Research Article

CHARECTERISTICS OF ON-STREET PARKING IN ISTANBUL

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ABSTRACT

On-street parking in city centers is an attractive option for drivers because of the accessibility and the closeness to the commercial areas, markets, shopping centers etc. On-street parking is defined in literature as "the vehicles parked on the sides of the street itself". On-street parking leads to reduction in the capacity of the roadway due to the occupation of the lane, parking maneuvers and the effects it makes on the other lanes. The time spent by the vehicles while maneuvering to enter and leave the parking, type of the parking and the duration of the parking were observed in Yildiz Technical University Traffic Management Center (YTU-TMC). Using these data, traffic count was conducted and then the possibility of parking for any vehicle passing through the area was computed. The data were collected at the peak periods which are between 11:30 AM – 14:30 PM and 17:00 PM – 20:00 PM for the each direction of the roadway. Monte Carlo simulation was implemented to find out the possibility of parking using the data. The results of the study clearly indicate that the commercial center is considered as one of the most important factors that plays role in increasing the possibility of parking. Parking between two parked vehicles takes more time than the other parking types. Monte Carlo simulation can be used to find out the probability of parking for all parking types.
Keywords: On-street parking, maneuver time, Monte Carlo simulation, parking maneuver.

1. INTRODUCTION

On-street parking in city centers is an attractive facility for drivers. However, the availability of such parking facilities may affect the capacity of the highway and be a contributory cause in the high number of road traffic accidents as well as having other direct or indirect effects on other issues such as the use of public transport, business, environment and property values [1]. On-street parking refers to the parking space made available along the curb or shoulder of a street or road that are designed to accommodate vehicle. If a city provides on-street parking, particularly in commercial area, it makes conscious choices to provide better access to adjacent land use at the expense of more efficiently moving traffic [2]. Parking is one of the experiences that people have when traveling to a destination and it plays a crucial role in managing traffic and congestion as it is generally recognized that town center depends on a rapid turnover of parking to meet the demand for short-stay visit [3]. Studies [4,5] have shown that the design of on-street parking often influence the road capacity if parking locations are not selected and controlled in a careful manner. Most previous studies have taken into account the reduction in road width to

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accommodate for on -street parking and its effect on reduction in road capacity. Hobbs [5] reported the influence of the physical use of road space, parking maneuvers and opening of car doors on increasing delay. Studies in Nebraska, USA [6] indicated that on-street angle parking is more hazardous than that of parallel parking. The main reason is the lack of adequate visibility for the driver during reversing maneuvers. In the process of design and evaluation of traffic management schemes, vehicle maneuvers entering and leaving parking stalls are often ignored. This may be attributed to the relatively short periods of time required for such maneuvers and the localized interaction with the traffic stream seems to be insignificant. Thus, with the increase in the frequency of parking and with increasing traffic volumes, this becomes a potential cause of congestion [7]. Akhuewu (2010) identifies the characteristic of on-street parking which are noted to be the nature of parking which affects the street based on the nature of the environment. He observes that in developed countries like Europe and America, majority of the vehicle owners in a commercial area parked their cars in accordance to the parking principles and guideline. This is because there are provisions of parking space that are enough for both the users of the spaces and those residing within the area. This was as a result of planning with the inclusion of parking facilities to discourage any obstruction on the streets. The various characteristics that are linked with street parking are advantageous due to monitoring and control of street parking in the developed nations of the world [8]. O'Flaherty (1986) has suggested alternative designs for on-street parking spaces based on average sized vehicles in the UK. The study presents designs which will minimize the need for the reverse parallel parking maneuver and thus reducing the delay incurred on the flow of traffic [9]. The results that obtained by Hongwei Guo and Wuhong Wang and Weiwei Guo (2012) showed that the driving maneuvers of on-street parking can antedate traffic state transition from free flow to congested flow at low density. The maximum volume and travel speed are also influenced significantly. The finding in this paper has important ramifications for policy in the area of parking management and planning [10]. The utilization of on-street parking is considered to be a more efficient use of land as it limits the need for off-street parking and access points to properties adjacent to major arterial roads (Litman 2013, Jakle & Sculle, 2004). This aspect of on-street parking also reduces costs for the businesses, maximizes land utilization and creates a pedestrian friendly environment for the community by delineating vehicles and land use. [11]

2. METHODOLOGY

2.1. Study Area

This study was conducted in Istanbul, which is considered to be the most populated city in Turkey. For the study, four streets have been selected from the Anatolian side of the city and some information of the selected streets were given in Table 1 and the location of the sites are shown in Figure 1.

Table 1. Selected Street Information

City name	Street name	Direction	Numbers of lane/direction	Numbers of on-street parking lane/direction
Atasehir	Atasehir bulvari	2	3	1
Umraniye	Alemdag Cad. Recep Aga	1	4	2
Uskudar	Fistikagaci Cumhuriyet Cad.	2	2	1
Uskudar	Fethipasa Pasalimanı Cd.	2	2	1

All of these sites have parallel parking option. The data had been collected in order to determine the charactiristics of on- street parking.

Figure 1. Study area

2.2. Data Collection

For the study, video streaming of the selected streets was recorded using Traffic Monitoring Cameras of Istanbul Greater Municipality in Yildiz Technical University Traffic Management Center (YTU-TMC) that has been established by ISTKA (Istanbul Development Agency). There are four different parking possibilities for parallel parking depending on the parking space in front of and behind the available parking lot. The types of the parking are shown in Figure 2.
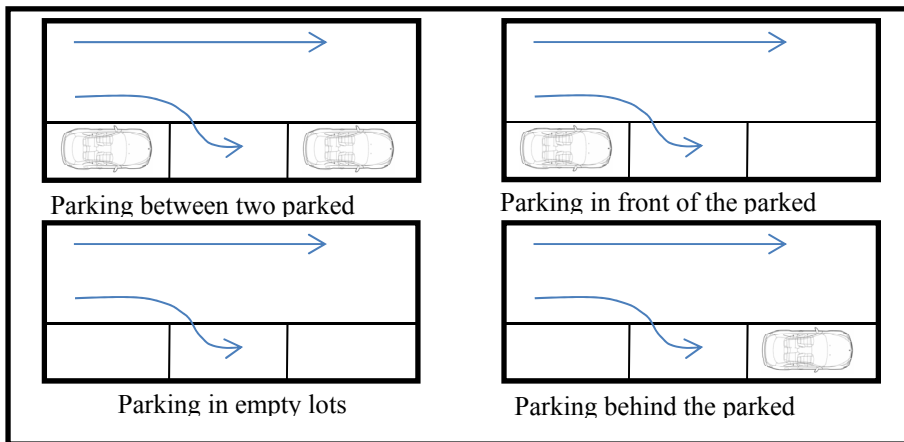

Figure 2. Types of parking

In order to identify the details of the characteristics of on-street parking, data were collected at the peak periods which are between 11:30 AM – 14:30 PM and 17:00 PM – 20:00 PM for each direction of the roadway. The video tapes were then played back to obtain the necessary information. The data were stored in computer files and later accessed using spread sheet software

for the analysis. The number of vehicle that passes through the segment and the number of vehicle parked were counted in addition to type of parking. Entering the park and leaving it was also observed and the duration of parking (waiting time) was calculated using stop watch, then all information was saved on Microsoft Excel sheet. One of the example of the collected data for Atasehir (Atasehir Bulvari Street) is shown in Table 2. In the table, B indicate parking between two parked vehicle, F indicates parking in front of a parked vehicle, BH refers to parking behind a parked vehicle and E refers to parking in empty lots. The total number of counted vehicles for each site can be seen in Table 3.

Table 2. Collected data for Atasehir

Time	Cumulative traffic flow	Enter parking		Exit parking	
		Veh. ID	Park type	Veh. ID	Park type
11:30-11:45	483	----	----	1	----
11:45-11:50	611	2	B	----	----
11:50-12:06	1021	3	B	----	----
12:06-12:07	1030	4	B	----	----
12:07-12:18	1368	----	----	2	B
12:18-12:43	2014	----	----	4	B
12:43-12:44	2021	5	BH	----	
12:44-12:46	2106	6	B	----	
12:46-13:12	2838	7	F	----	
13:12-13:45	3714	8	BH	----	
13:45-13:58	4064	----	----	6	B
13:58-13:59	4082	9	E	----	
13:59-14:00	4136	----	----	7	F
14:00-14:08	4393	10	E	----	
14:08-14:10	4431	----	----	5	BH
14:10-14:13	4533	11	B	----	
14:13-14:30	4696	----	----	8	BH

Table 1. Total number of counted vehicles for each site

Zone	Noon Period 11:30 – 14:30	Afternoon Period 17:00 – 20:00
Atasehir 1	4203	4640
Atasehir 2	4696	5829
Fistikagaci 1	2109	2617
Fistikagaci 2	1505	1469
Recep Aga	3810	4042
Fethipasa 1	1764	1828
Fethipasa 2	1189	1264

3. RESULT AND DISCUSSION

3.1. Possibility of Parking

The possibility of parking for each vehicle has been calculated for the four sites using Equation 1 below. Waiting time represents the time that a vehicle spends between entering the parking lot and leaving it.

$$Possibility\ of\ parking = \frac{1}{number\ of\ passing\ vehicle\ at\ the\ time\ of\ parking} * 100 \tag{1}$$

After this equation was run, the mean and standard deviation were computed as show in Table 4 and 5 below. The mean of the possibility of parking and waiting time were shown in Figure 4 and 6, and the standard deviation were shown in Figure 5 and 7. The date of selected bidirectional streets were collected separately for each direction. The direction of the street is named 1 and 2, for example Atasehir 1 and Atasehir 2, based on the camera views. The closest direction of the camera was named 1 and the other one 2.

Table 4. Mean and standard deviation for parking possibility

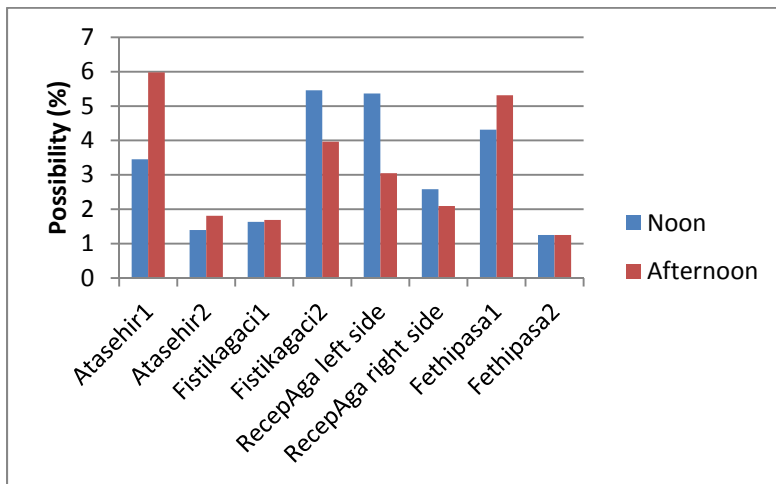| Zone		Noon Period 11:30 – 14:30		Afternoon Period 17:00 – 20:00	
		Mean	S.D.	Mean	S.D.
Atasehir 1		3.45	5.30	5.97	15.88
Atasehir 2		1.4	3.25	1.81	2.67
Fistikagaci 1		1.63	0.98	1.68	2.25
Fistikagaci 2		5.45	9.34	3.96	5.18
Recep Aga	Left side parking	5.36	9.23	3.04	4.89
	Right side parking	2.58	2.38	2.0	1.61
Fethipasa 1		4.31	9.6	5.31	10.59
Fethipasa 2		1.25	1.22	1.25	1.22

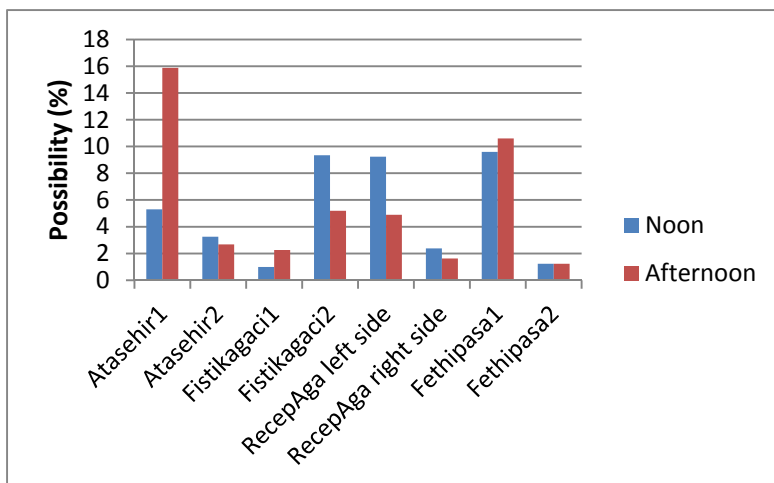**Figure 4.** Mean of possibility of parking

Figure 5. Standard deviation of possibility of parking

As it can be seen in Figure 4, the highest possibility of parking for mean was in Atasehir 1 with an approximate value of 6, which is greater than the value of the other side of the same street (Atasehir 2). This situation stems from the fact that Atasehir 2 is not close to the commercial center, so the possibility of parking will be less. Fethipasa (Uskudar) gave the lowest parking possibility with a value of 1.25 in both directions since it does not accommodate any commercial centers in it. As for standard deviation same patterns have been observed. While Atasehir 1 has the highest value of 16, Fistikagaci 1 (Uskudar) has the lowest value of 0.9.

Table 5. Mean and standard deviation for waiting time

Zone		Noon Period 11:30 – 14:30		Afternoon Period 17:00 – 20:00	
		Mean	S.D.	Mean	S.D.
Atasehir 1		11.63	22.36	9.19	11.86
Atasehir 2		48.16	21.77	31.90	22.87
Fistikagaci 1		19.68	24.58	24.07	46.18
Fistikagaci 2		12.85	12.10	28.92	45.36
Recep Aga	Left side parking	10.12	7.12	10.92	14.56
	Right side parking	19.86	31.47	12.41	13.06
Fethipasa 1		3.14	2.19	3.14	2.19
Fethipasa 2		24.6	27.69	24.6	27.69

For the waiting time, , Figure 6 shows that Atasehir 2 yields the highest value of mean, which is 48 whereas Fethipasa 1 (Uskudar) yields the lowest value of 3.1. The highest value of standard deviation, which is 46, for waiting time belonged to Fistikagaci 1 (Uskudar) and the lowest value was 2.1 in Fethipasa 1(Uskudar) as it can be seen in Figure 7 above.
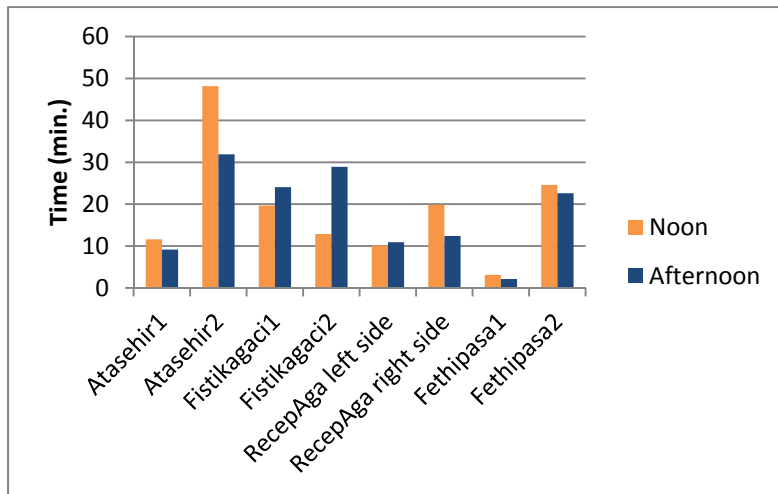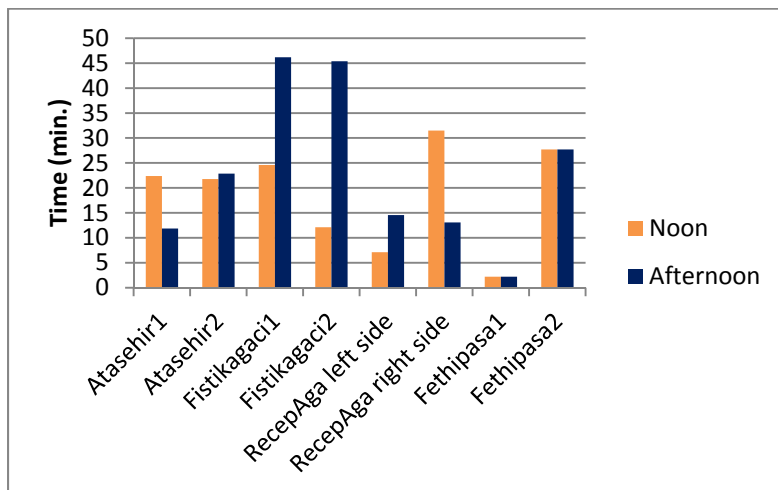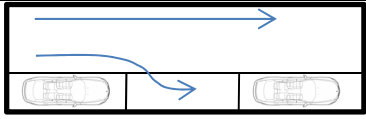
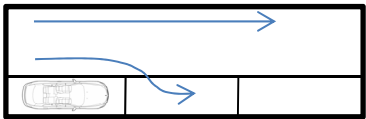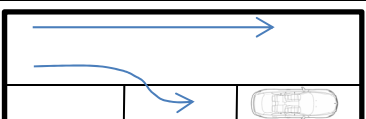**Figure 1.** Mean for waiting time

Figure 2. standard deviation for waiting time

3.2. Parking Maneuver Time

Parking maneuver time is the time that the vehicle needs to to enter or leave the parking stalls. Table 6 below shows the average time for each type of parking that is needed by a vehicle to leave or enter the parking in the noon and afternoon period. Figure 8 and 9 refer to mean and standard deviation of the average manuover time.

Table 2. Average maneuver time

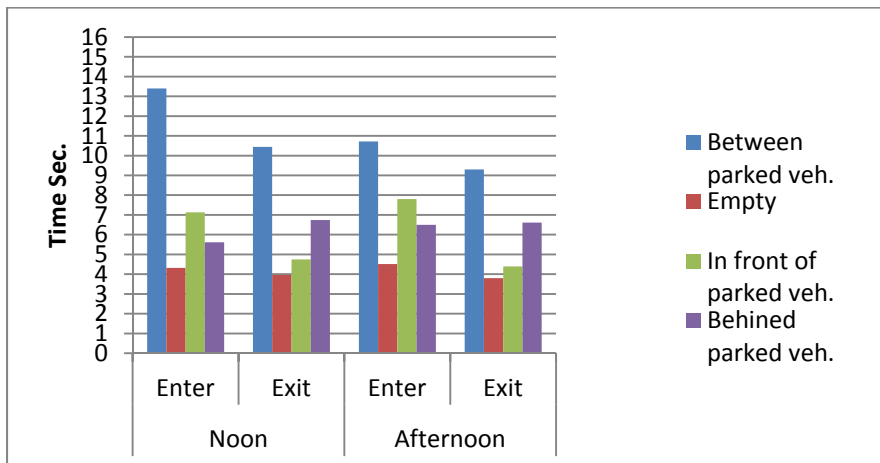| Type of parking	entering time (sec.)		leaving time (sec.)	
	noon	afternoon	noon	afternoon
	13.40	10.72	10.44	9.30
	7.13	7.80	4.75	4.39
	5.61	6.50	6.74	6.61
	4.32	4.51	3.96	3.80

Figure 3. Mean of the average maneuver time.

As seen in figure 8, the highest value of maneuver time was in the case of parking between two parked vehicles and this is due to the fact that the driver will make reverse maneuver to enter or leave the park. Here, the period being noon or afternoon bears no significance. On other hand, parking in empty lots does not require any extra maneuver to complete parking so its value is the lowest one.
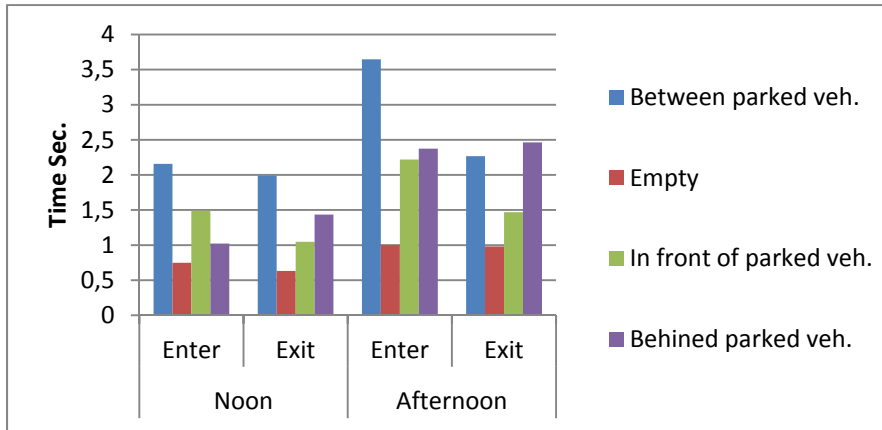
Figure 4. Standard Deviation of the average maneuver time.

3.3. Monte Carlo Simulation

Monte Carlo simulation, or probability simulation, is a technique that is used to understand the impact of risk and uncertainty in financial, project management, cost, and other forecasting models. In a Monte Carlo simulation, a random value is selected for each of the tasks, based on the range of estimates. Monte Carlo simulation results are used to describe the likelihood, or probability, of reaching various results in the model. Tables 7 and 8 shows the results of simulation of our model for the two periods.

Table 3. probability of car parking in observed and Monte Carlo simulation for noon period

Sites	Number of car parking		Difference
	Monte Carlo simulation	Observed Data	
Atasehir 1	39	42	3
Atasehir 2	12	12	0
Fistikagaci 1	14	22	8
Fistikagaci 2	25	33	8
Recep Aga	52	46	6
Fethipasa 1	11	10	1
Fethipasa 2	15	9	6

Table 4. probability of car parking in Observed and Monte Carlo simulation for afternoon period

sites	Number of parked car in Monte Carlo simulation	Number of Observed parked car	Difference
Atasehir 1	53	52	1
Atasehir 2	28	22	6
Fistikagaci 1	19	18	1
Fistikagaci 2	16	17	1
Recep Aga	38	46	8
Fethipasa 1	12	9	3
Fethipasa 2	10	7	3

4. CONCULUSION

In this study, parallel parking types of on-street parking have been examined in. Different parking maneuver patterns have been observed. These patterns are effected by many factors including the type of parking, direction of travel, presence of parked vehicles, driver maneuver preferences and traffic conditions.

This study has focused on investigating the characteristics of on-street parking facilities. Maneuvers may be a contributory factor to causing temporary bottlenecks in the moving traffic, which may result in causing operational problems such as congestion and delay on the roadway accommodating on-street parking.

Parking between two parked vehicles takes more time than the other parking types and this is due to the reverse maneuver that is needed to park the vehicle. Therefore, stalls should be designed to provide sufficient maneuvering space for parking vehicles by making possible arrangements to create adequate gaps between the different stalls. Commercial center is considered one of the most important factors that plays a role in increasing the possibility of parking as in the case of Atasehir. Monte Carlo simulation can be used to find the probability of parking for all type of parking.

REFERENCES

[1]   Chick, C., (1996) On-Street Parking: A Guide to Practice, *Landor Publishing, London*.
[2]   Olorunfemi S.O, (2013) Assessment of On-Street Parking in Lokoja, Nigeria, Master Thesis, *Department of Urban and Regional Planning, Federal University of Technology* Akure, Nigeria.
[3]   Asiyanbola R.A, Akinpelu A.A, (2012) The challenges of on-street parking in Nigerian Cities transportation routes, *International Journal of Development and Sustainability.*
[4]   Kimber, R.M., (1984) The Effects of Wheel Clamping in Central London, *Transport and Road Research Laboratory, TRRL Laboratory Report 1136, Crowthorne.*
[5]   Hobbs, F.D., (1979) Traffic Planning & Engineering, *Pergamon Press, London*.
[6]   James, J.Leds, (1992) Traffic Engineering Handbook Fourth Edition*, Institute of Transportation Engineers (ITE Prentice Hall New Jersey, pp204-238).*
[7]   Yousif, S and Purnawan, (1999) A study into on-street parking: effects on traffic congestion, *Traffic Engineering and Control, vol. 41, no. 9, pp. 30-33.*
[8]   Akhuewu, (2010) Impacts of On-Street Parking on Commercial Activities in Auchi.Unpublished HND Dissertation, *Department of Urban and Regional Planning Federal Polythenic* Auchi, Nigeria.
[9]   O'Flaherty C A, (1986) Highways: Traffic Planning and Engineering, 3rd edition, *Edward Arnold Publishers*, London.
[10]   Hongwei Guo, Wuhong Wang and Weiwei Guo, (2012) Micro-simulation Study on the Effect of On-street Parking on Vehicular Flow *15th International IEEE Conference on Intelligent Transportation Systems Anchorage*, Alaska, USA,
[11]   Litman T, (2013) Parking management: strategies, evaluation and planning*, Victoria Transport Policy Institute,* Victoria, Canada.