Parking Behaviour of Al-Hillah City Centre

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Abstract. Knowing the rhythm of daily life is more important in investigating some travel behaviours of people. Most importantly, improving parking behaviour in urban cities is one an useful characteristics in reducing traffic congestion problems. The aim of this study is to shed light on the parking behaviours for both off and on-street parking in urban areas. The methodology of this study could be summarized by collecting data from sixteen off-street and eight on-street parking facilities within the CBD area in Al-Hillah city. Mainly, the investigated parking characteristics are average turnover, occupancy, duration, purpose of trip, origin and destination. In addition, the type of vehicle parking has been investigated such as parallel, inclined angle and double or single parking style. In fact, the based-data results indicate that parking duration for medical activities has more duration than commercial and other activities. Similarly, the average turnover for medical land use is less than other land uses. Furthermore, it was found that there are a total of 2275 parking spaces in the study area, of which 1296 are in off-street parking space. While other spaces 979 are along the streets. Moreover, most on-street parking was illegal (about 68.5%). Finally, the reduction in capacity and speed for streets with on-street parking activities are 20% and 62.5%, respectively.

1. Introduction

Every day, a large percentage of drivers in single occupancy cars look for a parking lot. In addition, less experienced drivers contribute to increased traffic congestion [1]. Cities witness a wide range of activities, on a daily basis in general, and the main proportion of these activities is concentrated in the Central Business District (CBD), i.e. the commercial and business center of a city [2]. Notably, the reason behind the difficulty of developing and sustaining effective parking policies lay in the lack of information concerning parkers’ behaviors and preferences in choosing a certain parking location in the CBD area, especially for commuting, business and shopping trips [3]. Consequently, the effective method to evaluate the effects of parking strategy measures lays in the proper understanding of parking behavior [3]. Since the shortage of space availability in urban areas can conduce to a rise in the demand for parking spaces, particularly in CBD influences the selection of mode and exert a profound effect on economy. With the rising growth of vehicle density on road, the parking problem is expected severe on road. Therefore, a systematic study of parking characteristic, demand, and regulatory measures that are likely to achieve control over parking is extremely significant [4].

As a matter of fact, parking can exert negative effects on urban settings. Among these effects are [5]:
A. Congestion: Parking occupies considerable street space reducing the capacity of road. Therefore; traffic speed will be limited, journey time and delay will also grow as a result. The operation cost of vehicles increases inducing a considerable economical loss to the society.

B. Environmental pollution: Parking is also responsible for causing pollution. This is caused by noise and fume emissions. In addition, it may distort the aesthetic quality of the buildings since vehicles parked at each existing space generate a sense that building rises from a plinth. This pollution can hopefully be addressed in future studies.

Accordingly, urban transportation planners in India and other developing countries are encountering difficulties in road designing owing to the absence of proper capacity guideline that would take into consideration the impact of parking as well. Although relatively few endeavors have been made in the direction of assessing the influence of on-street parking on capacity, never the less they lack proper quantification which is more significant from the point of view of transportation planners. Hence, it is important to carry out additional studies in developing countries to obtain an accurate quantification of this effect by means of developing some models or adjustment factors [7]. Finally, parking decreases street capacity by 70-40% due to traffic congestion [13].

2. On-Street Parking in Urban area

On-street parking may offer natural contributions to the economy. The influences entailed by on-street parking differ widely basing on road class. Especially, for major roads, on-street parking is absolutely unsafe [7]. A review of the literature demonstrates that 93% or more crashes occur on major roads only outcomes of the presence and occupancy of on-street parking [8]. Thus; it would be justifiable to abolish on-street parking at the least for major streets since its negative consequences far surpass benefits that are derived from it. As Box [9] said; “Curb parking represents a potentially hazardous and congestion causing use of public road space. It should be restricted wherever practical especially along major roadways.” Instead, in the case of a lack of off street parking spaces, parking could be permitted on minor roads where less traffic volume run at a lower speed. As far as undivided minor streets are concerned, the frequency of crashes which are parking related is considerably lower [10]. Actually, the absence of on-street parking can occasionally exposes pedestrians leaving them vulnerable to accidents, and can increases accident frequency (up to 11%) particularly on minor roads [10]. There is a far lower probability of accidents to extend its severity on minor roads [8]. When permitted, on-street parking should be parallel, not angled, since the later may be hazardous in all aspects. Angle parking, owing to its problematic maneuver, is responsible for a higher crash rate. According to the collision records, angle parking conduces to more than double collisions per unit distance in companions with parallel parking [9]. Furthermore, angle parking results in a greater decrease in road capacity [11]. Accordingly, it is unjustifiable to deem angle on-street parking, and it should be regarded as a thing of the past. Regarding lower types of road, on-street parking is frequently associated with the street-vending activities. A higher parking density might charm more road vendors. Regardless of there has been a little research on the influences of road vending activities on operating such as characteristics of the road [12], research that concentrates on the effect of on-street parking on the extent of road vending activities have been unavailable in previous studies, so that, such influence can hopefully be addressed in future studies. Accordingly, urban transportation planners in India and other developing countries are en countering difficulties in road designing owing to the absence of proper capacity guideline that would take into consideration the impact of parking as well. Although relatively few endeavors have been made in the direction of assessing the influence of on-street parking on capacity, never the less they lack proper quantification which is more significant from the point of view of transportation planners. Hence, it is important to carry out additional studies in developing countries to obtain an accurate quantification of this effect by means of developing some models or adjustment factors [7]. Finally, parking decreases street capacity by 70-40% due to traffic congestion [13].
3. Parking lots demand in shopping centres

Mainly, in big cities with a high ratio of car ownership leads to a huge lack of parking spaces in multi-story housing areas [14]. As the number of residential districts increases, a problem of the abundance of cars parking right beside residential houses appears. It has been reported that each shopping center of 20 m² area may use one parking space[15]. In contrast to laws in many other countries, Lithuania's rules allow the formation of shopping malls of various sizes in residential areas. At night, parking lots near these shopping centers are almost empty, while residents of adjacent multi-storey houses struggle with parking spaces near their home. Through the initial analysis in a visual way, and on the basis of marking parking spaces, the actual number of parking spaces in parking lots in shopping centers was calculated in addition to their design capacity. In the event that the exact number of areas is not marked, it is supported by GIS techniques [16].

4. Transport demand management (TDM)

TDM measures primarily attempt to tackle several key issues especially traffic congestion, deterioration in air quality, and safety on the roads. Policies adopted to influence travel behavior belong to various classes and include strategies concerning economic measures, land use, instruction, information for travelers, or substitution of communications for travel. For example, recently, parking meter technology is widespread to change meter heads and machines that take different types of currencies. At West Hollywood, drivers use one of three flexible payment options, i.e. bills, credit cards and even prepaid keys. This improves user comfort and satisfaction in addition to revenue from these parking meters. Additional elaborate tests include electronic payment and parking guidance systems [17]. Parking guidance systems were evaluated in forty cities in Japan and many places in Europe. Their aim is to offer guidance about parking availability through shows mounted on streets [18]. For instance, in Europe there is the significant interest in this scope for sophisticated parking management systems based on in-vehicle, roadside and broadcast information [19]. The first developed parking guidance system has been installed in Aachen, Germany over two decades ago, and from that time the number of systems is developed in 75 sites as in Germany [20].

5. Methodology

To summarize the main steps of this study, four main stages have been implemented. Firstly, select the study area and the possibility of collected the required data. Secondly, determine the type of car park either on or off-street. Thirdly, determine the suitable and possible parameters for each parking type. Finally, analyze the collected data and evaluate each car park.

5.1. The study area

Al-Hilla city is the capital of Babil province in Iraq which is located between these coordinates 44° 22' 12.426” – 44° 22' 12.554” E and 32° 24’ 23.54” – 32° 31’ 57.4767” N and it covers an area of about 161 km² [21]. In particular, the selected area is located at the city center which represents the CBD area. With regards to the diameter of this selected area, it is about 2km. So, all off-street and on-street parking in this area have been surveyed. In addition, the flow of all streets there also have been determined.

5.2. Off-Street parking inventory

To start with the data collection stage, initially, the period of this stage has been selected from January to February 2019 during different days in week because this period is the period of activities. Three hours per day were considered to get peak hour. Every parking facility in the study area was covered entirely utilizing an inventory form. Sixteen off-street parks were chosen in the study area. These parking facilities are: An-Nisa garden Park1, Park2, Park3, Park4, Park5, Saad bridge Park6, Alrahmaa Park7, Al tejara Park8, Al akhwaan Park9, Alameen Park10, Park11, Park12, Park13, Park14, Park15 and Park16.
Table 1. Parking facilities information.

| Park No | Date      | Spaces | Initial counts | Peak hour          |
|---------|-----------|--------|----------------|--------------------|
| 1       | 11/1/2019 | 80     | 62             | (3:00-4:00) PM     |
| 2       | 13/1/2019 | 50     | 30             | (4:00-5:00) PM     |
| 3       | 15/1/2019 | 120    | 70             | (4:00-5:00) PM     |
| 4       | 18/1/2019 | 60     | 40             | (11:00-12:00) AM   |
| 5       | 20/1/2019 | 82     | 68             | (3:00-4:00) PM     |
| 6       | 23/1/2019 | 170    | 150            | (3:00-4:00) PM     |
| 7       | 25/1/2019 | 194    | 70             | (11:00-12:00) AM   |
| 8       | 31/1/2019 | 70     | 30             | (4:00-5:00) PM     |
| 9       | 7/2/2019  | 45     | 15             | (4:00-5:00) PM     |
| 10      | 9/2/2019  | 125    | 120            | (3:00-4:00) PM     |
| 11      | 15/2/2019 | 50     | 30             | (10:00-11:00) AM   |
| 12      | 22/2/2019 | 30     | 30             | (9:00-10:00) AM    |
| 13      | 23/2/2019 | 60     | 30             | (4:00-5:00) PM     |
| 14      | 25/2/2019 | 50     | 30             | (4:00-5:00) PM     |
| 15      | 27/2/2019 | 60     | 30             | (4:00-5:00) PM     |
| 16      | 26/2/2019 | 50     | 20             | (4:00-5:00) PM     |

The table illustrates the date of survey, the number of spaces for each parking, the initial counts or the initial number of parked vehicles at the start time and finally, the peak hour for each parking during the survey period.

5.3. On-Street parking inventory
Data were collected in March 2019 in different days of week, for three hours per day were considered to get peak hour as indicated in Table 2. Eight streets were chosen in the study area. These streets are 40th Street (ST1), Jabal Street (ST2), Imam Ali Street (ST3), Ray Street (ST4, ST5), Al-Atibba Street (ST6), An-Nisa Street (ST7) and Shreaa Street (ST8) as indicated in Figure 1.

![Figure 1. Locations of on-street parking in the study area.](image)

Regularly, all roads in the selected area have been chosen as indicated in Figure 1. Using GIS (ArcMap 10.5) to determine the area and the length of these roads as demonstrated in Table 2. This
table also shows the width of each road, the direction of flow, the number of spaces based on 5m as an average length of vehicle and lastly, the type of parking such as on one side or both sides.

**Table 2. Existing on-street parking inventory in the study area.**

| Street name      | Width (m) | Length (m) | Direction of flow | Number of spaces | Type of parking                        |
|------------------|-----------|------------|-------------------|------------------|----------------------------------------|
| 40th (ST1)       | 10        | 2085.8     | Two–way           | 413              | Both sides (parallel, right angle)      |
| Jabal (ST2)      | 12        | 542.5      | Two–way           | 60               | Both sides (parallel)                   |
| Imam Ali (ST3)   | 12        | 644.8      | Two–way           | 72               | Both sides (parallel)                   |
| Ray (ST4)        | 14        | 207.8      | One–way           | 40               | One side (parallel)                     |
| Ray (ST5)        | 14        | 230.4      | One–way           | 55               | Both sides (parallel, right angle)      |
| Al-Atibba(ST6)   | 16        | 391.6      | One–way           | 125              | Both sides (parallel, right angle)      |
| An-Nisa(ST7)     | 12        | 428.2      | One–way           | 113              | Both sides (parallel, 30 and right angle) |
| Shreaa(ST8)      | 10        | 1218.5     | Two–way           | 101              | Both sides (parallel)                   |

5.4. Interview survey

In this survey, a total of 400 interviews were conducted with actual parkers where the initial counts inside the center of Al Hillah city, including the following questions:

- Origin and destination of the trip.
- Journey purpose.
- Time of arrival at the park place.
- Time of departure from the parking place.
- Type of parking utilized.
- Types of vehicles

The survey has been implemented by interviewing the people when getting off their vehicles or coming out from the parking. It was a difficult task which consuming time. The survey results indicate the following statistics: 35% of the people come to the city center for medical purposes (especially in afternoon period), 31% come for official purposes (mostly, from 8:00 AM to 3:00 PM), 28% for commercial purposes, and 6% (the least percentage) come for entertainment purposes.

5.5. Environmental data

Environmental data gases emission like CO\(_2\) and another air pollutants like lead, SO\(_2\), CO, NO\(_x\), were collected also in parking spaces by cooperation with environment office in Hillah city using (the device: exhaust gas analyzer) and (suggested air quality specification for EPA, 2009, Environmental Ministry).

- Noise Level (Iraqi limit = 55 dB)
- Lead (Iraqi suggested limit = 2 microgram/m\(^3\))
- SO\(_2\) (Iraqi suggested limit = 40 ppb)
- CO (Iraqi suggested limit = 35 ppm)
- NO\(_x\) (Iraqi suggested limit = 50 ppm)
- CO\(_2\) (Iraqi suggested limit = 300 ppm)

Field measurement of the levels of the five pollutants and the noise level at the 40th street revealed the following results:

- Noise level = 71.13 dB
- Lead = 1.6 mg/m\(^3\)
SO₂ = 53 ppb  
CO = 36 ppm  
NOx = 41.5 ppb  
CO₂ = 250 ppm

According to the standards mentioned above, the noise level, SO₂ and CO exceed the acceptable limits which need urgent improvements. Removing the interaction of parking vehicles may help more in reducing the emissions of SO₂ and CO.

5.6. Parking fee
Knowing the parking fee may be a good indication of using off-street parking. It was observed through field survey in the study area wages of standing for all off-street parking is fixed on the price of 2000 Iraqi Dinars approximately (1.5 $) whether it is long or short standing and without wages in case on-street parking. Free on-street parking and the absence of applying control system may be a good motivation to use on-street parking.

5.7. Influence of parking on road capacity
Having reported the effect of on-street parking in Section 2, on-street parking mainly decreases road capacity in two ways. Initially, it mainly narrows the width of the roadway cause restricting the traffic stream. Therefore, vehicles move into this reduced width resulting in a decrease in the total speed of these vehicles. Secondly, frequent parking of vehicles leads to congestion. In this survey, the results showed in Shreaa street:

- Capacity without parking space = 3000 vehicle per hour
- Capacity with parking space = 2400 vehicle per hour
- Reduction in the capacity = 20 %
- Average speed without parking space = 40 Km per hour
- Average speed with parking space = 15 Km per hour
- Reduction in the average speed = 62.5 %

The data have been collected in two periods; one at peak hour of parking demand and the second at off-peak period of parking demand. Then, the flow has been determined for both two cases as indicated above. These values could be used as an indication or criterion of the expected reduction in both capacity and speed in other similar cases. However, the reduction in capacity obtained by this study is much less than the reduction value (40-70%) obtained by Mohamed and Riad [14] as mentioned in Section 2. The survey which was done in the study area indicated a total of 2195 spaces (the number of locations specified for cars to park) out of which 1216 spaces (55 percent) are located at off-street parking facilities. The rest 979 spaces (45 percent) are distributed along roads.

6. Data analysis and discussion
The obtained results from these surveys could be summarized into two classes; one for off-street parking and the second for on-street parking as in the following sub sections:

6.1. Off-street parking
Referring to Table 1, the percent of accumulated of these 16 parking facilities are demonstrated in table 3. For example, both Park1 and Park3 reach their capacity through the survey period. Likewise, Park5, Park7, Park12 and Park16 reach their capacities as demonstrated in Figures 4 to 6. The survey is conducted through various time as illustrated in Table1 focusing on the peak period for each site. Nevertheless, some of these parks operate under their capacities along the day which may be attributed
to the lack of suitable information obtained by drivers about available parking spaces in these sites. Consequently, this leads to high illegal parking vehicles along most of the streets there. Basically, turnover is calculated as the number of vehicles present in that bay for that particular hours. The average turnover represents a significant factor about the number of times at which each space is used. Ultimately, Park5 and Park12 are the utmost indications of utilization than other parks while Park10 is the minimum using than other parks. Where average turnover scaled during interval survey (for three hours in day) and when this indicator is high, it indicates that the vehicles use one space for more than once and increase parking volume during day. Average turnover to all surveyed parks found equal 2.3 vehicle.

Occupancy for that time interval is accumulation in that particular interval divided by total number of bays. Average occupancy helps to find the number of parking spaces occupied at different times of the day in order to know the peak demand, and site of the peak demand. Average occupancy to all surveyed parks found equal approximately 80%. Parks 2, 6, 10 and 14 represent the most parks which are close to the capacity of each park, whereas, Park 12 represents the lost occupancy which is about 65%.

Average duration represents the average time for which the parking lot is utilized by the vehicles. It can be computed as sum of the accumulation for each time interval multiply with time interval divided by the parking volume. Average parking duration was implemented to know the length of time vehicles are parked in a given space. Overall, Park1 and Park14 represent the highest indications than other parks while Park12 is the minimum using than other parks.

Table 3. Off-street parking characteristics.

| PI | Parking volume | Average Turnover | Average Occupancy | Parking Duration | Parking Load | Efficiency |
|----|----------------|------------------|-------------------|-----------------|-------------|------------|
| 1  | 143            | 1.98             | 84.9              | 76.78           | 61          | 84.7       |
| 2  | 115            | 2.34             | 95.5              | 68.86           | 44          | 89.7       |
| 3  | 199            | 2.21             | 87.6              | 71.3            | 78.83       | 87.59      |
| 4  | 149            | 2.29             | 84.3              | 66.2            | 54.8        | 84.3       |
| 5  | 214            | 2.6              | 83.1              | 57.4            | 68.3        | 83.3       |
| 6  | 335            | 2.39             | 88.5              | 66.6            | 124         | 88.5       |
| 7  | 380            | 2.42             | 84.8              | 63              | 133.16      | 84.8       |
| 8  | 133            | 2.18             | 71.8              | 59.3            | 43.8        | 71.8       |
| 9  | 98             | 2.33             | 82                | 63.3            | 34.5        | 82.1       |
| 10 | 241            | 1.92             | 90.8              | 56.51           | 113.5       | 90.8       |
| 11 | 107            | 2.37             | 80.6              | 61.1            | 63.3        | 80.7       |
| 12 | 78             | 2.6              | 66.65             | 42.3            | 18.3        | 61.1       |
| 13 | 79             | 2.15             | 77.8              | 64.9            | 35          | 77.7       |
| 14 | 89             | 2.1              | 89.25             | 75.84           | 37.5        | 89.2       |
| 15 | 118            | 2.2              | 84.8              | 68.6            | 45          | 84.9       |
| 16 | 104            | 2.31             | 73.9              | 57.6            | 33.3        | 74         |

Average parking load can be attained by multiplying the number of cars occupying the parking area at every time interval with the time interval. Parking load helps us to calculate efficiency as indicated in Eq(1).

Efficiency = parking load / no. of bays available ………. .................................(1)

The average efficiency is nearly similar to the most of these parks which is about 80%. In contrast, the parking demand is so high but as mentioned before the lack of information about the availability of spaces may be the reason behind that. Other significant features are obviously illustrated in Table 3 such as parking volume, average turnover, occupancy, parking load and efficiency. The average turnover is mostly from the clear sign about the
number of times at which every space is used. For that reason, Park5 and Park12 have the highest indices of utilization than other parks while Park10 is the minimum using than other parks. Conversely, the average efficiency is roughly similar to the most of these parks which is about 80%. On the other hand, the parking demand is so high but as mentioned before the lack of information about the availability of spaces may be the reason behind that.

6.2. On street parking
Accumulation count, average turnover, parking duration and other data were obtained during hours survey for both legal and illegal parkers and as shown in Figures 2 to 6. Specifically, Figures 2 to 6 represent the accumulation percentages through on-street parks. Most investigated streets reach their capacity (i.e. reach 100% of accumulation) as indicated in 40th Street. The peak period of parking demand could be classified into two periods; morning and evening. The morning peak parking demand is recognized in Jabal and Shreaa street segment1 only. Whereas, the evening peak was observed for all other streets such as 40th, other segments of Jabal and Shreaa; and other streets.

Regarding to average turnover, the average turnover factor for each segment changing from one to another. Table 5 demonstrates that this factor changing for each segment for the same street this could mainly depend on the activities for each segment such as shopping and medical activities. Where average length of time vehicles are parked in four segments on 40th Street equal 70.55 minute and in two segments in Shreaa street was 73 minute. The highest value for parking duration is 80.6 minute in Imam Ali Street (ST3) Whereas the lowest value calculated 58.7 minute in Ray Street (ST4). The highest value for average turnover is 2.375 in Ray street (ST4) Whereas the lowest value calculated 2 in Imam Ali street (ST3) and Shreaa Street (ST8).
Figure 4. Accumulated curves in Jabal and Shreaa Street Segment 1.

Figure 5. Accumulated curves in Shreaa Street Segment 2.

Figure 6. Accumulated curves in other streets.

Results in Tables 3 and 4 demonstrate that illegal parking could be well-known in Al-Hillah city on weekdays and weekend. Legal parking represents the parked car in first lane, while illegal parking refers to the parked car close intersections, second row, on side walk, on pedestrian crossing, and near the prohibited sign. Illegal parking is noticed in all study area. This could be in connection with the type of
activities in the selected area of Al Hillah city. When the demand for parking increases, illegal parking increases, too. It was noticed that the peak period from 3:00 to 5:00 PM and from 9:00 to 12:00 AM on Friday is the most noteworthy time where illegal parking was occurred. This period represents the peak shopping period both weekdays and the weekend. Most of the people are off work and study during this period and came to see doctors. Though, illegal parking is highly associated with the high demand for parking (legal) and shortage of infrastructure in some of the studied sites where sound to be indifferent behavior of the motorists. This could be attributed to the observed illegal parking in various durations even the demand for (legal) is low.

Table 4. Legally and illegally parked vehicles.

| Street No. | Number of spaces | Legally parked vehicles | Illegally parked vehicles | Parking index % |
|------------|------------------|-------------------------|---------------------------|----------------|
| ST1        | 413              | 130                     | 283                       | 90.19          |
| ST2        | 60               | 22                      | 38                        | 85.8           |
| ST3        | 72               | 20                      | 52                        | 90.2           |
| ST4        | 40               | 10                      | 30                        | 77.5           |
| ST5        | 55               | 40                      | 15                        | 78.45          |
| ST6        | 125              | 25                      | 100                       | 89.6           |
| ST7        | 113              | 20                      | 93                        | 84             |
| ST8        | 101              | 41                      | 60                        | 77.1           |

Data results from Table 5 shown that the park runs on over capacity at all-time survey, which indicates that there is an obvious problem in managing the parking system. Moreover, the results illustrate that the average PI above maximum capacity (PI=50%), for that reason; the results found that the all sites are inadequate in performance.

Having surveyed the study area, the parking behaviors which included knowing the guidelines, techniques of parking and how to use parking signs are vital to be improved and developed. The improved behaviors include avoiding illegal parking close to the destination and double parking which have been observed over eight roads within the study area. These behaviors are one of main problems which lead to traffic congestion and bottleneck. In addition, the absence of parking policy in this area has led to long period of on-street parking.

Table 5. On street parking characteristics in study area.

| Street No. | Seg. No | Parking Volume | Average Turnover | Average Occupancy | Parking Duration | Parking Load | Efficiency |
|------------|---------|----------------|------------------|-------------------|------------------|--------------|------------|
| ST1        | 1       | 220            | 2.44             | 93.4              | 68.8             | 84.1         | 93.5       |
|            | 2       | 449            | 2.03             | 84.9              | 67               | 167          | 85.6       |
|            | 3       | 172            | 2.15             | 94.3              | 79               | 75.5         | 94.3       |
|            | 4       | 113            | 2.35             | 88.16             | 67.4             | 42.3         | 88.19      |
| ST2        | -       | 126            | 2.01             | 85.5              | 73.5             | 51.8         | 86.4       |
| ST3        | -       | 145            | 2.0              | 90.2              | 80.6             | 65           | 90.2       |
| ST4        | -       | 95             | 2.375            | 77.5              | 58.7             | 31           | 77.5       |
| ST5        | -       | 125            | 2.27             | 78.45             | 62.16            | 43.16        | 78.48      |
| ST6        | -       | 281            | 2.15             | 89.6              | 71.7             | 112          | 89.6       |
| ST7        | -       | 260            | 2.03             | 84                | 65.7             | 95           | 84         |
| ST8        | 1       | 82             | 2.05             | 85.4              | 75               | 43.1         | 85.4       |
|            | 2       | 119            | 1.95             | 68.8              | 71               | 47           | 77         |

In the light of above, parking in the city is currently unregulated, and occurs both on-street and in illegal as well as legal off-street car parks. There is insufficient off-street parking which causes a propagation of on-street parking which is uncontrolled. There are no such restriction as controlled parking zones; areas where parking is only allowed in designated parking spaces, and subject to restrictions indicated
by painted roads markings. This uncontrolled parking, both on and off-street, results in flow breakdown, through the reduction of the available width of the roads, and results in safety issues. Looking at managing parking operations; this study recommends of using smart car parks as mentioned in Alabassi and Al-Jameel [22] for both on and off-street parking.

7. Conclusions and recommendations
This study mainly has the following conclusion:

1. The highest value for parking duration is 80.6 minute in Imam Ali street whereas the lowest value calculated 58.7 minute in Ray street.
2. The highest value for average turnover is 2.375 vehicle in ray street on the other hand, the lowest value calculated 2 vehicle in Imam Ali street and Shreaa street.
3. Parking practice in AL Hillah city centre is not healthy and hampers sustainability of transportation as indicated by the exceeding the level noise, SO2 and CO.
4. Illegal on-street parking represents on both direction of road. This parking results in bottlenecks and even blocks movement. The main decision in this regard is to remove on-street parking (on-street parking forbidden) and the imposition of fines for each person beyond the law to reduce the phenomenon.
5. The reduction in capacity and average speed for streets understudy with on-street parking activities is 20% and 62.5% , respectively.
6. Different parking maneuver patterns have been observed. The patterns are influenced by many factors including the class of parking, direction of travel, existence of parked vehicles, driver maneuver preferences and traffic circumstances.
7. Where curb parking is under-priced and overcrowded, some drivers may search for a curb space rather than pay to off-street parking.
8. Regulating on-street parking and providing smart off-street parking.
9. Encouraging public transports to reduce the use of private vehicles and reduce traffic congestion.

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