At this stage, the integration of rail and other public transport modes with urban land use has become inevitable. There is a wide variety of rail system applications working in an integrated way in cities and around cities. In general today the world cities are operating high-speed and high-capacity systems (subway) in order to ensure fast access within the city and between cities also light rail systems, which are situated between tram and metro in technical aspects, are being operated for less distance [2].

Table 1 Capacity Comparison Types of Urban Mass Transit [2]

TRANSPORTATION SYSTEM	CAPACITY (P/H/D)
Bus	2.000-4.000
Tram	2.000-6.000
Commuter Train	5.000-15.000
Light Rail System	10.000-20.000
Metro	20.000-60.000
Regional Metro	40.000-80.000

Metro systems, has emerged as a solution to meet the demand which slow and crowded wheel systems not meet in more sustainable aspects for cities. Metro offers a service in high-capacity and faster than other systems. Therefore it has become the most important transportation choice for the world's metropolis. These systems provide high accessibility and speed at the same time has become the solution to establish a long-distance and regional connections [3]. Connections to the airport and the ports where provided, they are an important part of the international journey. Requiring its own characteristic features and their spatial organization, these systems are applied in cities have much sharper impact than the other rail system applications.

### ***LIGHT RAIL SYSTEMS AND METRO SYSTEM IN PASSENGER TRANSPORTATION***

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 [4].

However, a metro system brings a dynamic process affecting land use and economic activities of the city centre 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. 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 [5]. 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.

For many years, Metro which provides o fast and reliable access is preferred by the metropolitan cities but in recent years light rail systems started to be developed which have lower investment costs than the Metro. These systems identified as "modern tram" is seen as a rail system solution due to the ability of meeting much more travel demand than the wheel systems, being comfortable, safety and harmless in environmental aspects in cities or between parts of the city which do not require high-

speed rail system investments. Another important point in preference of these is that a more flexible adaptation to the other systems. These systems that can be applied easily than on the ground in contrast to the Metro are preferred for the realization of public transportation in urban centre due to the low speed and low cost. At the same time a positive impact on issues such as urban development and renewal of the city centre is a cause of widespread use [6]. They play an important role in shaping urban development with right investment and supporting local policies. However, issues of increasing in the cost of urban land and increasing of susceptibility to settle around the stations as well as in other rail systems should be examined carefully during the planning phase. On the other hand, this return of light rail systems is very important to the revitalization of urban decay areas. Due to low-performance passenger carrying capacity and low speeds they have fewer effects than high-speed rail systems to the city and frequently located stations do not allow urban sprawl. At the same time, another positive effect of these systems on cities is that to allow more effective using of places allocated parking areas as urban open spaces in city centres by reducing private car using.

The size of the city centre and the density of residential areas are important factors that determine the need for a light rail system. Looking at examples of these investments in the world, residential areas, they located in a corridor including commercial areas, industrial areas and service sector. For this reason, the most important factor in determining the effectiveness of light rail systems is working integrated with existing systems. In addition, public transport systems recently developed to be adapted to the rail system is very important. Provided lower costs and more flexible structure than high speed rail systems, light rail systems are especially preferred by governments whose main policy is to create in the urban centres due to the substantial contribution of pedestrian priorities to the cities.

### ***RAIL TRANSPORTATION SYSTEMS IN IZMIR***

Countries of the world having achieved speed rail system investments but in zmir the Transportation Study came up with a new rail projects eventually in 1992. 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 (Fig. 1) [7]. In March of 2012, this system was put into operation by adding two more stops. In addition, ZBAN was planned as a new rail system on the TCDD railway line along the Alia a-Menderes corridor by increasing the capacity of that line instead of the metro line which had been thought to extend to Çi li according to the same courses of study. Opened in 2010, ZBAN rail system is 80 km long, and consists of two main sections as Aliaga-Alsancak-Halkapinar (north) and Halkapinar-Alsancak-Cumaovası (south) axis [7].



Figure 1 Izmir Metro Applied and Construction Phases

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 [8]. 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. 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. Besides, bifurcation of main line is seen on many points is an attempt that prevents the effective use capacity of the system. 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.

**EFFECTS OF URBAN RAIL TRANSPORTATION PROJECTS ON URBAN AREAS IN IZMIR**

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 zmir Metro will meet 2.97 per cent of the zmir’s need for travel when it was operated alone. Until 2030 there will be steadily increasing coverage ratio in travel demand but zmir Metro planned to be completed in 2030 with all the stages expected to meet only 6.86% of whole travel demand. Although ZBAN opened in 2010 has much larger area coverage and capacity than zmir 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 (Table 2).

Table 2 Rail System Travel per Day Estimated [9]

	2008		2010		2015		2020		2030	
	# of passengers	%	# of passengers	%	# of passengers	%	# of passengers	%	# of passengers	%
zmir Metro	112,974	2.97	135,875	3.38	223,917	4.87	344,036	6.79	488,842	6.86
ZBAN	-	0.00	225,034	5.60	353,550	7.69	420,204	8.29	585,161	8.21
Total Number of Travel	3,808,909		4,017,274		4.594.773		5.067.328		7.128.847	

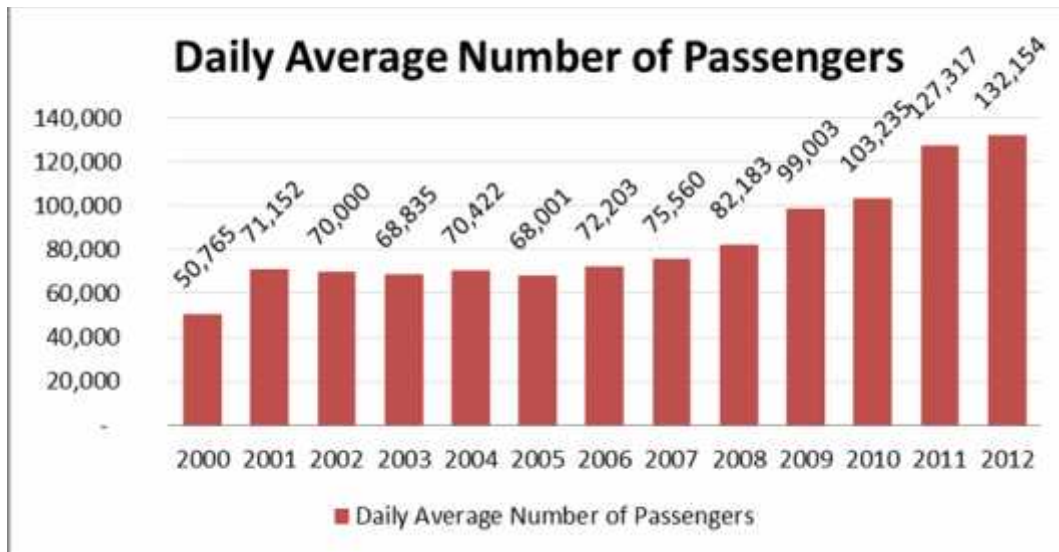


Figure 2 Daily Average Number of Passengers of zmir Metro [10]

Table 1 Coverage Ratios of Daily Number of Passenger of zmir Metro [10]

Years	Daily Average Number of Passengers	Coverage Ratios	Estimated Travel Demand
2008	82,182	2.16%	3,808,909
2010	103,235	2.57%	4,017,274
2012	132,154	3.11%	4,248,274

If the data obtained from zmir Metro Inc. and the annual service reports of Izmir Metropolitan Municipality is compared, it is obvious that the real number of passengers of zmir 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% (Table 5).

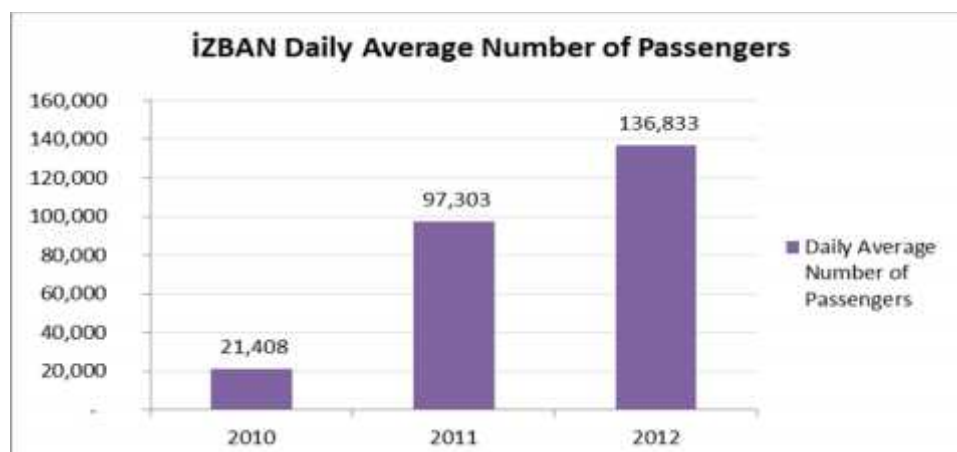


Figure 3 ZBAN Daily Average Number of Passengers [10]

In addition, ZBAN 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.

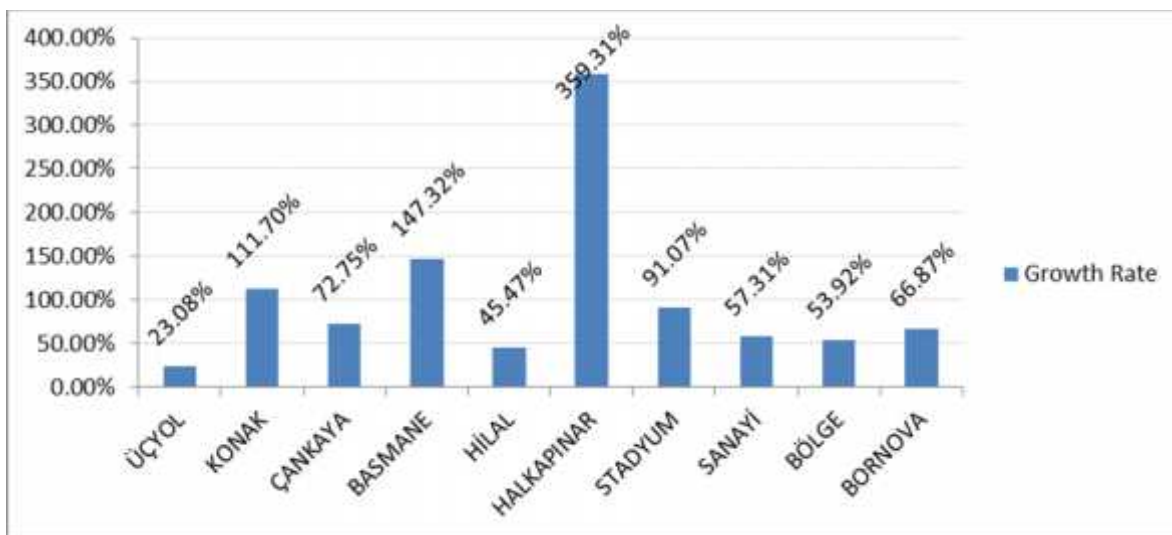


Figure 4 Between 2004-2012 zmir Metro Rate of Increase in the Number of Passengers [10]

Table 2 Coverage Ratios of Daily Number of Passenger of ZBAN [10]

Years	Daily Average Number of Passengers	Coverage Ratios	Estimated Travel Demand
2010	21,408	0.53%	4,017,274
2011	97,303	2.35%	4,132,774
2012	136,833	3.22%	4,132,774

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. 5). Looking at the residential area around the station is seen that mostly transportation projects had been realized.



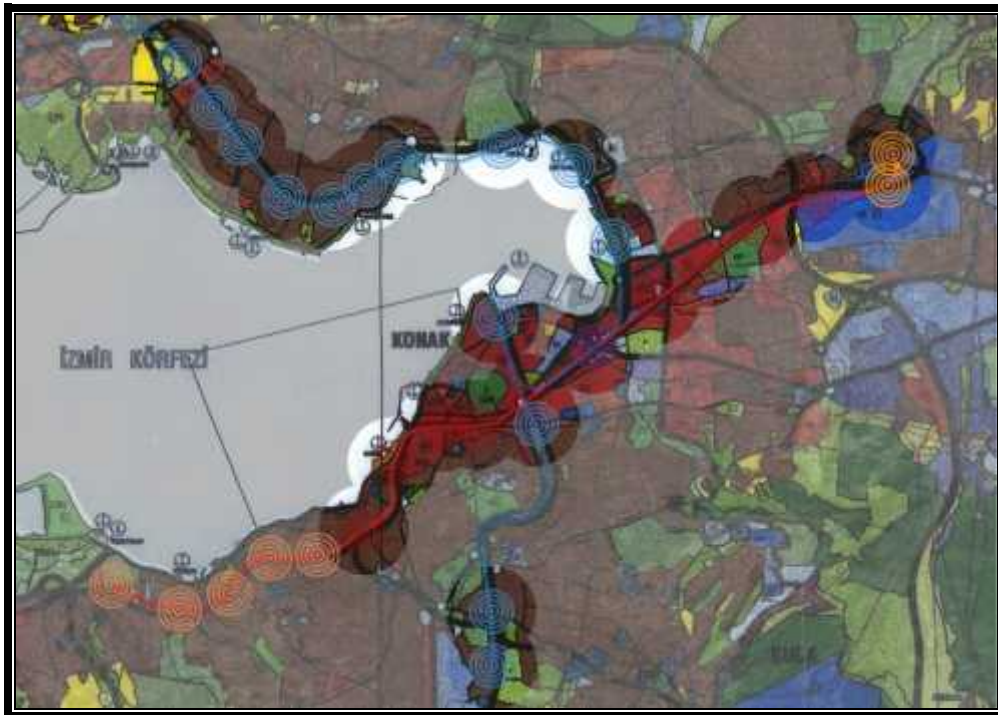


Figure 5 Master Plan around the ZBAN and zmir Metro

According to the survey conducted by zmir 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.

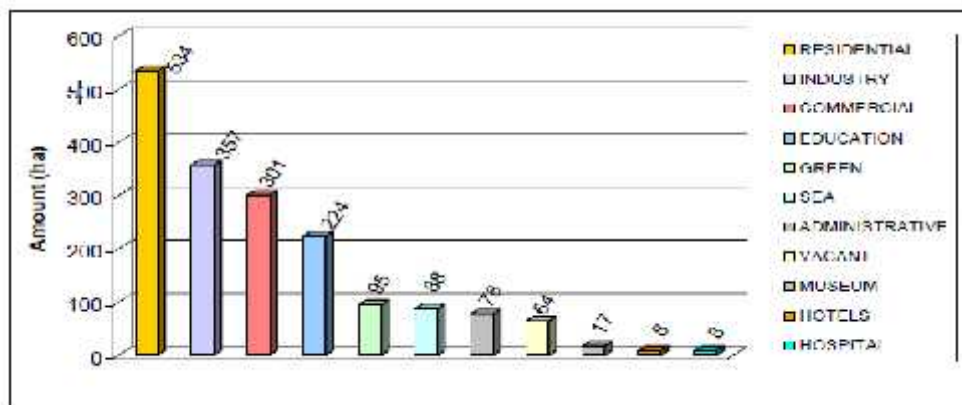


Figure 6 Distribution of Land Use In The Domain of zmir Metro [11]

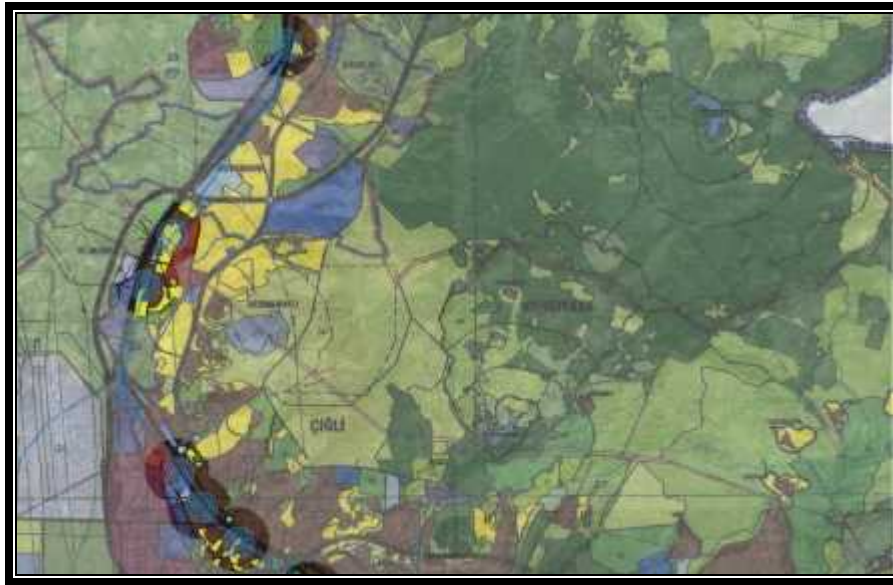


Figure 7 Northern Axis surroundings Master Plan ZBAN



Figure 8 Southern Axis surroundings Master Plan ZBAN

ZBAN 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, ZBAN 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. 7, Fig. 8). 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 axes and cycle paths which should cover whole city.

Travel corridor utilization rates and distributions by purpose of travel obtained from a questionnaire hold by Izmir Metro Inc in 2001 are seem to support land use plans and master plans. According to the survey most of the travels (5.16%) take place between Bornova-Üçyol that combines the working areas located in Bornova and Konak-Çankaya. In addition, home-work purpose for travel is emerging as a top priority by 48% in accordance with land use around the station.

## CONCLUSION AND RECOMMENDATIONS

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 Izmir Metro to Üçkuyular and a new light rail system ( ZBAN) opened in Izmir. Especially, opening of Üçyol-Üçkuyular line will be resulted in effective usage of Izmir 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.

## REFERENCES

- [1] Cervero, R. (2007) Light Rail Transit and Urban Development. *Journal of the American Planning Association*.
- [2] Krantzberg, G. (2012) Light Rail Transit in Hamilton: Health, Environmental and Economic Impact Analysis. *Springer Science+Business Media*.

- [3] Vasica, B. (2012) Defining the functional and physical compatibility of a modernized tramway rolling stock with a newly planned LRT system: a case study of Belgrade. *Transportation Planning and Technology*, 241-261.
- [4] De Bruijn, H. (2009) Decision-making for light rail. *Transportation Research Part A*, 349–359.
- [5] Garmendia, M. (2012) High speed rail: implication for cities. *Cities*, **29**(26–31).
- [6] Russoa, C. F. (2012) City characteristics and urban goods movements: A way to environmental transportation system in a sustainable city. *Procedia - Social and Behavioral Sciences*, No. 39, 61 – 73.
- [7] ZBAN A. . (2012) Report. zmir.
- [8] zmir Metro A. . (2012) Report. zmir.
- [9] zmir Büyük ehir Belediyesi Yıllık Faaliyet Raporları, zmir Büyük ehir Belediyesi, 2000-2011.
- [10] Egercio lu, Y. (2013) Impacts of Rail Transportation Projects on Urban Areas in Izmir-Turkey. *International Congress of Urban Planning and Transportation*, Madrid, Spain.
- [11] Özgür, Ö. (2011) Performance Analysis of Rail Transit Investments of Turkey: stanbul, Ankara, zmir and Bursa. *Transport Policy*, 18(147-155).