ISTANBUL METROBUS SYSTEM

by

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ABSTRACT

Public transportation is an important key to improve quality of life for cities. It is a key to show development of the cities. In today, there is a need having new solutions for mass transit. For this reason transit authorities try to find best solution for the cities which are having high passenger demand. The best solution is different due to budget, infrastructure, demand and behavior of passenger, although it should be effective and sustainable. Bus rapid transit (BRT) system gives us effective and sustainable solution. For effective side it can be analyzed with cost effectiveness method. For the sustainable side it is an environmental system which is the most important issue for the 21st century. Bus rapid transit is used effectively in the world due to its low cost, speed, high capacity, and innovative design and easy to implement. All of these properties answer the question why BRT system is selected for public transportation. Istanbul which is the most population density city in Turkey has BRT system. Istanbul BRT which the other name is bus rapid transit is implemented in 2007. It connects Asia and Europe side and consists of four main parts. The last part is established in 2012. The BRT line composes of 52 kilometer with 45 stations. IETT is a bus company; it is responsible buses and BRT for Istanbul. IETT has comprehensive operation knowledge about public transportation. It has managed buses for 141 years. With this experience Istanbul BRT is operated effectively. System analysis is an important issue for management. If you know system exactly, you can find critical points to improve it. From this viewpoint there are lots of analyses about Istanbul BRT system. These analyses can be categorized in four main category; passenger demand, operation performance, improving system quality and benchmarking with other BRT systems in the world. In this study, Istanbul bus rapid transit system is analyzed in detailed, such as why BRT system is selected, implementation of Istanbul BRT system, what are the main elements of the system, operation model with operation information, cost effectiveness of Istanbul BRT system, after implementation what is savings and benchmarking Istanbul BRT with other BRT systems including what are the common points and what is difference of Istanbul BRT.

KEYWORDS
New Transportation Trend, Sustainable Transportation, Bus Rapid Transit, Istanbul BRT System Analysis

PUBLIC TRANSPORTATION

Public transportation has been an important issue in the world due to high passenger demand with traffic jam. There are main public transportation modes such as bus and rail system. Bus transportation includes normal bus, minibus and private services. Rail system consists of metro, LRT and tramway. Comparison of bus and rail system is showed that in Table 1.

TABLE 1
TRANSIT PERFORMANCE FACTORS

Standard	Conventional Bus	Double deck Bus	Articulated Bus	LRT	Two-Car Trams
Length (m)	10	12	18	24.5	2*30
Width (m)	2.5	2.5	2.5	2.55	2.65
Passenger Capacity	75	105	125	160	350
Seating	35	95	50	60	150
Standing	40	10	75	100	200
Maximum Hourly Capacity	4,500	6,300	7,500	9,600	21,000

Source: Gleave (2005)

For the crowded cities rail system is preferable than bus system by reason of high passenger capacity and frequent service frequency. In rarely sea transportation can be used for public transportation.

BUS RAPID TRANSIT (BRT) SYSTEM

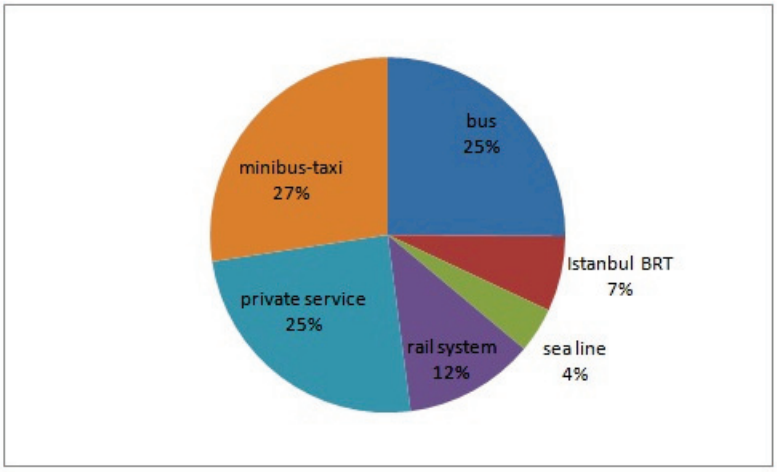
Bus rapid transit system is a type of public transportation which can be named BRT. It has a special corridor, in the other words it operates on its own way which is strictly separated from city streets. With this feature, BRT system is different than traditional bus system. BRT can be defined, "A flexible, high performance rapid transit mode that combines a variety of physical, operating and system elements into a permanently integrated system with a quality image and unique identity"(FTA, 2004). Flexibility of the system provides a wide application in transport area.

Why BRT system is preferred? Before transit authorities make a decision, lots of analyses are sorted out. During decision process main criterias are identified such as budget, time, capacity and sustainable solution. BRT system includes all of these properties. In addition, it is a green solution due to reducing transportation emission. In latest century, environmental solutions have critical importance especially in the field of public transportation because it is estimated that transport is responsible for nearly a quarter of global energy-related CO_2 (Dalkmann & Sakamoto, 2011).

ISTANBUL AND IETT

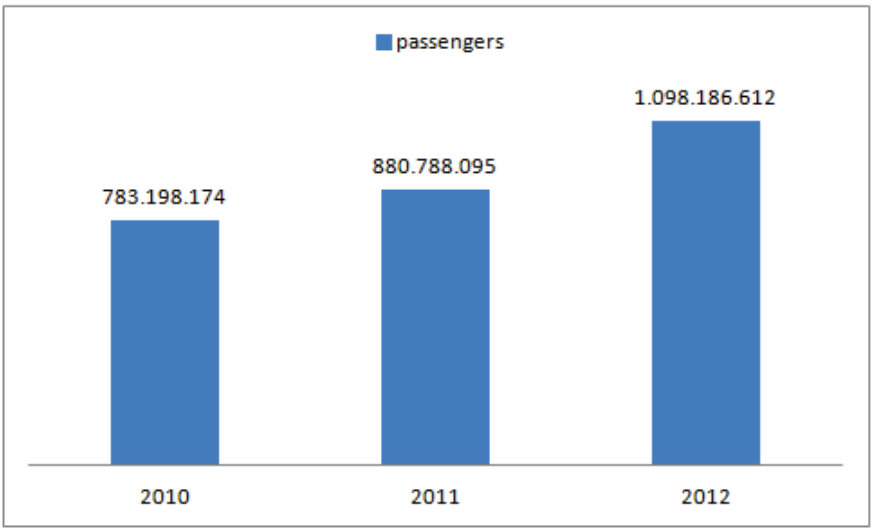
TUIK (2011) introduces that Istanbul has 13.624.240 population with 39 zones. It is the most crowded city in Turkey. At the same time, it is capital of culture and finance of Turkey. Mass transit includes bus, rail, sea and BRT system in Istanbul. Percent of transportation mode is indicated that in Figure 1.

FIGURE 1
PERCENT OF TRANSPORTATION MODE IN ISTANBUL



11 million passengers are carried by public transportation and average journey time is 49 minutes in Istanbul. IETT was founded in 1869 by government for operation and management of public and private buses in Istanbul. In today, IETT is managing 2.200 public and 2.697 private buses with 11.092 stops, 9 garages and 1 renewal unit. Bus passengers of 2010, 2011 and 2012 are showed in Figure 2.

FIGURE 2
YEARLY PASSENGERS OF BUSES IN ISTANBUL



HISTORY OF ISTANBUL BRT SYSTEM

BRT system is implemented step by step. The first part with 15 stations is opened in 2007. Second part with 11 stations is opened in 2008 and the third part with 8 stations is opened in 2009. The last part with 11 stations is opened in 2012. Thus, BRT line is 52 kilometer with 45 stations. Istanbul BRT history is indicated in Figure 3.

FIGURE 3
PHASES OF ISTANBUL BRT

Table 2 summarizes implementation of Istanbul BRT line. Information of lines are denoted three categories including date, number of stations and line kilometer.

TABLE 2
INFORMATION OF ISTANBUL BRT PHASES

Phase	Date	Number of station	Line km
Avcılar-Topkapı	2007	15	18
Topkapı-Zincirlikuyu	2008	11	12
Zincirlikuyu-Söğütlüçeşme	2009	8	11,5
Beylikdüzü-Avcılar	2012	11	10

MAIN ELEMENTS OF ISTANBUL BRT SYSTEM

BRT is a comprehensive system. It consists of different elements. These elements are denoted as follows:

- middle separated lane

Figure 4 shows that middle separated lane of Istanbul BRT.

FIGURE 4
ISTANBUL BRT MIDDLE SEPARATED LANE

- stations
- well-design high vehicles
- flexible operation plans
- control center

Control center of Istanbul BRT is indicated in Figure 5.

FIGURE 5
ISTANBUL BRT CONTROL CENTER

- pre-payment system
- safe journey
- disabled access
- passenger information with announcement system
- distance-based pricing.

Table 3 shows that distance based pricing of Istanbul BRT.

TABLE 3
DISTANCE-BASED PRICING OF ISTABUL BRT

Number of Station	Discount Card (TL)			Normal Card (TL)
	Student	Teacher	Elderly	
1-3	0,85	1,15	1,15	1,60
4-9	1,00	1,40	1,40	2,40
10-15	1,00	1,40	1,40	2,50
16-21	1,00	1,50	1,50	2,60
22-27	1,00	1,50	1,50	2,70
28-33	1,00	1,60	1,60	2,80
34-39	1,00	1,60	1,60	2,90
40+	1,00	1,60	1,60	2,95

OPERATING SYSTEM OF ISTANBUL BRT

Istanbul BRT has serviced main artery of city since 2007. The system carries 750.000 passengers a day with 410 vehicles and 3.500 trips. Service performance rate is rather high that is average 98-99 percent. Service frequency of rush hours is 20-25 seconds 7:00-9:00 a.m. in the morning and 5:00-8:00 p.m. in the evening. Journey time of BRT line is 83 minutes with 52 kilometer. Commercial speed is approximately 35 kilometer an hour which is the quickest speed in BRT systems around the world. The system services all day including 24 hours owing to passenger demand. Nearly 1.400 staffs are employed in the system. Table 4 summarizes operation information of Istanbul BRT.

TABLE 4
OPERATION INFORMATION OF ISTANBUL BRT

Peak hour per peak direction	35.000 peak hours/peak direction
Daily passenger	750.000 passengers/day
Max trip number	3.500 trips/day
Headway during peak hours	20-25 seconds
Headway during other than peak hours	45-60 seconds
Beylikdüzü-Söğütlüçeşme travel time	83 minutes
Total line number	6(34, 34A, 34B, 34C, 34Z, 34G)
Total line kilometer	52 km
Total service number	410 vehicles
Total station number	45 stations
Service time	24 hours
Total number of staffs	1.350 staffs

6 lines are operated for BRT system. Their operation modes are indicated in Figure 6. 34A line services only in the morning and evening rush hour. 34G is a night line which it is not showed in Figure 6. It services between Beylikdüzü-Söğütlüçeşme from 1:00 a.m. to 5:00 p.m.

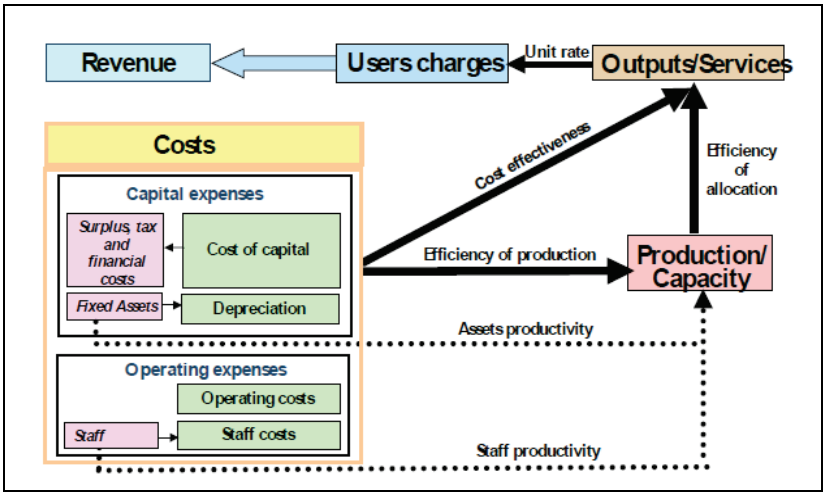
FIGURE 6
LINES OF ISTANBUL BRT

COST EFFECTIVENESS OF BRT SYSTEM WITH ISTANBUL BRT

Policy makers need enough information about relative costs to determine what combination of interventions can yield the greatest improvements in projects. At this point, cost effectiveness analysis appeared. This method is a tool for weighing different costs and outcomes of project when policy makers have to make resource allocation decisions (Savedoff & Smith, 2006).

Cost can be categorized as capital and operating expenses. Using costs production/capacity service is generated. After producing, outputs/services are obtained and then revenue occurs. Cost-Revenue circle is indicated in Figure7.

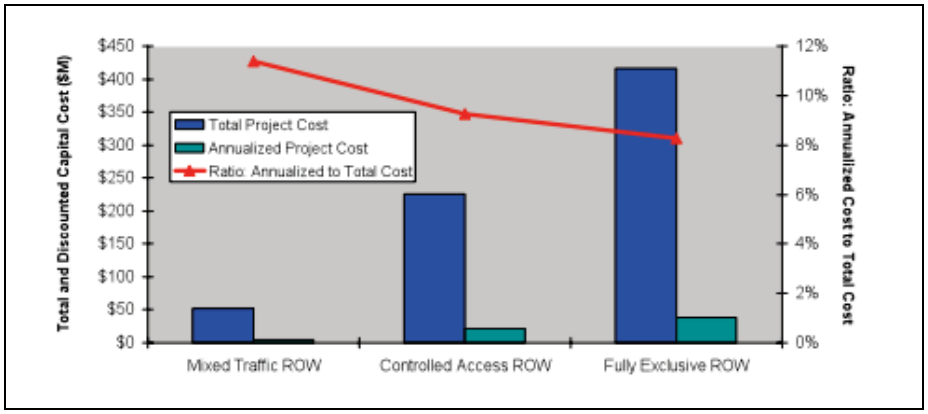
FIGURE 7
MEASUREMENT OF COST EFFECTIVENESS AND PRODUCTIVITY



Source: KPI Drafting Group (2001)

Cost per hour of user benefits which is a FTA's cost effectiveness measure is calculated for varying levels of investment in BRT. Calculation of cost effectiveness is showed in Figure 8. From Figure 8 fully exclusive row (right of way) is effective than the controlled access row and mixed traffic row. In other words, implementing fully exclusive row is low cost, exclusive row is middle cost and mixed traffic row is the highest project in BRT.

FIGURE 8
COST EFFECTIVENESS ANALYSIS EXAMPLE FOR CORRIDOR WITH LIMITED RIDERSHIP POTENTIAL



Source: Federal Transit Administration (2009)

Cost of Istanbul BRT system includes capital, operational, maintenance, service quality and staff cost. Benefits of the system are segregated lines, continuous transit, high capacity and low floor vehicles, innovative design, pre-payment system and reduction of air pollution. Benefit of Istanbul BRT is classified five main categories such as efficiency, saving in public transport, environmental impact, travel time saving and private comfort. Benefit analysis of the system is indicated in Table 5.

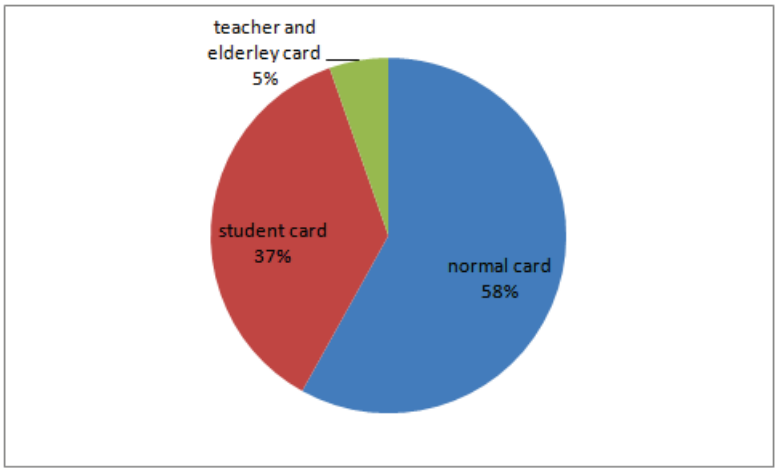
TABLE 5
BENEFITS OF ISTANBUL BRT SYSTEM

Efficiency	Savings in Public Transport	Environmental Impact	Travel time in Savings	Private comfort
18 lines were cancelled	133 İETT	Reduction of 80 thousand vehicles	Daily 132 min/passengers	Customer satisfaction
11 lines were shortened	76 Private buses	Daily 613 tonne CO_2 reduction	Yearly 34 days/passengers	*
*	1.316 minibuses	*	*	*
*	242 tonne fuel oil	*	*	*

PASSENGER PROFILE OF ISTANBUL BRT

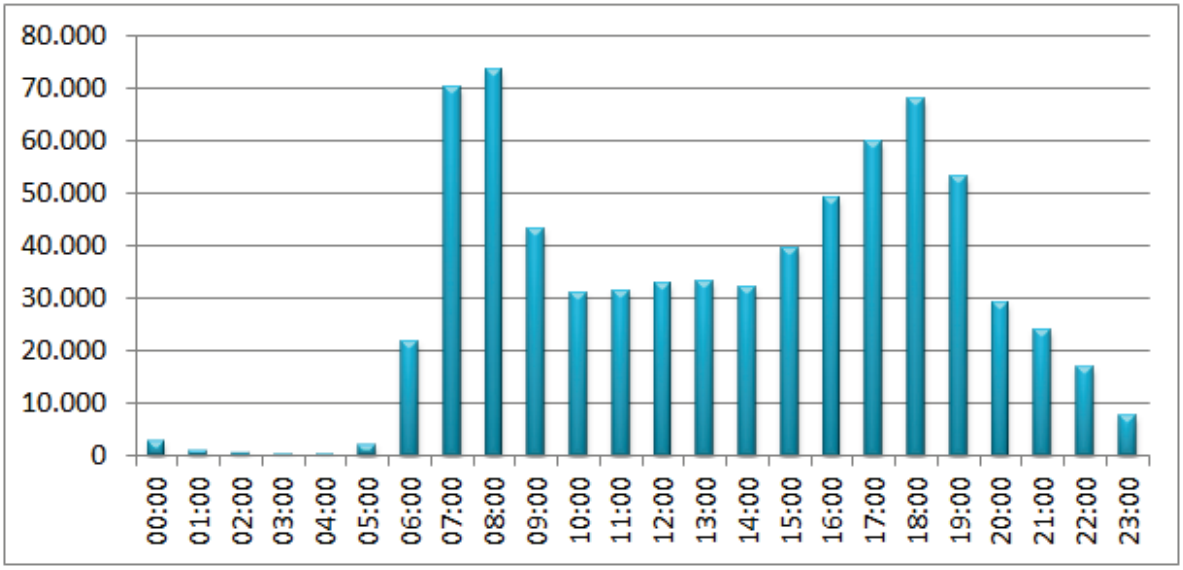
There are 3 categories about passenger profile in Istanbul BRT. The biggest pie belongs to full ticket and the smallest pie is related to social ticket which includes teachers and age persons. Pie chart of BRT system ticket is indicated in Figure 9.

FIGURE 9
ISTANBUL BRT PASSENGER PROFILE



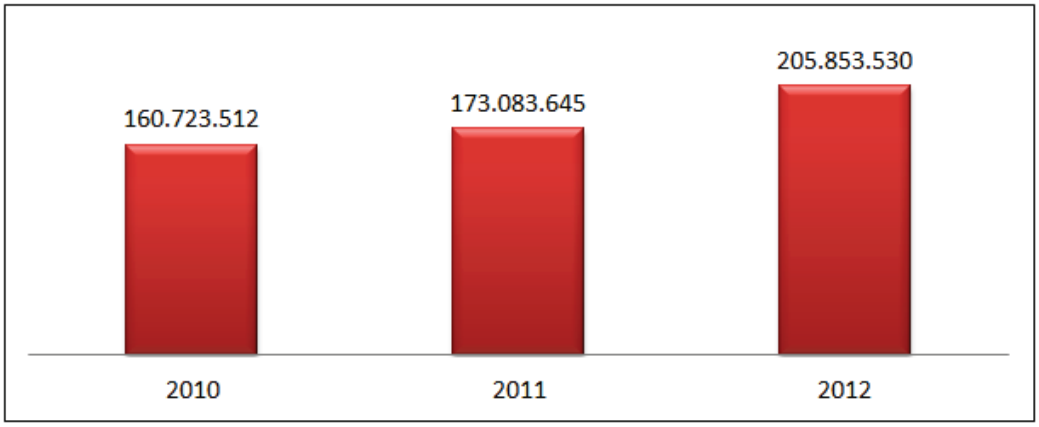
Distribution of Istanbul BRT is like Figure 10. In the morning between 7:00-9:00 a.m. passenger demand is nearly 190.000 and in the evening between 5:00-8:00 p.m. the demand is average 220.000 that is 29 percent of total daily passenger.

FIGURE 10
DISTRIBUTION OF DAILY ISTANBUL BRT PASSENGERS



Annual passengers of the system are showed in Figure 11. Passengers of Istanbul BRT have been increasing from year to year.

FIGURE 11
YEARLY PASSENGERS OF ISTANBUL BRT



BENCHMARKING OF ISTANBUL BRT WITH OTHER BRT SYSTEMS

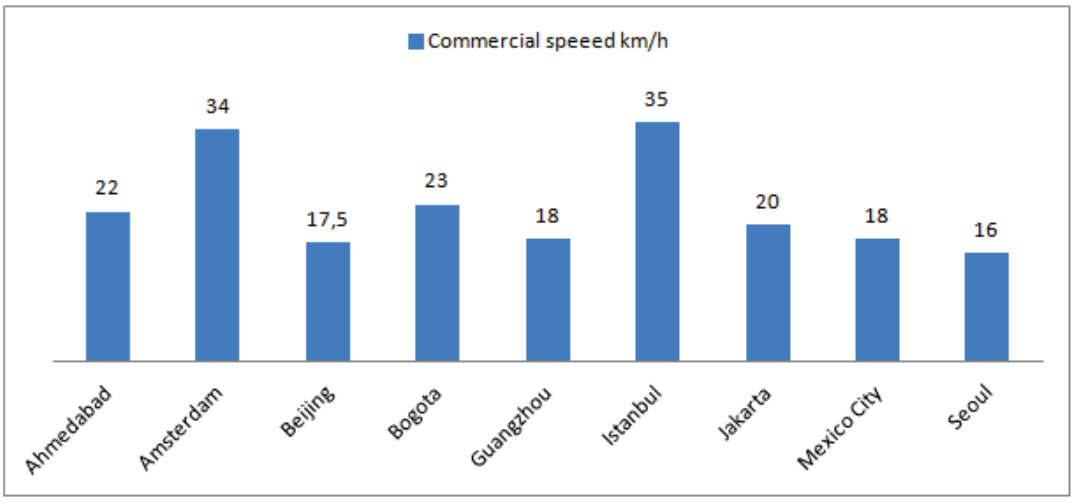
Recently, BRT system has been a new trend for public transportation. It is used worldwide such as Ahmedabad, Amsterdam, Beijing, Bogota, Curitiba, Guangzhou, Jakarta, Mexico City, Paris, Seoul, Istanbul. Figure 12 points out location of BRT systems in the world.

FIGURE 12
BRT SYSTEMS IN THE WORLD

Source: http://www.chinabrt.org/defaulten.aspx

Istanbul BRT system is slightly different than the others about commercial speed and density of passenger. Istanbul BRT has the highest commercial speed in BRT system which is 40 kilometer an hour. Comparison of commercial speed of BRT system is showed in Figure 13.

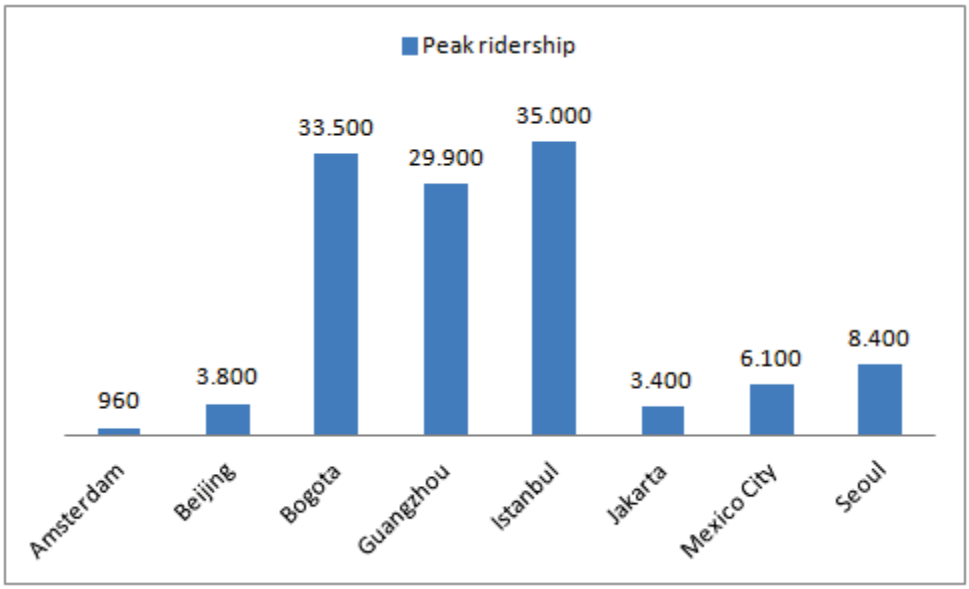
FIGURE 13
COMMERCIAL SPEED COMPARISON



Source: http://www.chinabrt.org/defaulten.aspx

Benchmarking of peak ridership is pointed in Figure 14. 30,000 or more passengers per hour per direction ridership of Metro-Bus systems are Bogota, Guangzhou, Istanbul. Although Istanbul BRT has nearly 35.000 passengers for per hour per direction, it has no a passing line.

FIGURE 14
PEAK RIDERSHIP COMPARISON

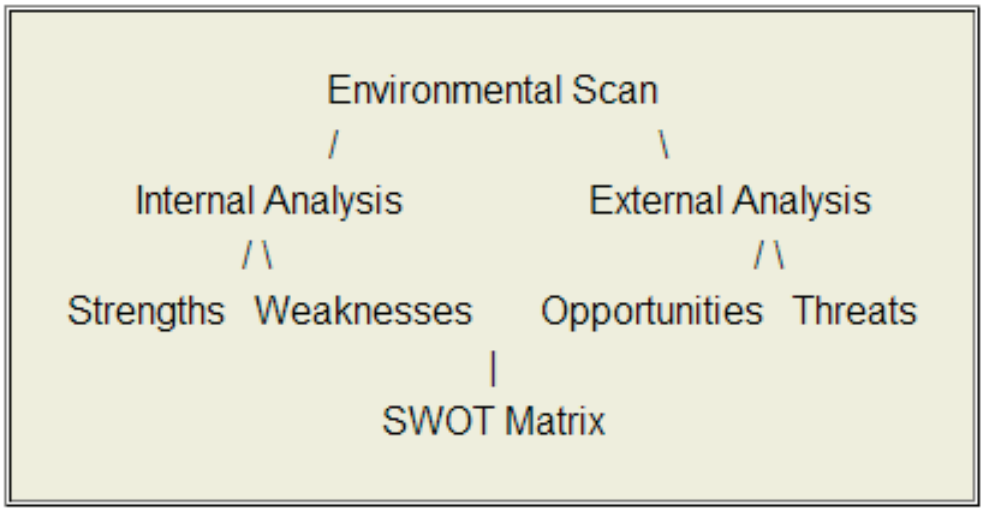


Source: http://www.chinabrt.org/defaulten.aspx

SWOT ANALYSIS FOR ISTANBUL BRT

SWOT analysis is a strategic tool to evaluate firm about where it is in the market. It provides extensive information including internal and external area. Figure 15 shows that framework of SWOT analysis.

FIGURE 15
SWOT ANALYSIS FRAMEWORK



Source: Bartol & Martin, 1991

Internal Analysis for Istanbul BRT

Strengths

- reducing travel time
- low ticket cost
- no traffic jam
- innovative design
- green transportation
- integrated with the other public transport modes
- high commercial speed
- all day service
- passenger demand

Weaknesses

- insufficient station capacity
- insufficient vehicle capacity
- no passing line
- having mid-lane
- accidents

External Analysis for Istanbul BRT

Opportunities

- having highest commercial speed
- having one of the most passenger density
- new BRT projects
- know-how

Threats

- increasing passenger demand
- needing more vehicles
- reducing commercial speed

CONCLUSION

While public transportation systems are planned, there are lots of constraints including budget, time, and sustainability. In recent years, green transport system is added in these constraints. BRT system meets all needs. In this study, Istanbul BRT system is denoted with different viewpoints. The system is evaluated with Swot analysis technique. Although the system has strengths and opportunities, it has also weaknesses and threats. Using opportunities weaknesses are eliminated. In the same way, threats are eliminated with strengths. This study has the potential of being a starting point for many future researches. I can only conceive of apparent ones.

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