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ILLEGAL DRIVER BEHAVIOR AT SIGNALIZED INTERSECTIONS

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ABSTRACT

This paper deals with two common driving offensive cases at signalized intersections: 1- The sudden change in lane on the beginning of the green interval to pass the intersection using the right turning lane. 2- The forced emerging through queued vehicles passing T intersection on the through approach, always green lane.

The objective of this study is to observe and count the percentages of those impatientdrivers on four intersections during peak hour period. The data was collected within Duhok city at two intersections, for each of the above mentioned cases. Video camera was used to collect the flow of vehicles in each case. Traffic counting was carried out on the video using the laptop keys and EVENT computer program. Peak hour period for the four intersections was (5:00pm -6:00pm) according to a comprehensive previous study for traffic in Duhok city.

The total hourly traffic flow was collected on the diagnosed approach. The percentage of the offensive drivers was collected relative to the total traffic flow at the approach during the same period.

For the first case, the analyses of data shows that: The percentage of offensive vehicles to the total flow of the approach was 11% at Bira intersection. Larger rate was noticed at Mam intersection reaching 27%. Adding painted street markers did not change the tendency to break the regulations.

For the second case, the data was collected at two intersections, namely Safin, and Sulav. The percentage of the offensive vehicles was within 20% for the two intersections.

Off peak period observations did not show any obvious change in drivers behavior.

KEYWORDS:Driver behavior, Traffic flow, Intersection, exclusive line.

INTRODUCTION

Different factors lead to noticeable illegal driver behavior at signalized intersections among which:

1- The tendency of drivers to pass the intersection at a short time taking over the queued vehicles.

2- Busy intersections with a very high rate of flow and narrow approaches that led to long waiting queue and perhaps a delay for the second green period.

3- The lack of penalties and strict punishments on many driving offences.

Two of such illegal behaviors are the subject of this study:

The first is that on the activation of the green light interval, drivers suddenly change lane from the left and middle lanes to the exclusive right turn lane. Usually such drivers tend to increase their speed taking over most of the queued vehicles at the intersection trying to pass before starting the red interval that force them blocking the right turning movement.

The second of such illegal behavior is the almost forced emerging through queued vehicles passing T intersection on the through approach, always green lane. Vehicles queued for this lane for tens of meters are cut by drivers emerging the queue at the neck of this exclusive green lane barrier marks.

On this study the extent of such behaviors was investigated. After consulting traffic police department, data was collected during peak and off peak periods on two locations for each of the abovementioned two cases. Traffic counts were carried out in these two locations to account for the percentage of the illegally behaved drivers

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relative to the overall traffic movement in the intersection.

Proper channelization, clear road marking, and increasing the approach capacity with the presence of surveillance cameras can be possibleremedies to such offensive cases.

Literature Review

Lane change (LC) behavior studies were conducting by many authors among whom is Guo, 2018 analyzed different aspects of LC behaviors, i.e., the LC rate, motivation, target lane choice and impact on traffic. His results suggested that LC is a transient behavior that randomly occurs with high frequency, which is the main feature of aggressive driving. Several LC patterns and the combination effect of ramps, fast lanes and various vehicle types were presented. Guo also concluded that aggressive drivers change lanes whenever they want regardless of the speed.

Al-Jameel, 2017, focused in his study on driver behavior which represents the core stone in a traffic simulation. This behavior represents lane changing (LC) and lane utilization (LU) in normal sections. Three normal sections with three lanes have been selected in different sites in Iraq. The results of his data analysis show that the driver behavior in both LC and LU is similar to the behavior in the UK. The author also concluded that the number of LC obtaining from field data in Iraq is higher than observed in the UK. This may be attributed to several reasons such as Iraqi drivers are more aggressive in accepting small gaps than the British drivers. The author results show that total number of lane change per kilometer in all sites increases with the increase of flow.

Al-Obaedi, et al, 2018, also concluded in his study on a freeway Normal Section at Baghdad City thatwith traffic flow increased the frequency of lane change increased.

Many references tackle the design of intersections as a measure of reducing conflicts among road users. Brocken rough and Boedecker, 2004, in the highway engineering handbook quote "exclusive right turn lanes can significantly improve the level of service of signalized intersections. They also provide a means of safe deceleration for right turning traffic on high-speed facilities and separate right-turning traffic from the rest of the traffic stream at stop-controlled or signalized intersections. As a general guideline, an exclusive right turn lane should be considered when the right turn volume exceeds 300 vehicles per hour per lane. The recommended maximum length of right turn lanes at signalized intersections is 266m, with 30m the minimum length. The blockage of the right turn lane by the through vehicles should also be checked using Tables."

AASHTO, 2011 gave a description of the geometrical design of intersection, channelization of lanes, reflective markers, and painted strips. Garber and Hoel, 2009 state that: “channelized islands are used to eliminate confusion to motorists at intersections with different traffic movements by guiding them into the correct lane for their intended movement. This is achieved by converting excess space at the intersection into islands in a manner that leaves very little to the discretion of the motorist." The authors also included different channelized intersection design.

Gaston, Ptoe, 2014, reviewed the turn lane design criteria, giving details on when the turning lanes are required, the design of the right turning lanes, storage lanes on right turns, and the taper length.

Stover and Dixon, 2015, reviewed the full design of the right turn lanes. Accounting for the elements of the turn lane, Figure (1), giving the design elements of taper lanes, divisional islands, and,Decele ration distance

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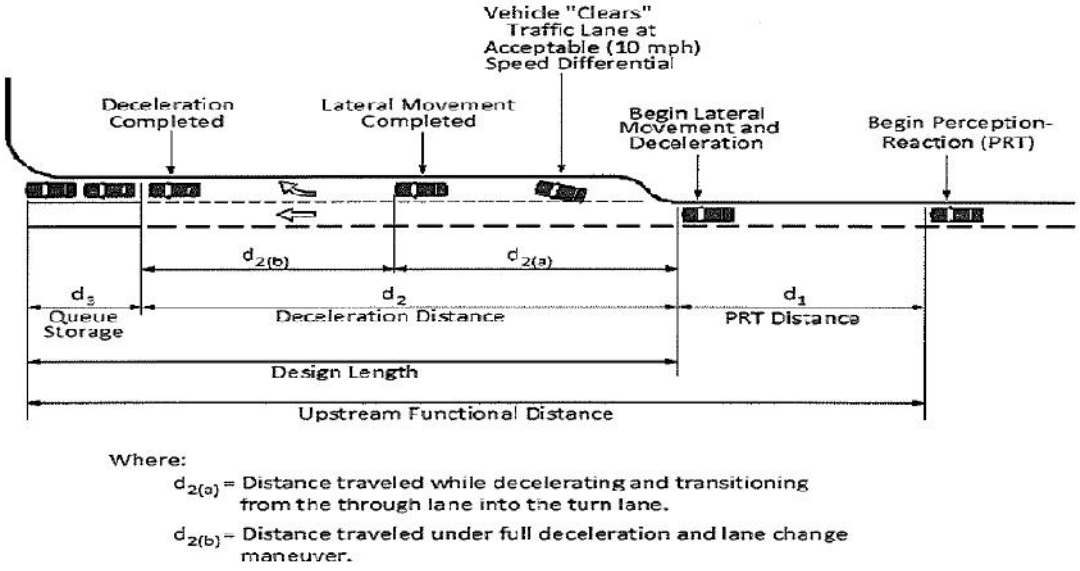

Fig.(1): The elements of right turning lane, after Stover and Dixon, 2015

Dixon et al, gave an account for the right turn treatment summarizing in Figure (2) five specific entrance treatments occur commonly for conventional right-turn movements.

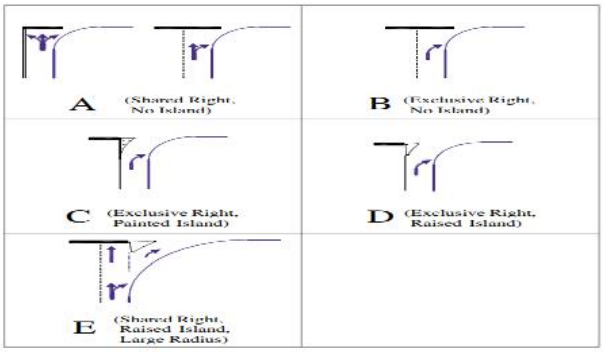

Fig. (2): Entrance treatment, after Dixon et al.

Tian et al, introduces a capacity estimation model under the conditions where the approach at a signalized intersection has a short right-turn lane. The model takes into account of the stochastic nature of queue blockage of the short lane, and the effect of such queue blockage on capacity is specifically addressed from probabilistic point of view.

Data collection method

A base mounted digital video camera type Sony, Figure (3) was used to collect video record for each site during peak and off peak hours.

Fig.(3): Data collecting video camera type Sony

The video record was displayed on the laptop computer and lane flow counting software developed by EVENT, counting the flow on the whole approach. The video is played and the (F1, F2, and F3) laptop keys were used to count vehicles with different movements representing case 1 and case 2 for the studied intersections, Figure (4).

Fig.(4): Process of Data Abstraction

Field observations cases

Based on the results of a comprehensive traffic study on Duhok city intersections (Dilshad A. 2011) including the intersections under study, the peak hour traffic volume in these intersections was found to be between 5:00pm and 6:00pm.Figure (A1) shows the traffic volume in Sulavintersection as a represened example afteradjustment for thetime passed since that study was conducted.

Case 1: The suddenlychange lane from the left and middle lanes to the exclusive right turn lane on the activation of the green signal, Figure (5).

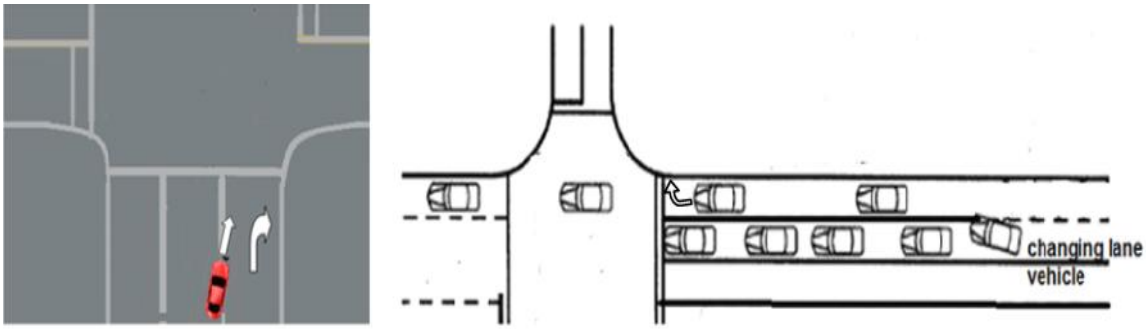

Fig.(5): The sudden change of lane on the start of the green interval

Observations on such case were carried out on two intersections:

a-The Bira intersection on Qazi Mohammed Street, Figure (6).

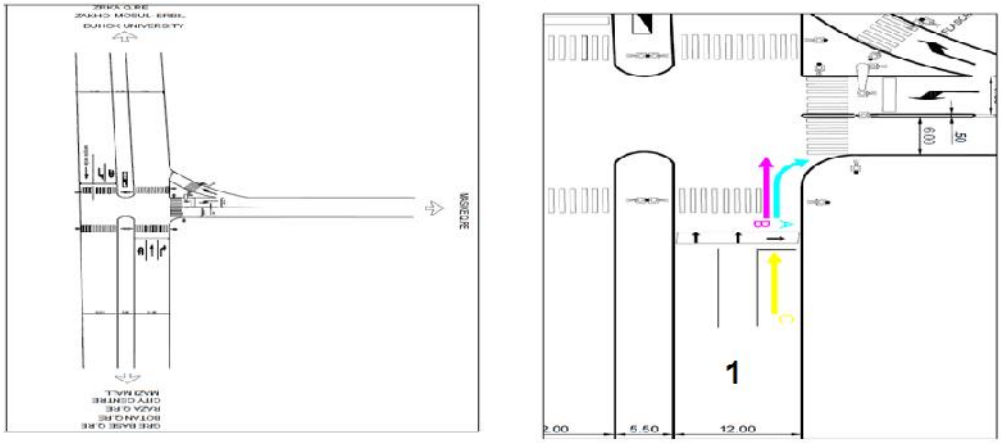

Fig..(6): Bira T intersection with exclusive right turning lane

The intersection is a T type. The through main street is six lane divided by a 5.5m median. An all amber light signal allows the drivers to turn right from the main street.

On side 1 of this street and on the red interval, vehicles queue on the left and middle lanes. The right lane is usually kept open for the right turning vehicles.

On the activation of the green signal, a substantial percentage of the queued vehicles, especially those on the middle lane, Figure (7), suddenly change to the right lane in an attempt to pass the intersection before the end of the green period.

Fig.(7): Changing lane on the beginning of the green period

Drivers at the end of the queue lines are more prepare to make such a move because they have more space to maneuver and because they are certain that they couldn't catch the green period.

The observations on this intersection were carried out on the peak hour period: (5:00pm - 6:00pm). The total flow on this period on side 1 of the street which is effected by the offensive was 2253 vehicles. The data is recorded on Table (1).

Table (1): Flow data on Bira and Mam intersections

Data for side (1)	Bira intersection. Total flow=2253		Mam intersection Total flow=1716	
Type of movement	Veh.	%	Veh.	%
A: Vehicles moving through the exclusive right lane and turn right.	339	15%	72	4%
B: Vehicles Using exclusive right lane to move straight during green signal	246	11%	456	27%
C: Vehicles using exclusive right lane to move straight but couldn't catch green signal causing lane blocking	36	2%	35	2%

b-The Mam intersection on ZakhoStreet, Figure (8).

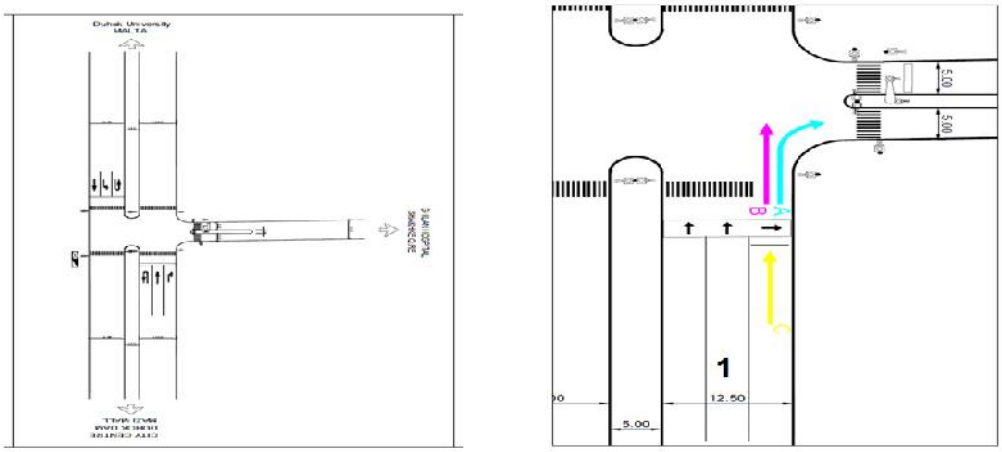

Fig.(8): Mam T intersection with exclusive right turning lane

The through street is a six lanedivided by a 5m median. An all amber light signal allows the drivers to turn right from the main street.

Observations were carried out during Peak hour period (5:00pm- 6:00pm).The total flow on this period on side 1 of the street was 1716 vehicles. The data on this intersection is given in Table (1).

To visualize the effect of having clear solid dividing white line and painted right turn arrow. The research group contacted Duhok municipality to add these marks on Bira intersection, Figure (9). And data on Bira intersection was collected after this change on two periods: the peak hour period (5:15pm-6:15pm) and the off peak hour period (9:30am-10:30am). The data is presented in Table (2).

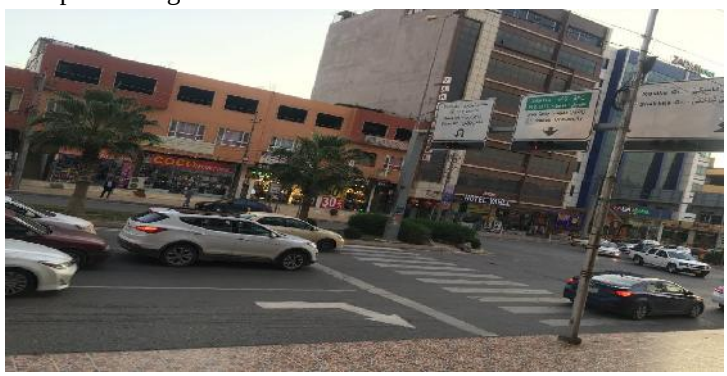

Fig.(9): Newly added white solid dividing line and right turn arrow, Bira intersection

Table (2): Flow data on Bira intersection after adding a painted signs

Data for side (1)	Peak hour period Bira intersection. Total flow=2130		Off peak hour Bira intersection. Total flow=1206	
Type of movement	Veh.	%	Veh.	%
A: Vehicles moving through the exclusive right lane and turn right	344	16%	162	13%
B: Vehicles Using exclusive right lane to move straight during green signal	264	12%	126	10%
C: Vehicles using exclusive right lane to move straight but couldn't catch green signal causing lane blocking	39	2%	12	1%

It can be noticed that adding these painted signs did not make any change in driver's behavior and the percentage of wrongly maneuvered drivers stayed around 11-12%. Even during the off peak hour period this percentage did not drop below 10%. One reason for this is the fact that drivers used for long period of time to make this wrong maneuver and itis not easy to change that behavior. The other reason is that such behavior iscontagious and one a driver move will encourage the other to do the same.

Case 2: The forced emerging through queued vehicles passing the intersection on the always green lane.

Along the Barzani arterial street, six intersections have always green lanes on the W-E direction. This lane is marked by yellow raised half sphere pavement marker, Figure (10). Vehicles queued for this lane for tens of meters (marked A in Figure (11)) prior to the intersection are obstructed by drivers (marked B in Figure (11)) emerging the queue at the beginning of the always green lane barrier marks.

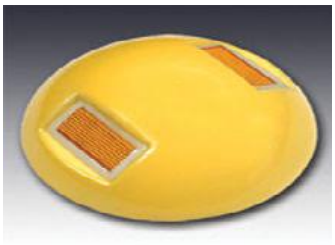

Fig.(10): Half sphere pavement marker

Observations on such case were carried out on two intersections:

a-The Safin intersection on Barzani Street, Figure (11).

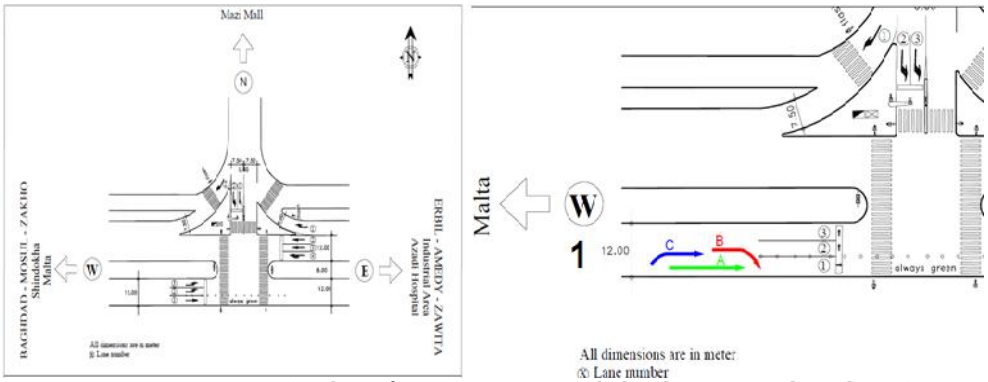

Fig. (11): The Safin T intersection with the always green lane (lane 1)

The street on side 1 is 3 lane each 4m wide. The right lane of side 1 of the street is always green lane allowing vehicles to pass the intersection with no need to wait for the green signal.

As flow on this street is very high and as substantial percentage of the flow on this side is straight through movement, the queue on the always green lane is always a long queue.

Some of the intolerant drivers emerge through the queue at the beginning of the always green marker line, Figure (12).

Fig.(12): Inpatient drivers emerging at the beginning of the queued vehicles

This will obstruct the already queued vehicles and decrease the flow on the whole street.

Traffic count on this street was carried out during peak hour period: (5:00pm- 6:00pm). The total flow on this period on side 1 of the street was 3108 vehicles. The data on this intersection is presented on Table (3).

It is clear from Table (3) that 19% to 20% vehicles of the total flow on this arterial street emerge to the always open right lane at the neck of this reserved lane during the red signal. Most of the queued drivers are generous enough to allow such drivers to emerge a head.

b-The Sulav intersection on BarzaniStreet, Figure (13).

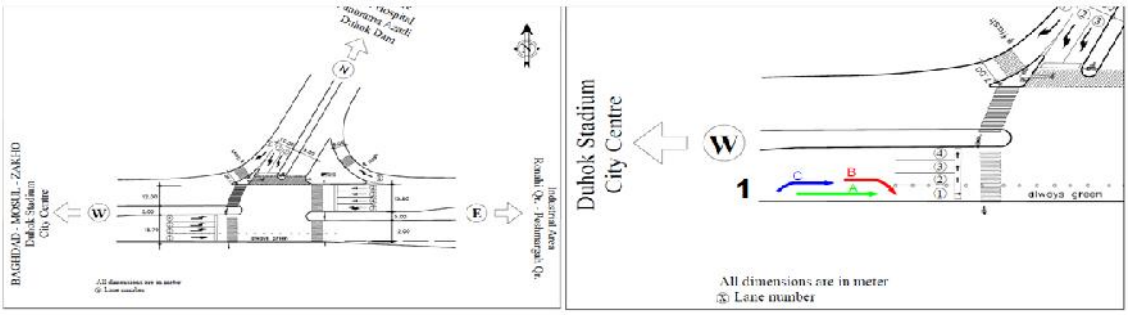

Fig.(13): The Sulav T intersection with the always green lane (lane 1)

Traffic count on this intersection was carried out during the peak hour period: (5:00pm- 6:00pm). The total flow on this period on side 1 of the street was 2984 vehicles.The data on this intersection is presented in Table (3).

Table (3): Flow data on Safin and Sulav intersections

Data for side (1)	Safin intersection Total flow=3108		Sulav intersection Total flow=2984	
Type of movement	Veh.	%	Veh.	5
A: Vehicles moving on always open through lane	846	27 %	804	27 %
B: Vehicles changing their lanes to always-green lane during red signal	621	20 %	560	19 %
C: Vehicles queued on the always-green lane change to other lanes during Green Signal	96	3 %	56	2 %

CONCLUSIONS

1- Figures (14) shows graphically the percentages of illegal maneuvers at the four studied intersections.

The left column of Figure (14) shows the percentage of the changing lane vehicles to the total flow at each intersection. The right column shows the percentage of the changing lane vehicles to the flow on the always green lane.

It is clear from the Figure and the data that around 40% flow on the always green lane is a changing lane offensive vehicles. On Mam intersection the percentage is higher reaching 86%.

2- At Bira and Mam intersections, 2 % of the total flow are vehicles using exclusive right lane to move straight but couldn't catch green signal causing lane block for right turning vehicles.

3- At Sulavand Safinintersections, 2% to 3% of the total flow are vehicles queued on the always-green lane change to other lanes during Green Signal. Those drivers are not patient enough for passing the intersection on the always green lane.

4- On Bira intersection no evidence was found to assume that driver behavior would change during off peak period.

5- Painting right turn arrow and solid line to mark the exclusive right turn lane on Bira intersection did not show any obvious changes in driver's behavior.

6- Most of the mentioned offensives are rarely happen in Duhok city in channelized intersections. As these intersections are wide and organized enough to increase the road capacity and reduce conflicts

Intersection Total Flow	

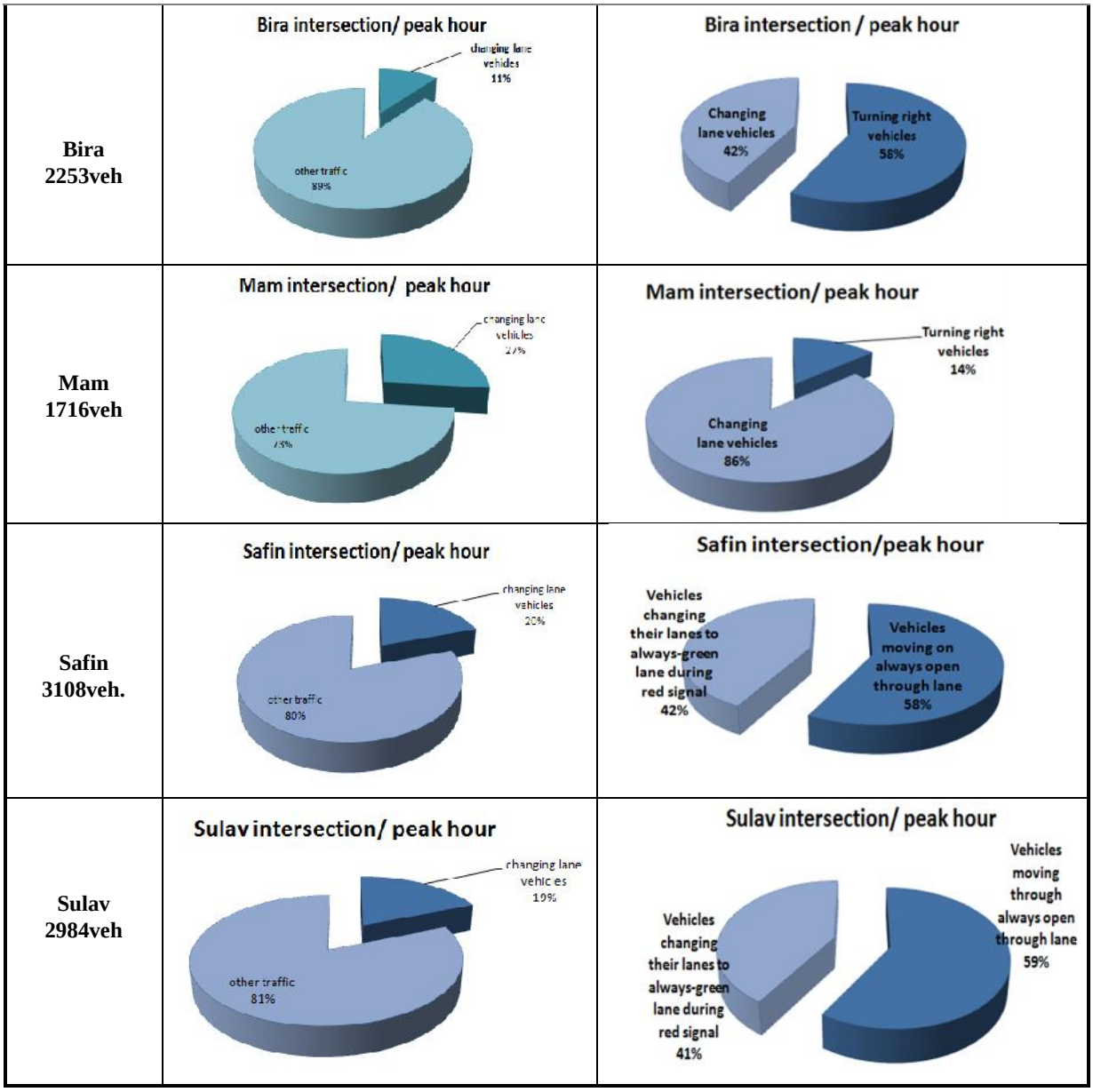

Fig.(14): Graphical presentation of the percentage of illegal maneuvers in the four intersections.

RECOMMENDATIONS

To reduce the extent of the minor offensives studied in this paper the following measure could be considered:

1- Continuous white lines are to be painted on the intersection approach at enough length. Also white turning right arrows should be painted on the exclusive right turning lane, Figure (15).

2- At important and high flow intersections, CCT closed circuit television cameras can be mounted to observe the offensive vehicles. Penalties can reduce the rate of wrong maneuvers as the sudden change in lane and the high acceleration on the intersection could led to accidents.

3- Half sphere plastic markers can be used to channelize the exclusive right turning lane.

4- Increasing the intersection capacity and hence reducing vehicles delay could lead to minimum traffic offensives at intersections.

5- Auxiliary turning lane with tapered entrance can be used exclusively for right turning vehicles if the intersection right of way allows.

Fig. (15): Solid white lines and clear turning arrows

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Appendix 1

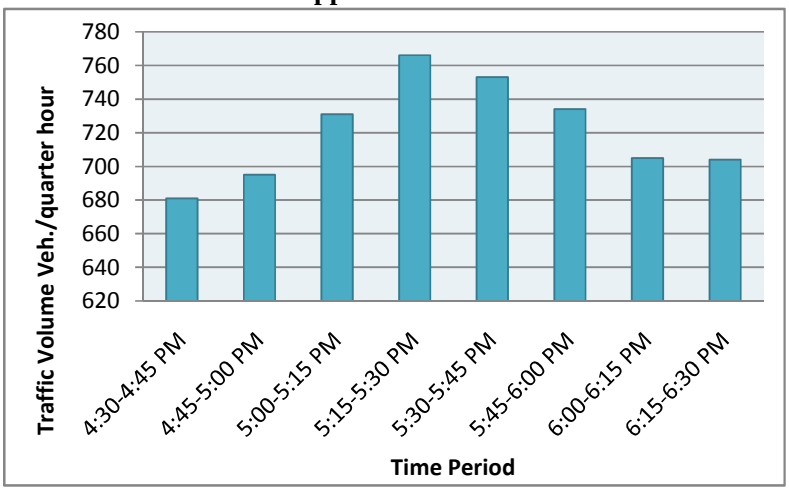

Fig. (A1): Traffic volume in Sulav intersection indicating the peak hour **period**

after Dilshad A. (2011)