



ASSESSMENT OF URBAN TRANSPORT SYSTEM IN TEHRAN

SUTI REPORT

Mina Mojtehdzadeh, TTO

2019

Disclaimer: This report has been issued without formal editing. The designation employed and the presentation of the material in the report do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The views expressed, analysis, conclusions and recommendations are those of the author(s), and should not necessarily be considered as reflecting the views or carrying the endorsement of the United Nations. Mention of firm names and commercial products does not imply the endorsement of the United Nations.

1-Introduction

Tehran, which is the largest city of the Islamic Republic of Iran is the capital city of the country and the center of the Tehran province. According to the last population census in 2016, Tehran population was 8.7 million [1], and Tehran Transport Model shows the population of Tehran in 2017 was 9.1 million [2]. The Tehran municipality information shows population density in Tehran in 2017 was, 12,100 per square kilometer.

Greater Tehran is located in the northern center of the country and limits by the southern foothills of Alborz Mountains and its average altitude from the sea level is 1,280 meters. Tehran area is about 750 km² and includes 22 municipal districts [2] and the most length and width of it, is respectively 45 and 27 km. In the figure (1) the area of Tehran and municipal districts are shown.

In 2017, the daily consumption of Gasoline and diesel fuel (for transportation) was respectively 12 and 4.6 million liters.

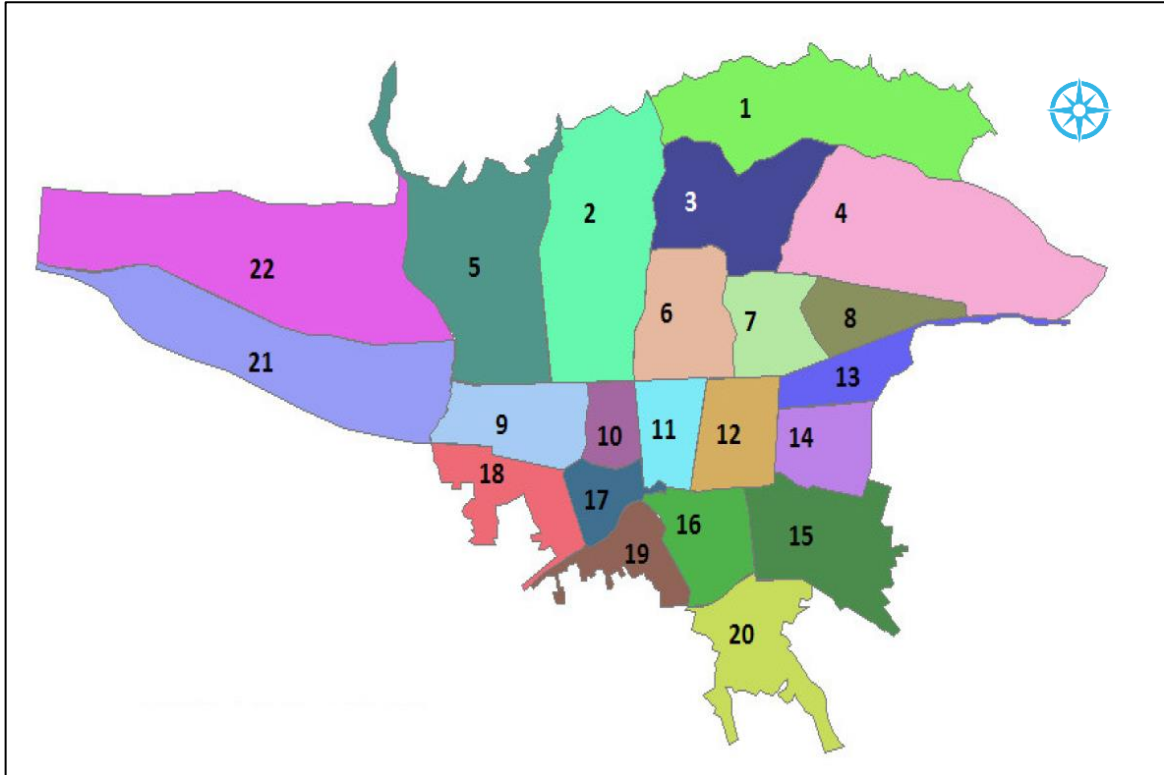


Figure 1. Municipal districts of Tehran.

2- Tehran Transportation

The transportation system of Tehran, with 9 million residents, size, and geographical characteristics, has many complexities. That transportation system in addition to 9 million residents, gives services to more than 1 million people who are commuting daily to Tehran from the suburbs.

– **Road network**

The vast road network of Tehran includes 931 km of highways, freeways and interchanges' ramps & loops. The length of major streets (primary & secondary arterials) is 1053 km and local streets' length is about 1552 km [2].

The road network in Tehran has been divided into three different type of traffic zones:

- 1- Central restricted zone which is open for public vehicles (Buses, Taxis, Ambulances, etc.).
- 2- The odd-even traffic scheme zone, which has been changed recently to the low emission zone (LEZ). The odd-even traffic scheme zone, as a method of limiting access to the streets for private vehicles, was being implemented in a zone far from the city center. The private vehicles, according to whether the last digit of a car's license plate is even or odd could enter into this zone on alternating days of the week. In the new scheme, all private vehicles are allowed to enter into this zone in 20 days of each season and for entering more than 20 days in this zone, they should pay fees hourly.
- 3- The area out of these 2 zones is a free zone for moving all types of vehicles.

These zones are shown in In figure (2).

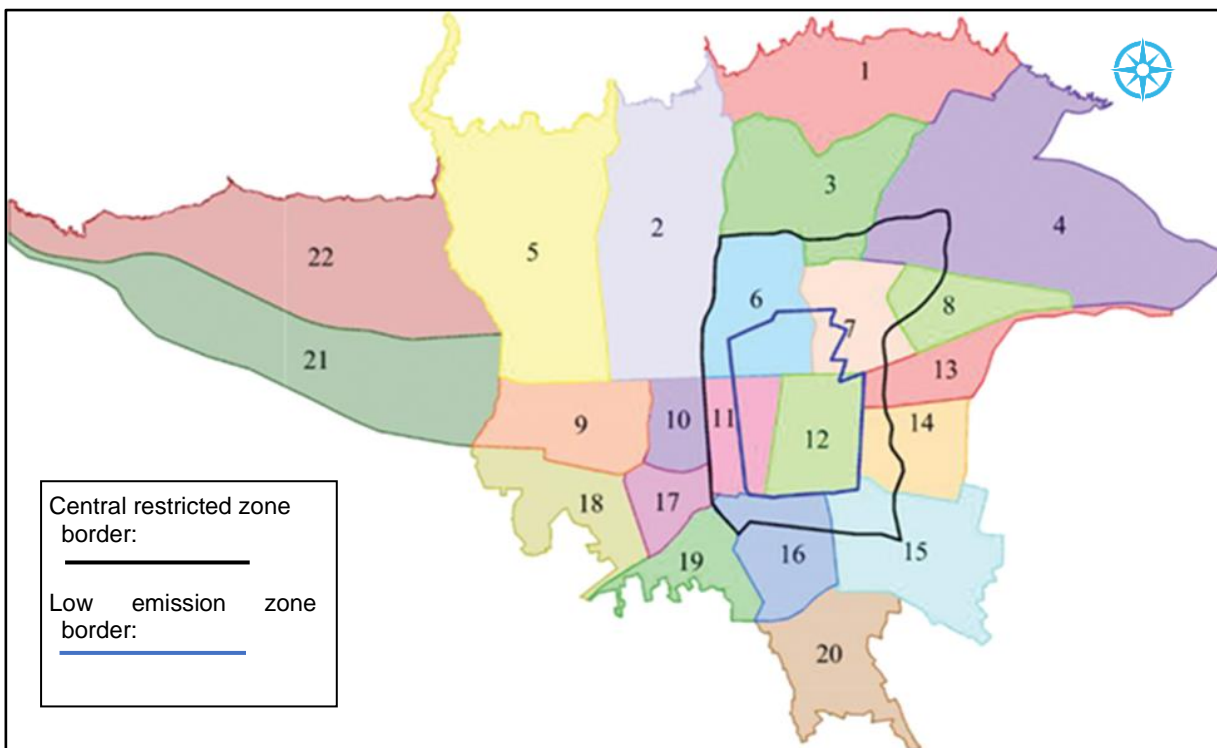


Figure 2: Restricted Traffic zones of Tehran.

Public Transportation

Tehran's public transport system includes variety of public transport modes like bus, bus rapid transit (BRT), Metro, Taxi, fixed- route taxi, private taxi and internet taxi.

According to Tehran Traffic Organization information in 2017, the Tehran bus system gave service to passengers by 240 regular bus and 10 BRT lines. The bus lines in Tehran are operated by two public and private sectors, and the number of the public and private fleet is respectively 1348 and 4800 buses. The number of bus and BRT stations in 2017 which connected bus lines and gave services to passengers, were respectively 4,785 and 347 stations. The total length of bus and BRT lines is about 3200 km. The 541 million passengers used bus lines to commute in 2017.

The first line of Tehran metro began operating in 1999. In 2017 Tehran metro consisted of six lines, with a total 215 km length and 114 stations. The total trips done by the metro lines at 2017, were 723 million trips.

One of the most popular public transport modes in Tehran is taxi. There are different kinds of taxis working in Tehran and give service to passengers. They are rotary taxi, fixed- route taxi, private taxi and internet taxi which give service, either through the taxi agencies or mobile applications to the passengers. These types of taxis are registered and supervised by The Tehran Taxi Supervision and Management Organization.

In addition, it should be mentioned, some private cars also work like taxis and move the passengers and charge them.

The yearly and daily passengers moved by registered taxi in Tehran in 2017, were respectively 1,261 and 3.5 million passengers. The taxi fleet in 2017 included 78,722 vehicles [2].

Private Vehicles

According to OD Survey of Tehran residents' trip [3], the number of personal cars and motorbikes owned by households in 2014 was respectively 2,440,684 and 406,889 vehicles.

Public bike

In the last 10 years in order to encourage Tehran residents to use the bike for their short trips, Tehran municipality has started to build bike houses in different locations in Tehran. In 2017, there were 153 bike houses with 4000 bikes to rent, in Tehran.

This year a new bike service named "Bidood" (which means smokeless) was launched in 3 districts of Tehran. "Bidood" is a bike- sharing service which offers clean transport to passengers and it allows the users to rent bikes through a mobile app anywhere they need.

Currently, data shows the number of daily passengers who rent bikes from this application, is 3500 [4].

The Transportation administration

The Transportation Deputy of Tehran Municipality is the highest authority in the Tehran Municipality which is responsible for policymaking, coordination, planning and controlling of transportation and traffic performance in Tehran.

It should be mentioned that each of 22 districts of Tehran Municipality has own transportation deputy that works under the supervision of the Deputy of the Tehran Municipality, and provide their annual planning according to the guidelines provided by the Municipality.

The affiliated organizations of Tehran Municipality Transportation Deputy are:

- **Tehran Bus Company:** this company is the top authority of the public bus and BRT systems in Tehran.
- **Tehran Urban & Suburban Railway Operation Company (METRO):** This Company is responsible for providing rail services for Tehran and its suburbs.
- **Tehran Traffic Control Company:** Tehran Traffic Control Company is responsible for design and implementation of Intelligent Transportation Systems (ITS) and traffic management in Tehran.
- **Air Quality Control Company:** This Company is active in planning and researching to reduce and control air and noise pollution in urban and industrial environments.
- **Tehran Technical Vehicle Inspection Bureau:** Set up standard centers for vehicle technical examination to provide services in the field of safety and air pollution reduction.
- **Organization of Passenger Terminals and Rider Parks of Tehran Municipality:** This organization is responsible to maintain and manage passenger terminals and rider parks all over the Tehran. Developing and improving these terminals and parks and their equipment, construction new terminals and parks are the other responsibilities of this organization.
- **Tehran Taxi Supervision and Management Organization:** In Tehran, this organization supervises and monitors the registered taxis services.

The Sustainable Transport Planning Efforts

The first transportation comprehensive studies of Tehran had begun in 1994 and in order to do these studies, at that time the comprehensive transportation studies company was established. In 2004 and 2014 these studies had been reviewed and updated. It should be mentioned that because of the closure of that company in 2014, the last review of these studies has not been completed yet.

Generally, the main approaches of these studies were, moving towards a safe, modern, clean and accessible transportation system in Tehran, which are the sustainable transportation characteristics.

As mentioned before the Transportation Deputy of Tehran Municipality is the top authority for managing transportation in Tehran. The strategic theme of the third five-year plan, which has been prepared recently, is “Safe and Smooth Transportation and Traffic” in Tehran [5].

Five main goals have been introduced related to this strategy:

- 1- Increase desirability of public transportations,
- 2- Utility control of travel by private vehicles,
- 3- Reduce the number and distance of trips inside the city,
- 4- Improve traffic smart management,
- 5- Increase trip safety.

All the studies and projects of covering the urban transport should be done to satisfy the above goals.

The Benefits of SUTI

Due to the population and geographical expansion of Tehran, the demand for the use of the transportation system has been increasing rapidly. Therefore, the massive number of city trips, frequent use of personal vehicles for daily trips, the need for an extensive road network, the environmental pollution caused by the fuel consumption of vehicles, are the challenges that the Tehran Transportation Authority has been facing for years.

Accordingly, the authorities have been seeking strategies and plans in order to resolve and decrease the transportation and traffic problems, within the framework of Tehran Metropolitan Development Plans, for years.

The upstream strategies and plans for Tehran's future are based on sustainable development and focus on transforming Tehran into a healthy city with a smooth commute.

The last plan which have been prepared by the Tehran Municipality is “**Transportation Strategic Document**”. The main object of this Plan is, to develop a smooth, clean and safe transportation system in Tehran.

Since the SUTI indicators are also defined in terms of sustainable transport development, they can be used as a benchmark to compare the performance of Tehran's transportation system with other cities and the success rate of strategic transportation plans.

3- The process of generating SUTI indicators

The process of collecting information to generate SUTI indicators faced some difficulties. Receiving some of the data requires formal request. These requests were sent through the Studies and Planning Deputy of TTO. Some organizations were better at providing information, while others did not.

Most of the data were collected from Tehran Bus Company, Tehran Urban & Suburban Railway Operation Company (Metro), and the different department of Transportation Deputy of Tehran Municipality and Tehran Traffic Organization.

Some of the data were found on the official websites of governmental organizations. In order to complete satisfaction surveys of public transit, which received from Bus and Metro companies, partial surveys were done.

One of the issues, was finding all information for calculating SUTI indicators for a particular year. Therefore, the indicators were calculated for different years and for some indicators the calculations were done for two years with two different set of data. Due to lack of information, in some cases to calculate the indicators, the data was estimated.

4- SUTI Indicators

Indicator 1: Extent to which transport plans cover public transport, intermodal facilities and infrastructure for active modes

To generate this index, first the most recent approved studies and plans which covered: 1- walking networks, 2- cycling networks, 3- intermodal transfer facilities and 4- expansion of public transport modes, were identified as key sources. These sources are:

- 1- Tehran Rail Master Plan Updated- 2018
- 2- Tehran Cycling Development Document- 2018
- 3- Tehran Pedestrian Master Plan- 2012
- 4- Tehran Municipality Third Development Plan- 2018

A panel of the 5 top transportation experts, were appointed to read and assess those plans and documents. At present, all the panel members are working in the Tehran Transport and Traffic Organization, Department of Studying & Planning. A questionnaire was prepared and asked the panel members to assess the plans' coverage extend of 1- walking networks, 2- cycling networks, 3- intermodal transfer facilities and 4- expansion of public transport modes and fill the questionnaire.

The average of the given scores by the panel members are considered as the scores of the coverage of 1- walking networks, 2- cycling networks, 3- intermodal transfer facilities and 4- expansion of public transport modes in the Tehran transportation plans and policies. The calculating of indicator 1 is shown in table (1).

Table 1. Extent to which transport plans cover public transport, intermodal facilities and infrastructure for active modes

Aspects	Explanation	Score
I) walking networks(*)	The main goals of plans are, to provide the possibility of generate walking trips in all areas of Tehran, increasing level of service of sidewalks and increasing the share of walking trips. The quantitative goals have been identified.	3
II) cycling networks(**)	Increasing non-motorized trips (pedestrian and bicycle) is one of the policies of Tehran transportation plans and studies. At present there is a cycling network in Tehran which is supposed to extend about 80% in the future.	3
III) intermodal transfer facilities(***)	Creating integration between public and active transportation had been considered in documents. Improving intermodal transfers and integration of modes are mentioned in plans and documents.	2
IV) public transport(****)	There are special attention to develop and improve public transport modes share and the ambitious quantitative goals are set in plans and documents.	3
Total (sum)		11

Indicator 2: Modal share of active and public transport in commuting

The last OD survey of Tehran resident's trips was conducted in 2014 [3]. Based on this data, the total daily work and study trips by different modes, was estimated. As a result, the share of public and active modes of work and study trips were identified. Using this data, the indicator 2 was calculated and is shown in table (2).

Table 2. Average number of trips per person by main mode of transport		
Average number of trips per person by main mode of transport		
PURPOSE	COMMUTING	
	(WORK AND EDUCATION)	
MODE	#	subtotals
a. Scheduled bus and minibus (*)	0.077	
b. Train, metro, tram	0.054	
c. Ferry	0.000	
d. Public transport	(a+b+c+d)	0.13
e. Walking	0.1544	
f. Bicycle	0.0031	
g. Active transport	(f+g)	0.16
h. Passenger car	0.3649	
i. 3W – Private	0.0000	
j. Shared Auto (Informal PT)	0.000	
k. Motorcycle	0.0550	
l. Institutional Buses and Auto Rickshaws	0.0157	
	0.0476	
n. Individual motorized (**)	(i+j+k+l+m)	0.48
o. Total	(e+h+o)	0.77
p. Public and active	(e+h)	0.29
q. Modal share of active and public transport		37.4

Indicator 3: Convenient access to public transport service

In order to calculate the convenient access of the inhabitants of Tehran to the public transport services, the GIS database has been used. Since the last Iranian Population and Housing Census was in 2016, this GIS database is formed by this information. The other required data for this indicator was public transportation modes (Bus, BRT, and Metro) information that was collected from relevant organizations. These data include public transportation lines, stations characteristics, their routes and locations. It should be mentioned, only the bus lines with headway less than 20 minutes were used to calculate the indicator 3. In 2016, there were 180 public bus lines with headway ≤ 20 minutes, 10 BRT lines and 6 metro lines.

With the completed GIS database, with public transportation data, the next step was to estimate the population living in a buffer within a 500-meters radius of each station. The total

population in Tehran who had convenient access to public transport services in 2016, was 8,092,378. In Fig (3), the GIS map with the public transportation lines and the inhabitants living around them in 2016, is shown.

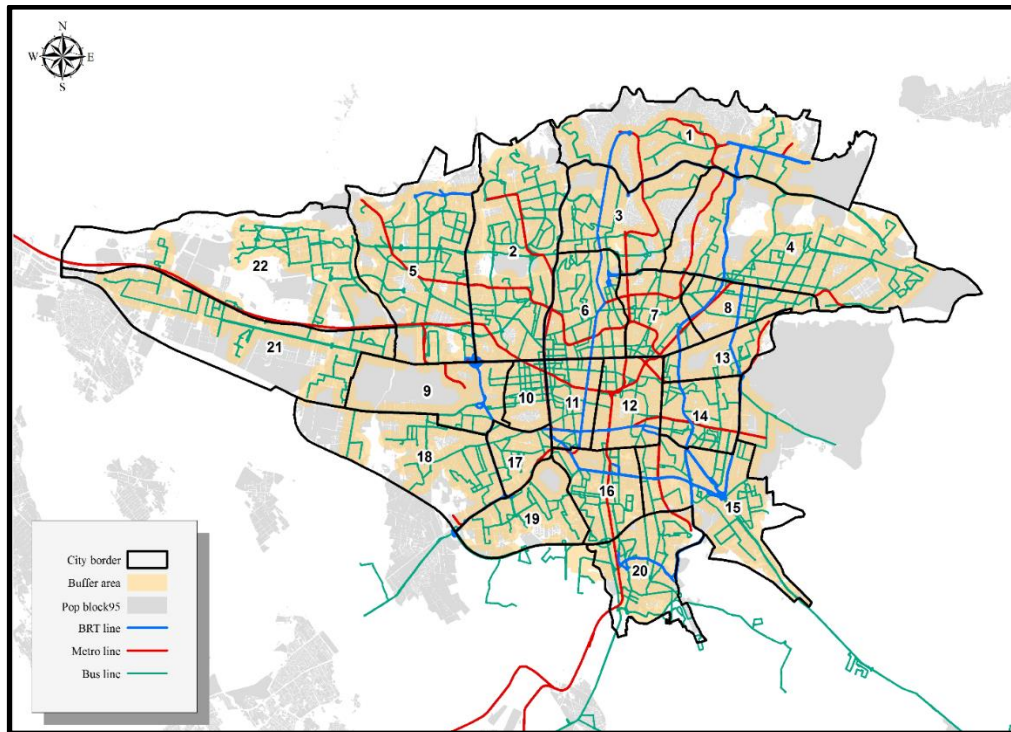


Figure 3: The inhabitants living in buffer zones around the public transportation stations in Tehran, 2016.

Indicator 4: Public transport quality and reliability

The last public bus and BRT users’ satisfaction survey was conducted by Tehran Bus Company in 2018. The questions which had been asked from the passengers of the bus and BRT in this survey are as below:

BUS	BRT
Frequency of the service	Frequency of the service
Condition of air & temperature inside the vehicles	Convenience of Boarding & Alighting
Cleanliness of inside the vehicles	Convenience of stops/stations
Cleanliness of outside the vehicles	Cleanliness of inside the vehicles
Personnel courtesy	Cleanliness of outside the vehicles
Satisfaction of vehicles driving	Availability of information inside the vehicles
	Availability of information in the stops/stations
	Personnel courtesy
	Satisfaction of vehicles driving
	Passenger density inside the vehicles
	Condition of air & temperature inside the vehicles

Every year Metro Company conducts a passenger satisfaction survey. The only available information of this survey was the overall satisfaction of Metro passengers, which does not cover all aspects of indicator 4.

Hence, three satisfaction surveys for the bus, BRT and Metro passengers, with the questions that cover the other aspects in the indicator 4, were conducted.

For these surveys, three different questionnaires were designed. The questionnaires were completed by asking the questions from the passengers in the bus, BRT and Metro stations.

The weighted average of the users' satisfaction level of these three modes, considered as the passengers' satisfaction degree of public transport. Tables (3) to (6) show the calculations of indicator 4.

<i>Table 3. BUS user's satisfaction level</i>				
	Dissatisfied	Satisfied		
Dimension			RESP	SATISF
Frequency of the service	25	75	100	75.00
Condition of air & temperature inside the vehicles	38	62	100	62.00
Cleanliness of inside the vehicles	27	73	100	73.00
Cleanliness of outside the vehicles	28	72	100	72.00
Personnel courtesy	21	79	100	79.00
Satisfaction of vehicles driving	23	77	100	77.00
Punctuality (delay)*	50	50	100	50.00
Convenience of stops/stations	50	50	100	50.00
Availability of information	84	16	100	16.00
Fare level	53	47	100	47.00
Responses	399	601	1000	73.00

<i>Table 4. BRT user's satisfaction level</i>				
	Dissatisfied	Satisfied		
Dimension			RESP	SATISF
Frequency of the service	18	82	100	82.00
Convenience of Boarding & Alighting	52	48	100	48.00
Convenience of stops/stations	47	53	100	53.00
Cleanliness of inside the vehicles	15	85	100	85.00
Cleanliness of outside the vehicles	18	82	100	82.00
Availability of information inside the vehicles	43	57	100	57.00
Availability of information in the stops/stations	37	63	100	63.00
Personnel courtesy	32	68	100	68.00
Satisfaction of vehicles driving	20	80	100	80.00
Passenger density inside the vehicles	38	62	100	62.00
Condition of air & temperature inside the vehicles	24	76	100	76.00
Punctuality (delay)*	67	33	100	33.00
Convenience of stops/stations	42	58	100	58.00
Availability of information	83	17	100	17.00
Fare level	39	61	100	61.00
Responses	575	925	1500	61.67

Table 5. Metro user's satisfaction level				
	Dissatisfied	Satisfied		
Dimension			RESP	SATISF
Frequency of the service	33	67	100	66.67
Punctuality (delay)*	43	57	100	57.33
Comfort and cleanliness of vehicles	44	56	100	56.00
Safety of vehicles	41	59	100	58.67
Convenience of stops/stations	55	45	100	45.33
Availability of information	73	27	100	26.67
Personnel courtesy	49	51	100	50.67
Fare level	68	32	100	32.00
Responses	407	393	800	49.17

Table 6. Public transport user satisfaction level			
Mode	SATISF	Mode Share (%)	SATISF
Bus	73.00	46	33.58
BRT	61.67	39	24.05
Metro	49.17	15	7.38
			65.01

Indicator 5: Traffic fatalities per 100,000 inhabitants

According to the 2017 Tehran traffic statistics handbook [2], the number of traffic fatalities in Tehran was 687 deaths. By using the detailed information of traffic fatalities in this book, the indicator 5 was calculated. In tables (7) & (8) the number of traffic fatalities by modes and the calculation for indicator 5, are shown respectively. The source of these data is Forensic organization. The same data provided by Police, is slightly different, therefore the indicator 5 is calculated by police information too. This calculation is shown in table (9). The population used in table (8) is estimated by transportation model for 2017 [2]. In table (9) the estimated population [3] for 2018, is used.

<i>Table 8. Traffic fatalities per 100,000 inhabitants- Police-2018</i>	
Fatalities	#
Road transport	656
Railway transport	0
Tram	0
Ferryboats	0
Other	0
Total	656
Inhabitants	8872028
Fatalities/100,000 inhabitants	7.4

<i>Table 7. Number of traffic fatalities by modes- Forensic organization</i>	
Vehicle type	Number
No vehicle(Pedestrian)	315
Bus	1
Trailer truck	1
Bicycle	1
Car	82
Truck	1
Mini truck	4
Motorbike	246
Minibus	1
Pickup	12
Other	23
TOTAL	687

<i>Table 8. Traffic fatalities per 100,000 inhabitants- Forensic organization- 2017</i>	
Fatalities	#
Road transport	687
Railway transport	0
Tram	0
Ferryboats	0
Other	0
Total	687
Inhabitants	9100000
Fatalities/100,000 inhabitants	7.5

Indicator 6: Affordability- travel costs as share income

In order to calculate indicator 6, a different type of information was collected. This information is:

The Average annual income of an urban household of the three lowest deciles [6]. The collected data is shown in table (9).

Decile	Average annual income of household(RIAL)-2014	Average monthly income of household(RIAL)-2014
1	65,402,000	8,818,444
2	112,225,000	
3	139,837,000	
AVE	105,821,333	

Public transportation modes' ticket price is taken from the bus line ticket price report [7]. In order to derive a general ticket price for the bus and BRT, first the average price of the public & private bus and BRT tickets per kilometer was calculated. Then, the ticket price of the bus and BRT was computed by multiplying the average length and average price per kilometer.

As the Metro ticket price per kilometer was not available, the price of a Metro single ticket was used. The number of trips by public transportation modes was derived from Tehran Comprehensive OD Survey [3]. By using the above data, indicator 6 was calculated as shown in table (10-1).

<i>Table 10-1. Affordability- travel costs as share of income</i>					
Services	Monthly Ridership	Market shares	Single ticket price(RIALS) - 2014	Monthly cost (60 tickets)	Weighted monthly cost
City Bus	1320812	46.0	4021	241283	110990
BRT	426789	39.0	3949	236912	92396
METRO	1121111	15.0	5000	300000	45000
Total	2868712	100.0		0	248386
Mean household income, 2014					8,818,444
					2.8

Since the number of bus, BRT and Metro passengers for 2018 obtained [8] & [9], the indicator 6 was calculated with these data too.

Because of the last national population and housing census was done in 2016, the estimated average annual income of an urban household in the three lowest deciles for 2018, was used. By applying the growth rate of the minimum wage in 2018 relative to 2016, this average income for the three lowest deciles in 2018, was calculated. The second method to calculate indicator 6, is shown in table (10-2).

<i>Table 10-2. Affordability- travel costs as share of income</i>					
Services	monthly Ridership	Market shares	Single ticket price(RIALS) -2018	Monthly cost (60 tickets)	Weighted monthly cost
City Bus	20718957	20.8	8930	535800	111501
BRT	17842399	17.9	7060	423600	75913
METRO	61000000	61.3	10000	600000	367613
Total	99561357	100.0		0	555027
Mean household income, 2018					19,774,573
					2.8

Decile	Average annual income of urban household(RIAL)-2016	Average monthly income of the third lowest decile(Rial)-2016
1	75,242,000	10,805,778
2	138,049,000	
3	175,717,000	
AVE	129,669,333	

Ref: Iran Statistics Center, Population and Housing Census (2016)

Monthly minimum Wage	Rial	Growth Rate (%)	Average monthly income of the third lowest decile(Rial)-2018
2016	8,121,660	83	19,774,573
2018	11,112,675		

Ref: Ministry of Cooperatives, Labor and Social Welfare

Indicator 7: Operational costs of the public transport system

In order to calculate indicator 7, the total fare revenue and operational cost of public transport in 2017 were collected [8, 9]. In order to calculate the market shares of Metro and bus, the data from the last OD survey have been used, because the collected data of these two modes in 2017, was not the same.

The Metro Company had the numbers of the total trips which had been done by Metro and the Bus Company had the total number of passengers who had been used the bus in 2017. The indicator 7 was calculated as shown in table 11.

	Market shares (estimated)	Fare Revenues (billion Rials)	Transport Operating expenses (billion Rials)	Farebox ratio
Services				
Bus+BRT	61.0	1,408	10,288	14%
METRO	39.0	3,336	3,536	94%
Total	100		Weighted	45.14

Indicator 8: Investment in public transportation systems

The Urban Development and Planning Department of TTO is responsible for planning and budgeting of various transport sectors, including the public transport in Tehran.

The approved budgets for the public transport (Bus, BRT and Metro) and the approved budget for the whole transportation section in Tehran in the last five years were obtained from this department. The indicator 8 was calculated by these data and is shown in table (11-1).

Table 11-1. Investment in public transportation systems						
Million Rials						
INVESTMENTS BY THE CITY	13-14	14-15	15-16	16-17	17-18	average
PUBLIC TRANSPORT FACILITIES	34,893.00	34,690.00	38,934.00	38,844.70	37,573	36,987
TOTAL TRANSPORT	40,125.00	41,131.20	44,806.70	45,481.80	46,022.80	43,514
SHARE						85

As this budget was not the budget of all sections of Tehran transportation, this indicator was calculated with the total budget of the Tehran municipality too. In table (11-2) the second calculation of indicator 7 is shown.

Table 11-2. Investment in public transportation systems						
Million Rials						
INVESTMENTS BY THE CITY	13-14	14-15	15-16	16-17	17-18	average
PUBLIC TRANSPORT FACILITIES	34,892.96	34,690.00	38,934.00	38,844.68	37,573	36,987
TOTAL TRANSPORT DEPUTY	40,125.00	41,131.17	44,806.71	45,481.78	46,022.80	43,513
TOTAL MUNICIPALITY	158,450.06	172,190.00	178,800.00	179,000.00	174,294.85	172,547
SHARE						21

Indicator 9: Air quality (PM10)

As mentioned before, the Tehran Air Quality Control Company is one of the affiliated companies of Transportation Deputy of Tehran Municipality, which is responsible to monitor the Tehran air quality. This company has 21 air control stations in various regions of Tehran. One of the pollutants is being monitored by this company is the PM 10. This company publishes the Tehran air quality report every year.

The yearly average of PM 10 for all stations in a one year was not available, therefore the total average amount of PM 10 in Tehran in 2018 [11], was applied to calculate indicator 9.

In table (12), the calculation of indicator 9, is shown.

<i>Table 12. Air quality (PM10)</i>			
Location	PM 10	Population	Population
	yearly mean	in area	percentage
Tehran	72.1	8872028	100.00
Total city population		8872028	100
Population weighted concentration	72.10	VALUE TO ENTER IN SUB-SHEET B	

Indicator 10: GHG emissions from transport

The emission factors which are monitor in air pollution control stations in Tehran are: O3, CO, NOX, NO2, NO, SO2, PM10, PM2.5. The Tehran Air Quality Control Company, does not monitor CO2. In order to calculate indicator 10, the alternative methods were applied.

For calculating indicator 10 by employing the first method, the total yearly vehicle kilometers which was traveled by each mode in 2018 in Tehran, were derived from Tehran Transportation Model. By applying the average fuel consumption and the amount of CO2 emitted per liter by each mode [12], the CO2 emission in a year is calculated. The calculation of indicator 10, is shown in table (13-1).

Table 13-1. GHG emissions from transport								
Traffic	Km/year							
	Pass cars	Taxi	Pickup	Bus	Private-Bus	Trucks	MCs	SUM
	16,595,733,000	3,321,816,300	1,378,858,800	205,810,219	149,912,400	209,982,300	2,614,114,800	24,476,227,819
TOTAL TRAFFIC	16,595,733,000	3,321,816,300	1,378,858,800	205,810,219	149,912,400	209,982,300	2,614,114,800	24,476,227,819
Emission factors	Total emissions							
Fuels and emissions		FAC(litre/km)	CO2(g/km)	CO2 (g/year)	Population(2018)	CO2 (Ton/year)		
Passenger cars	Petrol	0.17	116	334,186,314,000				
Taxi	Petrol	0.27	116	103,653,955,825				
Pickup	Petrol	0.21	116	32,949,209,885				
Bus	Diesel	0.56	1,163	133,561,364,925				
Private bus	Diesel	0.52	1,163	90,661,023,024				
Trucks	Diesel	0.45	1,163	109,894,236,705				
MCs	Petrol	0.06	70	11,829,048,000				
TOTAL CO2				816,735,152,364	8,872,028.00	0.09		

In second method, the total fuel (gasoline and diesel) consumption is used to estimate the amount of CO2 emission. The total fuel consumption in 2018 was obtained from Tehran Transportation Model. The calculation of indicator 10 with second method is shown in table (13-2).

<i>Table 13-2. GHG emissions from transport</i>					
	Litres sold	CO2-factor kg/l	Emissions tons/year	Population	Emission/capita
GASOLINE/PETROL	4,227,798,300	2.290	9,681,658.11		
DIESEL	445,404,300	2.685	1,195,910.55		
TOTAL			10,877,568.65	8,872,028.00	1.23

5- SUTI results

In table (14), the calculation results of the indicators are presented. The indicator 6, the Affordability of public transport (travel costs as share of income), has the highest normalized value and the lowest normalized value is related to Traffic fatalities per 100.000 inhabitants. The SUTI value for Tehran after normalization all indicators is about 51.

<i>Table 14. The result of indicator calculations</i>								
S. No.	Indicators	Natural unit	Weights	Range		VALUE	YEAR	Normalized Value
				MIN	MAX			
1	Extent to which transport plans cover public transport, intermodal facilities and infrastructure for active modes	0 - 16 scale	0.1	0	16	11.00	2018	68.75
2	Modal share of active and public transport in commuting	% of trips	0.1	10	90	37.4	2014	34.28
3	Convenient access to public transport service	% of population	0.1	20	100	93.23	2016	91.54
4	Public transport quality and reliability	% satisfied	0.1	30	95	62.01	2018	49.24
5	Traffic fatalities per 100.000 inhabitants	No of fatalities	0.1	10	0	7.39	2018	26.06
6	Affordability – travel costs as share of income	% of income	0.1	35	3.5	2.81	2018	102.20
7	Operational costs of the public transport system	Cost recovery ratio	0.1	22	100	45.14	2018	29.67
8	Investment in public transportation systems	% of total investment	0.1	0	50	21.00	2018	42.00
9	Air quality (pm10)	µg/m3	0.1	150	10	72.10	2018	55.64
10	Greenhouse gas emissions from transport	Tons/cap	0.1	2.75	0	1.23	2018	55.42
MUST SUM TO 1			1			SUTI RESULT	50.54	

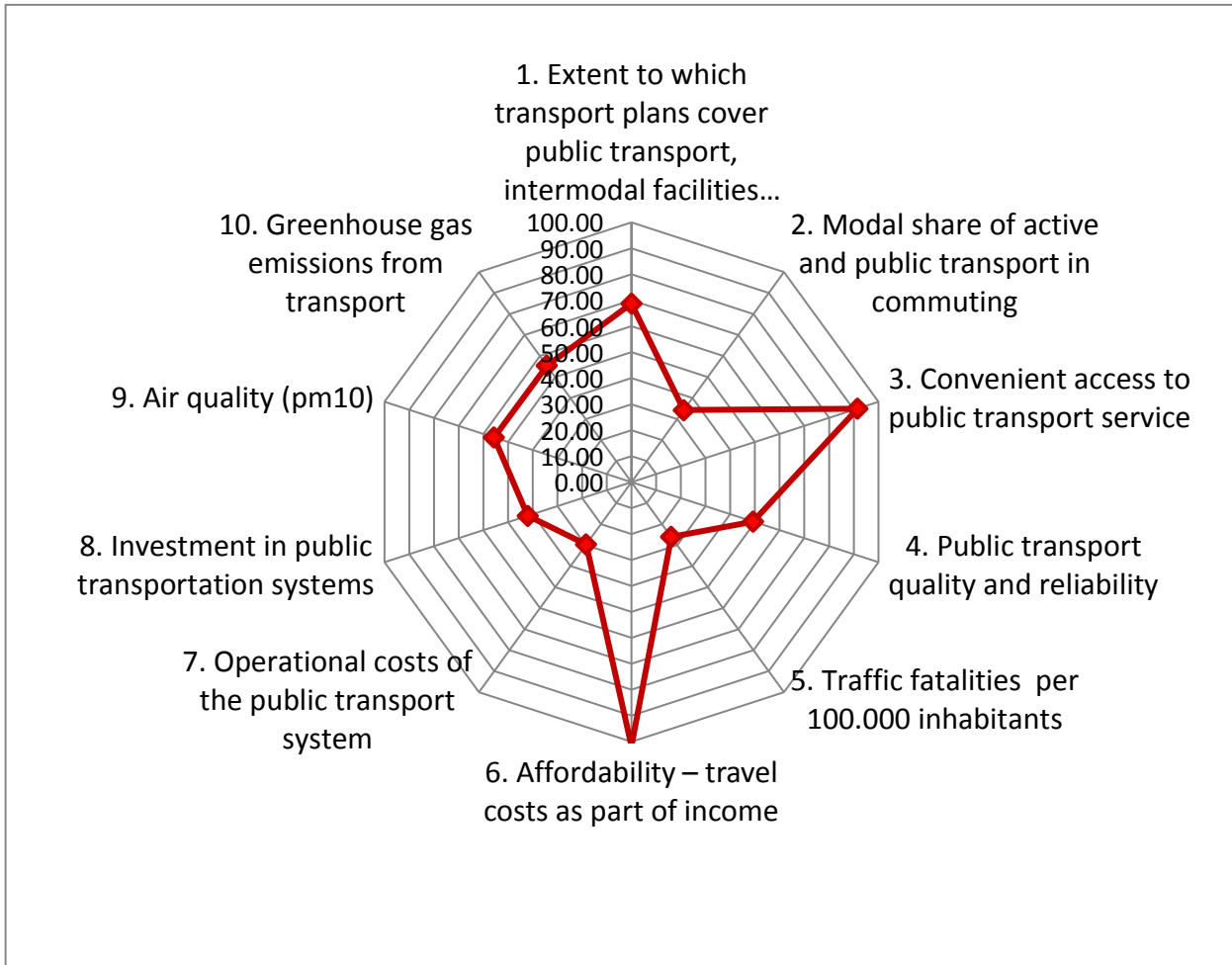


Figure 4: RESULT SPIDER DIAGRAM

In figure (4), the spider diagram shows the performance of Tehran transport system. As the diagram shows, Tehran has an affordable and convenient access public transport service and the quality and reliability of this service from users point of view, is relatively good.

The results show the coverage of public transport, intermodal facilities and the infrastructures of active transport in Tehran’s transport studies and plan, are acceptable.

The lowest results are related to the rate of traffic fatalities, the operational cost of public transport systems and the modal share of active and public transport of total daily trips in Tehran.

The diagram shows, the amount of investment in the public transport systems and air quality in Tehran are also poor.

The SUTI results show despite of Tehran does have an affordable, easy access with fair quality public transportation system, the modal share of public transport of total daily trips in Tehran is not what is expected.

This means to have a convenient public transport system without increasing the using private cars cost, does not make people to use more public transport instead of their own cars.

6- Perspective on SUTI result

The SUTI result has confirmed the strengths and weaknesses of Tehran transport system. These results show that to have a sustainable transport system all parts of the system must have the same approach and coordinated performance.

The approach of the Tehran Municipality's Transportation Deputy is moving towards a sustainable transport system. This organization has been taken a variety of actions to improve the performance of the different sections of the transportation system, especially public transport systems.

The SUTI results can help the transportation authorities to evaluate the approaches and decisions taken for the transportation system. With these results and comparing the performance of Tehran's transportation system with other cities in other countries, the situation of Tehran's transportation system can be better assessed and other countries' experiences may be useful to improve the performance of the transportation system in Tehran.

A review of the SUTI results in the coming years will provide a detailed assessment of the performance of Tehran's transportation system, and this can significantly help the authorities to improve their movement and decisions.

REFERENCES

- [1]. Iran statistics Center; <http://amar.org.ir>.
- [2]. Tehran Traffic Statistics Handbook, 2017; Traffic Organization of Tehran Municipality (TTO).
- [3]. OD Survey of Tehran residents' travel; Tehran Comprehensive Transportation &
- [4]. <https://www.irna.ir/news/83435405>
- [5]. Tehran Transportation Strategic document; Third Municipal Program of Tehran Municipality; 2017; Tehran Center for Studies and Planning.
Traffic Studies; 2014.
- [6]. Statistical Yearbook of Ministry of Cooperatives, Labor and Social Welfare; 2015
- [7]. Determination of Bus Lines' ticket price in Tehran in 2014; Tehran Islamic Council; <http://laws.tehran.ir>; 2013.
- [8]. Tehran Bus Company; 2018.
- [9]. Tehran Urban & Suburban Railway Operation Company (Metro); 2018.
- [10]. Tehran Air & Sound Quality; Tehran Air Quality Control Company; 2018.
- [11]. Iran's vehicle fuel consumption guide; Fuel Consumption Optimization Company; 2016.