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محاكاة الدورة الدولية
لمعرض بغداد المستدير في برمجيات

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كلية الاسراء الجامعة- بغداد/ العراق

V I S S I M

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1 - INTRODUCTION

In spite of the great advantages of standard roundabouts over signal or stop intersections, roundabout's properties cannot deal with both the safety and capacity issues of each intersection. Priority roundabout can be considered as a suitable design for any intersection that has high ratio of turning vehicles, in which the roundabout could improve their safety and traffic flow. However, due to its disadvantages, for example the pedestrian's uncontrolled crossings and its insufficiency under the existence of unbalanced traffic flows, when sometimes could cause intersection redesign. In this situation, there is a good solution to integrate signal control systems with roundabout geometry in order to achieve both of the strengths signalization and roundabout geometry simultaneously. In spite of the fact that roundabouts signalization has the potential to enhance the traffic condition at plenty of the existing roundabouts, in reality, it has not been used extensively yet. In addition, among the few signalized roundabouts, the design of these roundabouts has been with little or no formal experience (Stevens, 2005).

2 - PROBLEM DEFINITION

It is familiar to notice traffic congestion at most of the signalized roundabouts in Baghdad at rush hours in the morning or afternoon periods. Due to the rapid growth in number of traffic volumes in Iraq, this traffic congestion will proceed and it may worsen in the near future. The unsuitable planning of the road network and roundabouts poor geometric design have a great effect on the performance of roundabouts and the traffic congestion. Based on that, the evaluation of the performance of signalized roundabouts during ordinary traffic operation, could give a clear view to the traffic planners and engineers for future process of planning, operation control, and design to accommodate increasing traffic volumes. Some of the problems that will be considered, are:

1. Sub-standard geometric design characteristics of roundabouts such as large Roundabout Island
2. In signalized roundabout, one of the major causes of congestion: is the poor design of cycle time which could have huge effect of vehicle delay and roundabout performance
3. Absence of proper design of road marking signs and lights.

3 - METHODOLOGY and DATA COLLECTION

There are many signalized roundabouts in Baghdad city. These signalized roundabouts, diverge in shape, number of legs, dimensions, Security clearance for survey and traffic volume characteristics. These elements have influenced on the selection of study-signalized roundabouts in addition to the traffic data necessary for simulation program to function properly. As result, signalized roundabout locations met the desired criteria (normal operating condition) . After the necessary geometric data and traffic volume are collected at selected signalized roundabouts, Geometric design properties of the signalized roundabout have been obtained in details as required by computer software simulation VISSIM (version 7.0).

3.1 Baghdad Fair Signalized Roundabout

This four-leg signalized roundabout is located in the Karkh district of Baghdad city and this roundabout is distinguished among other by having direct path between Mansour St. and Damascus St., passing through the middle of roundabout, but not cutting the central island.

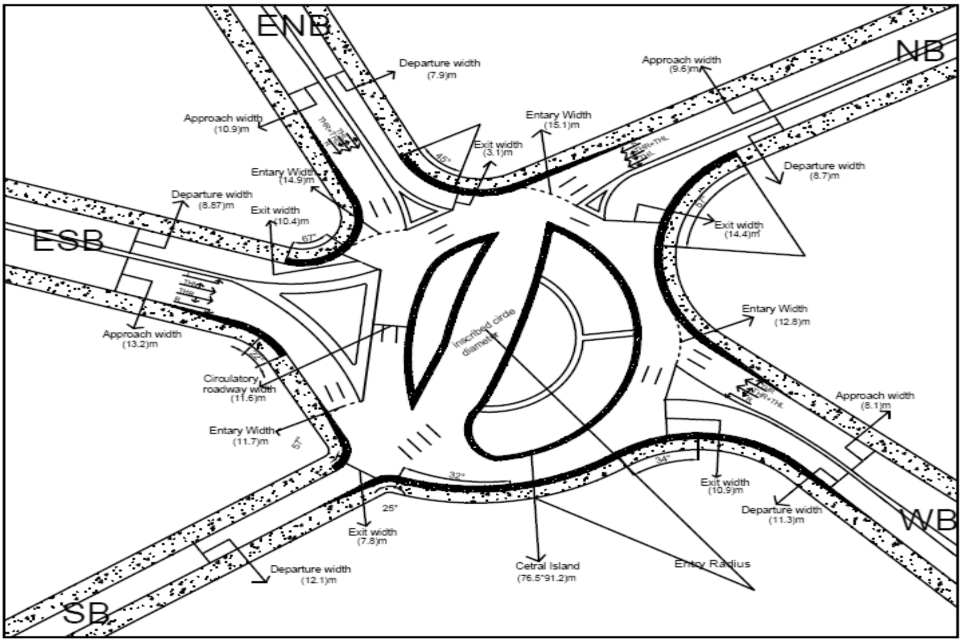

Figure (3-4): Baghdad Fair roundabout layout

3.2 Alterations

In this study, the alteration peak hour is from (7:00-9:00) and (14:00-16:00) for the signalized roundabouts. Four main alterations for the selected signalized roundabout are considering, for each alteration the roundabout is model and analyze separately and finally compared with each other numerically. The first alteration considered the roundabout in original existing condition and the output result analyzed as alteration No.0. The second alteration considers the roundabout in existing condition as signalized roundabout, but the cycle time optimizes to reach the pest performance, is model, and analyze as alteration No.1. In the third alteration, the replacement of roundabout with signalized intersection is proposed and named as alterations No.3. And in the last alteration, the use of roundabout with only the highest volume of vehicle is signalize and called alteration No.3. For each of the signalization technique, many different signal timings are try to achieve the best performance for all the suggestion modes. Also from the observation, the video records traffic flows and turning percentages have similar patterns and quite similar values for the two morning hours, but fundamentally different from afternoon two peak hours. All the alterations run in the VISSIM software for 15 replications. The replications average is calculated and the results are stored in the database. The comparison of all the alterations will be between their average outputs. In the following section, a calibration is conduct, where VISSIM software will be compare with software (Arcady) used before in similar studies in Iraq.

4 - DATA PRESENTATION and ANALYSIS

In This chapter, the simulation technique analysis of the selected roundabouts is applied and presented. Different alteration, which is mentioned earlier in chapter three, will be analyzed in details.

4.1 Alteration Output

4.1.1 Alteration No.0 (origin Signalized Roundabout Simulation Data)

Table (1) shows the output result from video recording using smart traffic analyzer software for Baghdad Fair Roundabout in original condition. As shown in Table (1) the level of service for the first, second, third, fourth hours are :(D, D, F, E), and the reason that, make roundabout reach LOS f in the third hour is due to: the high number of vehicle number. The behavior of different approaches is explained in Figures (1) to (4). From the analysis of these figures, it can be realized that, a direct relation exists between the average delay and vehicle travel distance and, also relative balance in average delay exists in all approaches. The most important factor that can help in reducing the average delay in the signalized intersection alteration is the shortest path that is shown in Figure (3) between EB and NB which handles high proportion of traffic volume. This figure also shows that, the movement from and to the same approach is very limited in all approaches, except the EB approach because of the fuel station and school area in sub street at exist of EB approach, (HCM, 2010).

Table (1): Mean delay and mean stop delay and average speeds outputs of alteration No.0 for Baghdad Fair roundabout.

Time from	Time to	Mean delay time (sec)	Mean stop time (sec)	Average speeds (km/h)
7:00	8:00	55.23	44.53	10.04
8:00	9:00	48.92	35.81	9.76
14:00	15:00	80.18	72.33	7.9
15:00	16:00	56.99	50.21	8.93

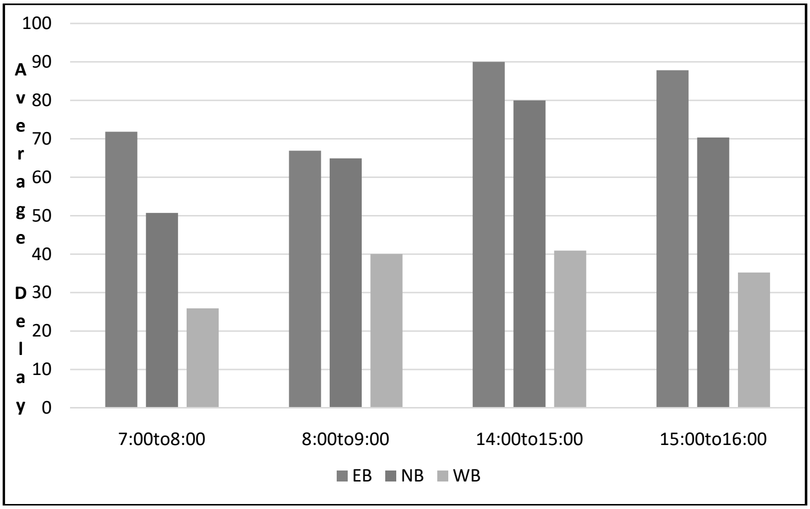

Figure (1): The average delay outputs of alteration

N0.0 for Baghdad Fair roundabout for vehicle traveling from SB to all Approaches.

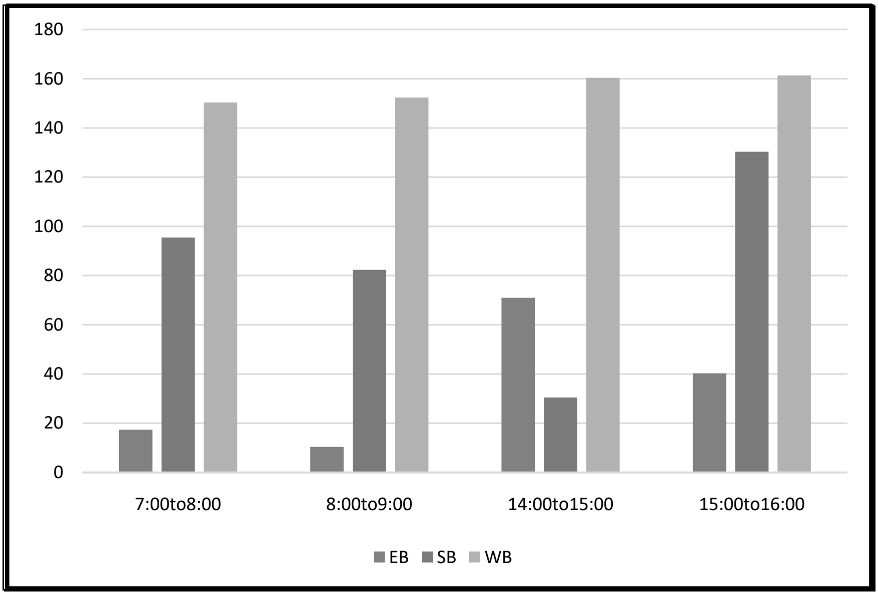

Figure (2): The average delay outputs of alteration No.0 for Baghdad Fair Roundabout for vehicle traveling from NB to all approaches.

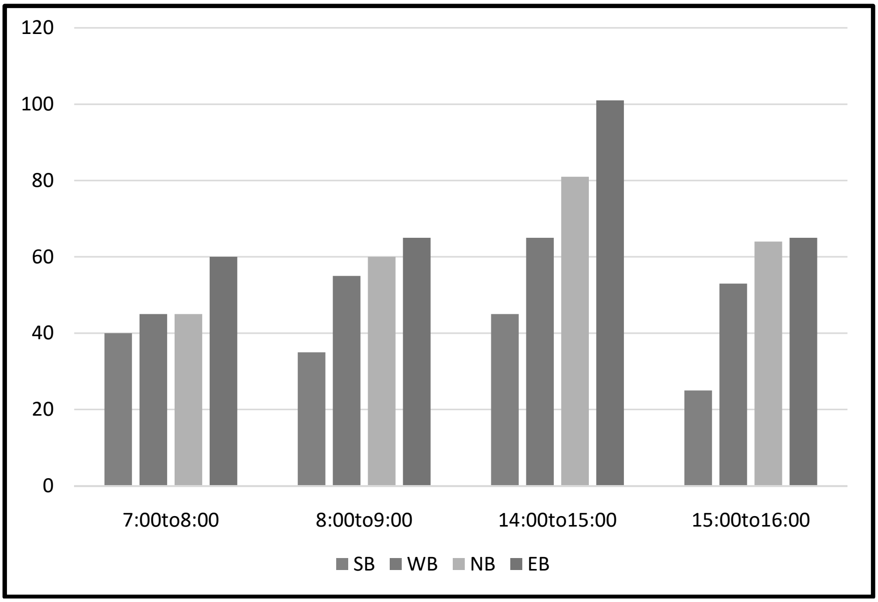

Figure (3): The average delay outputs of alteration No.0 for Baghdad Fair roundabout for vehicle traveling from EB to all Approaches.

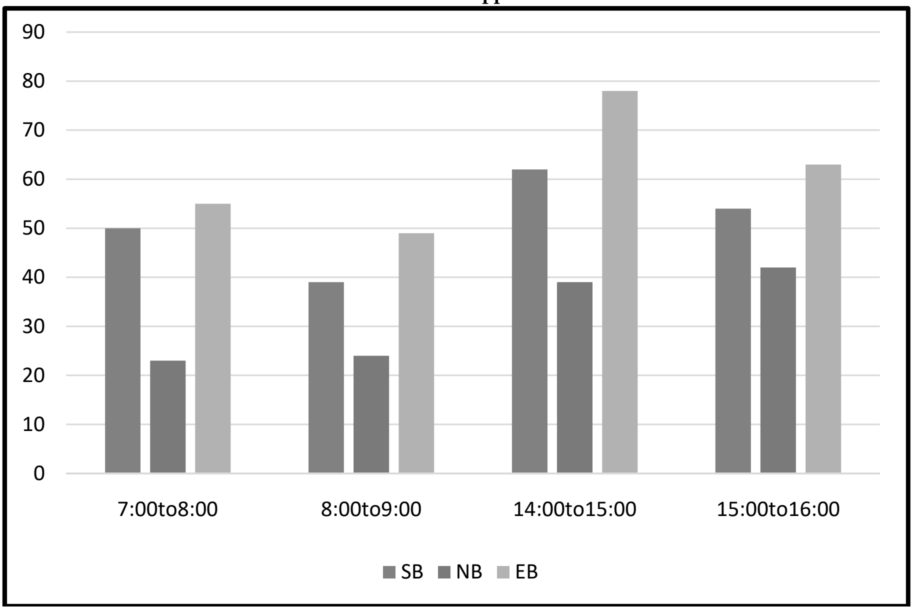

Figure (4): The average delay outputs of alteration No.0 for Baghdad Fair roundabout for vehicle traveling from WB to all Approaches.

Table (2) shows approaches queue length output of alteration No.0 for Baghdad fair roundabout. The main reason for the variation in the amount of the queue length in the roundabout legs is; in mourning peak period significant number of traffic vehicles (about 40%) is constrained in SB approach and also half of these vehicles travel towards NB and do not cycle the roundabout causing great reduction in the average queue length of all approaches, But at evening peak period, the traffic volume highly increases and constrains in both NB and SB which causes an increase in cycle movement and consequently an increase in average queue length in all approaches, as shown in Table (2).

Table (2): Approaches queue length output of alteration NO.0 for Baghdad Fair roundabout.

Approach Name	Mean Queue (meter)			
	From 7:00 to 8:00	From 8:00 to 9:00	From 24:00 to 25:00	From 15:00 to 16:00
SB	52.34	60.34	62.34	59.23
NB	80.99	39.02	118.51	140.75
EB right	60.10	39.34	70.12	41.98
WB	-	-	76.81	43.89
Inside roundabout	21.12	22.91	34.98	48.98
EB left	25.23	41.34	42.78	41.98

4.1.2 Alteration No.1 (Signalized Roundabout Simulation Data)

Table (3) shows the output results of VISSIM simulation of Baghdad fair roundabout as a signalized intersection. These results are for Alteration No.1, as shown in Table (3) for Baghdad Fair roundabout, (default condition as signalized roundabout), in the morning peak period, when the traffic volume is about 8000 veh/hr (the level of service is (D). In the evening peak period and as traffic hugely increases for more than 13000 veh/hr (Appendix A), entering from four approaches, the mean delay is 63.35 sec and the average speed is 9.8 km/hr and the LOS for two hours is (E, D). And also as shown by trying different cycle time and detracting the illegal traffic movement could reduce the delay an LOS and make the roundabout performed better, (HCM,2010),.

Table (3): Mean delay and mean stop delay and average speeds outputs of alteration No.1 for Baghdad Fair roundabout.

Time from	Time to	Mean delay time (sec)	Mean stop time (sec)	Average speeds (km/h)
7:00	8:00	40.81	27.63	13.04
8:00	9:00	35.88	26.57	12.87
14:00	15:00	63.55	41.81	9.8
15:00	16:00	42.99	43.35	10.13

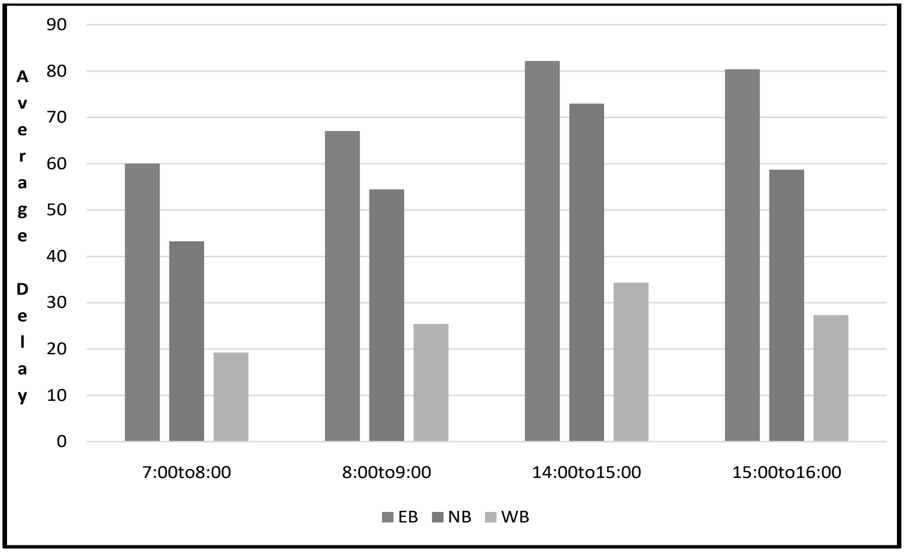

Figure (5): The average delay outputs of alteration No.1 for Baghdad Fair roundabout for vehicle traveling from SB to all Approaches.

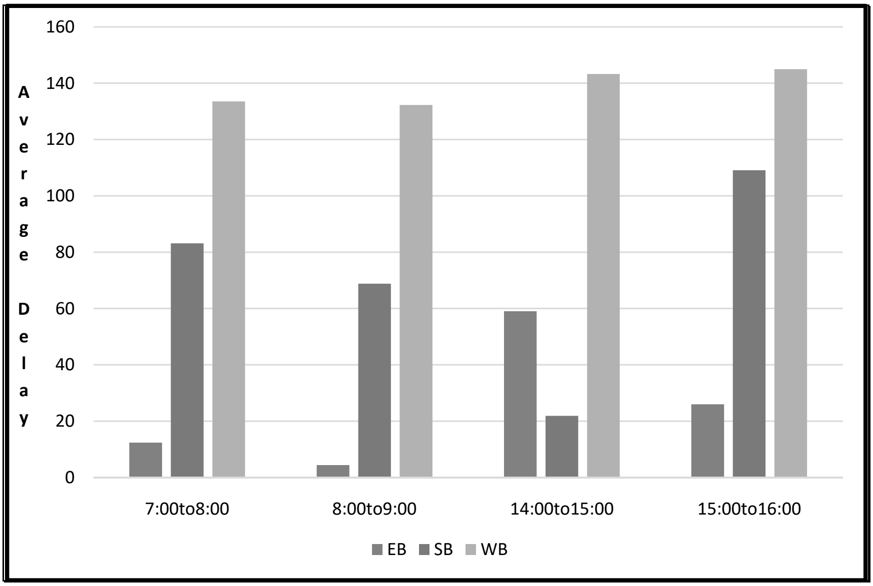

Figure (6): The average delay outputs of alteration No.1 for Baghdad Fair roundabout for vehicle traveling from NB to all approaches.

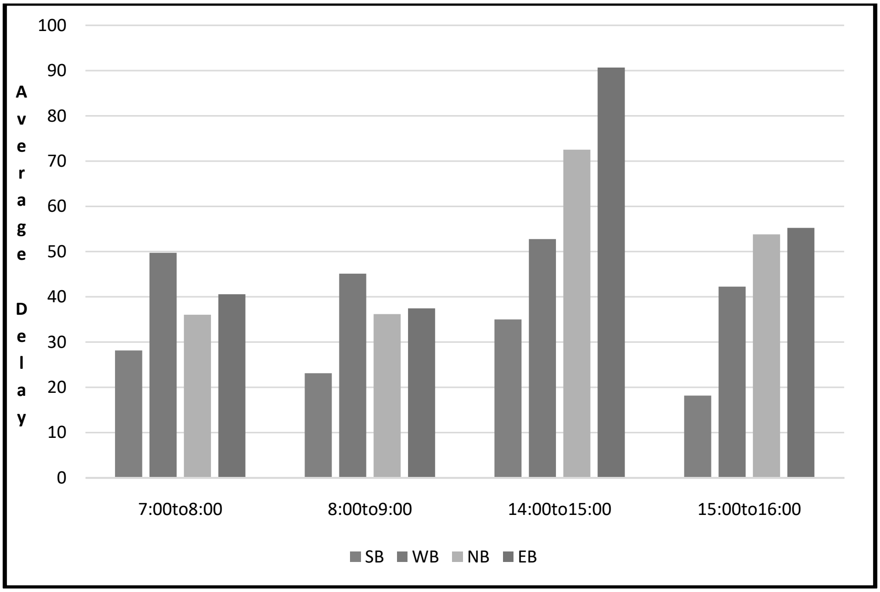

Figure (7): The average delay outputs of alteration No.1 for Baghdad Fair roundabout for vehicle traveling from EB to all Approaches.

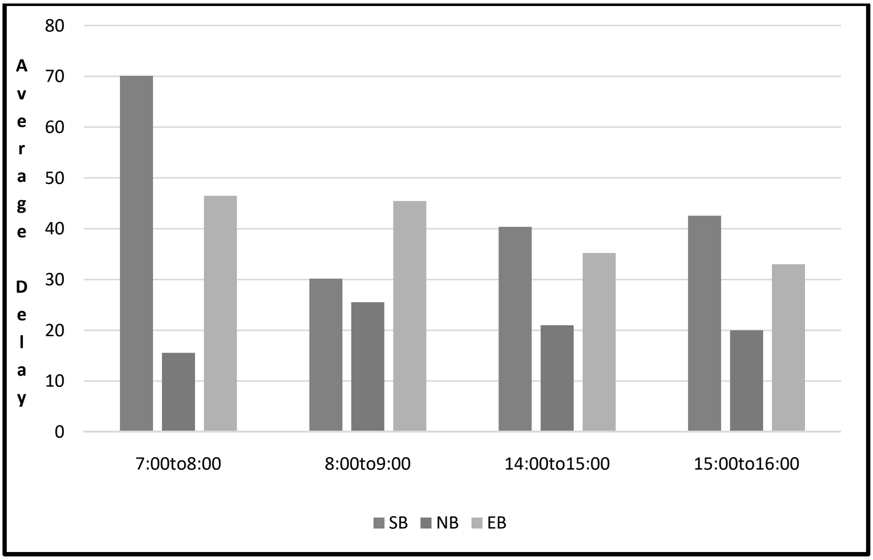

Figure (8): The average delay outputs of alteration No.1 for Baghdad Fair roundabout for vehicle traveling from WB to all Approaches.

Table (4) shows approaches queue length output of alteration No.1 for Baghdad fair roundabout. And by using different cycle time that reduces the delay the queue length is also decrease in all the approaches.

Table (4): Approaches queue length output of alteration No.1 for Baghdad Fair roundabout.

Approach Name	Mean Queue (meter)			
	From 7:00 to 8:00	From 8:00 to 9:00	From 24:00 to 25:00	From 15:00 to 16:00
SB	40.31	45.94	64.53	51.72
NB	64.44	30.72	109.91	120.34
EB right	43.07	34.6	66.85	33.13
WB	4.17	3.23	13.01	78.93
EB left	13.38	20.33	29.98	32.50

4.1.3 Alteration No.2 (Signalized Intersections)

Table (5) shows the output results of VISSIM simulation of Baghdad Fair roundabout as a signalized intersection. From Table (5), it can be concluded that, Baghdad Fair signalized intersection has a (D, D, E, E) level of service in the four hours of mourning and evening peak period which is acceptable level of service but critical in this intersection. This behavior is explained in Figures (9) to (12). It can be observed in Figure (9-12) that the delay value clarifies that average delay from the SB to all approaches is somewhat equal because the traffic flow is mostly traveling in the straight direction toward NB and the vehicles which need to turn left are already on the left lane. This reduces the number of maneuvers and lane change within the intersection area and vice versa. Figure (10) shows that, due to separated right turn lanes toward EB the average delay is much lower than the rest of the other directions. The same observation applies to SB direction in Figure (11) and it also should be noted that, although the U-turn movements of EB have the smallest travel distance, but due to the existence of near Sub Street, a high delay for number of vehicles that U-turn are generating, (HCM,2010), (Appendix D).

Table (6) shows approaches queue length as outputs of alteration No.2 for Baghdad Fair signalized intersection. One of the most important reasons for the contrast in the amount of the queue length between SB approach and other approaches is that, in mourning peak period, a significant number of traffic vehicles about 40% is constrained in SB approach. But at evening peak period, the traffic volume is nearly multiple at and constrained in both NB and SB

Table (5): Mean delay and mean stop delay and average speeds outputs of alteration No.2 for Baghdad Fair roundabout.

Time from	Time to	Mean delay time (sec)	Mean stop time (sec)	Average speeds (km/h)
7:00	8:00	52.79	30.38	13.06
8:00	9:00	50.7	31.11	13.19
14:00	15:00	79.79	50.44	10.63
15:00	16:00	70.09	50.04	11.25

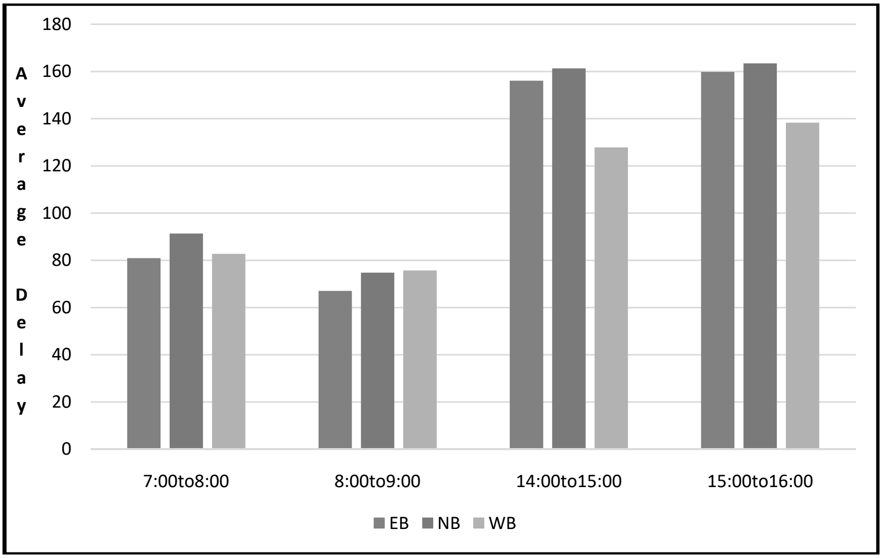

Figure (9): The average delay outputs of alteration No.2 for Baghdad Fair roundabout for vehicle traveling from SB to all approaches.

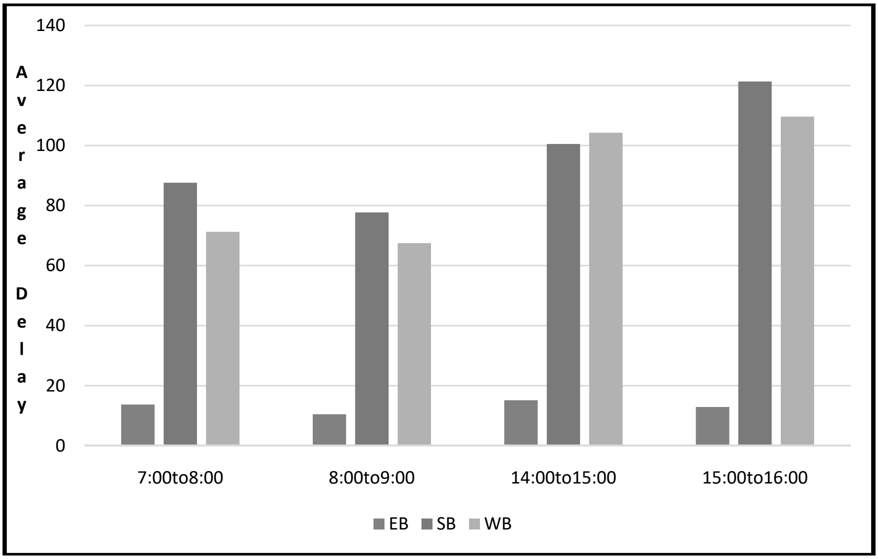

Figure (10): The average delay outputs of alteration NO.2 for Baghdad Fair roundabout for vehicle traveling from NB to all approaches.

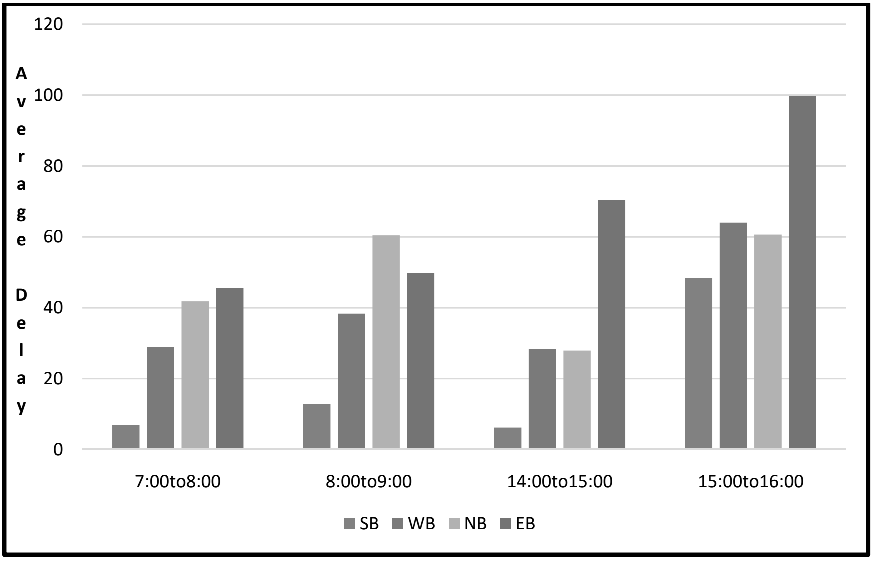

Figure (11): The average delay outputs of alteration No.2 for Baghdad Fair roundabout for vehicle traveling from EB to all approaches.

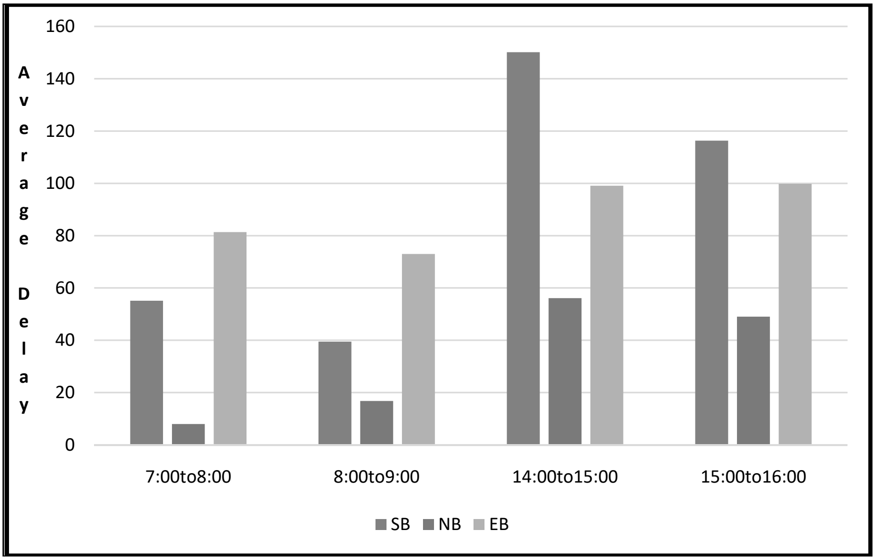

Figure (12): The average delay outputs of alteration NO.2 for Baghdad Fair roundabout for vehicle traveling from WB to all approaches.

Table (6): Approaches queue length outputs of alteration NO.2 for Baghdad Fair roundabout.

Approach Name	Mean Queue (meter)			
	From 7:00 to 8:00	From 8:00 to 9:00	From 24:00 to 25:00	From 15:00 to 16:00
SB	186.77	170.13	217.89	208.44
NB	47	35.52	130..74	150.85
WB	1.04	8.21	66.42	58.51
EB	9.92	20.62	121.68	9.55

4.1.4 Alteration No.3 (meter controlled)

Table (7) shows the output results of VISSIM simulation of Baghdad Fair roundabout as a meter controlled roundabout. From Table (7), it can be observed that, in Baghdad Fair meter controlled roundabout during the morning peak period with traffic volume around 8000 veh/hr (D, B) level of service could be expected but, in the evening peak period and as traffic is hugely increased for more than 13000 veh/hr entering from 4 approaches, the maximum mean delay is 79 seconds and the average speed is 9.8 km/hr and the level of services is (E, D). The behavior of the approaches is explained in Figures (13) to (16). It can be noted that, the installation of traffic signals at the heaviest approach helps in giving some balance in the average delay to the roundabout in which, in the morning peak period all the directions have an acceptable level of service and the highest delay could be seen in vehicles that need to cycle the roundabout and intersect with the heaviest approach (SB) but, in the evening peak period and as the traffic is hugely increased, the delay could reach critical LOS as EB direction has 140.54 sec delay. Table (8) shows approaches queue length as outputs of alteration No.3 for Baghdad Fair roundabout as a meter controlled roundabout. It is only logically expected: that the traffic signals which are set to provide sufficient gaps to cycling traffic could cause long queue length on SB approach especially if the signal is installed on the heaviest approach, as shown in Table (8). But in the second-high queue length in EB it has been created due to different reasons, at 14:00 to 15:00 time period more than 4000 veh/hr depart from EB approach, and most of these vehicles which are generated from this approach need to cycle the roundabout intersect with the heaviest approach (SB) to reach their destination so a long queue could be expected in this approach, (HCM, 2010),.

Table (7): Mean delay and mean stop delay and average speeds outputs of alteration NO.3 for Baghdad Fair roundabout.

Time from	Time to	Mean delay time (sec)	Mean stop time (sec)	Average speeds (km/h)
7:00	8:00	40.33	19.70	14.93
8:00	9:00	31.70	13.97	16.37
14:00	15:00	79.00	39.69	10.24
15:00	16:00	43.15	21.62	14.25

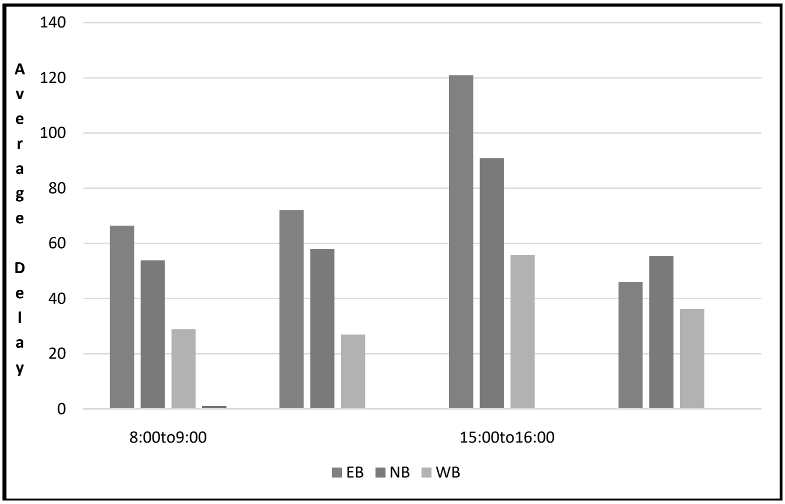

Figure (13): The average delay outputs of alteration No.3 for Baghdad Fair roundabout for vehicle traveling from SB to all approaches.

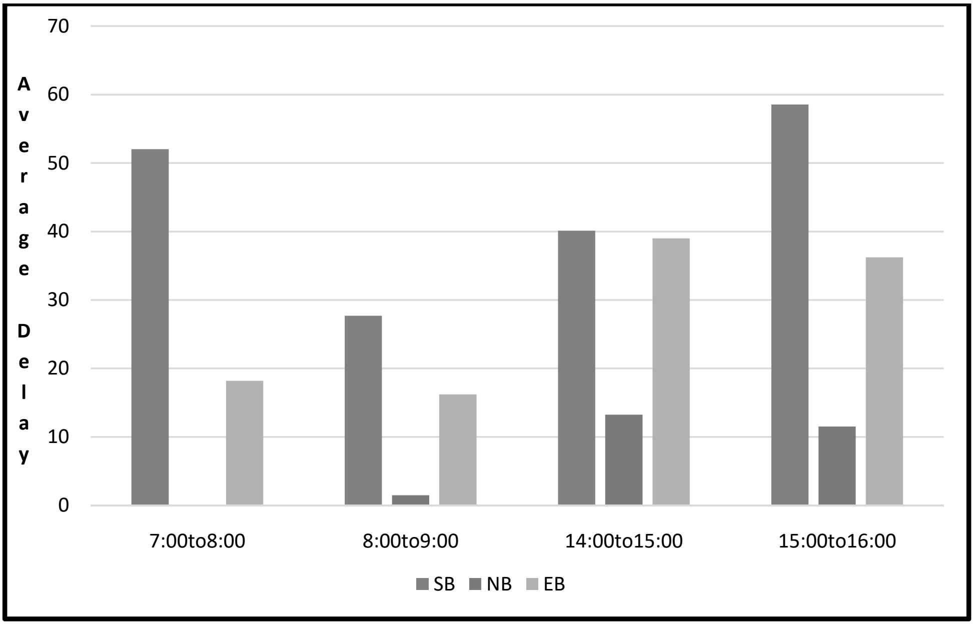

Figure (16): The average delay outputs of alteration No.3 for Baghdad Fair roundabout for vehicle traveling from WB to all approaches.

Table (8): Approaches queue length outputs of alteration NO.3 for Baghdad Fair roundabout

Approach Name	Mean Queue (meter)			
	From 7:00 to 8:00	From 8:00 to 9:00	From 24:00 to 25:00	From 15:00 to 16:00
SB	110.27	115.65	188.73	111.27
NB	2.88	1.34	57.86	56.02
EB	68.98	16.35	218.47	45.72
WB	4.34	0.55	1.32	3.57

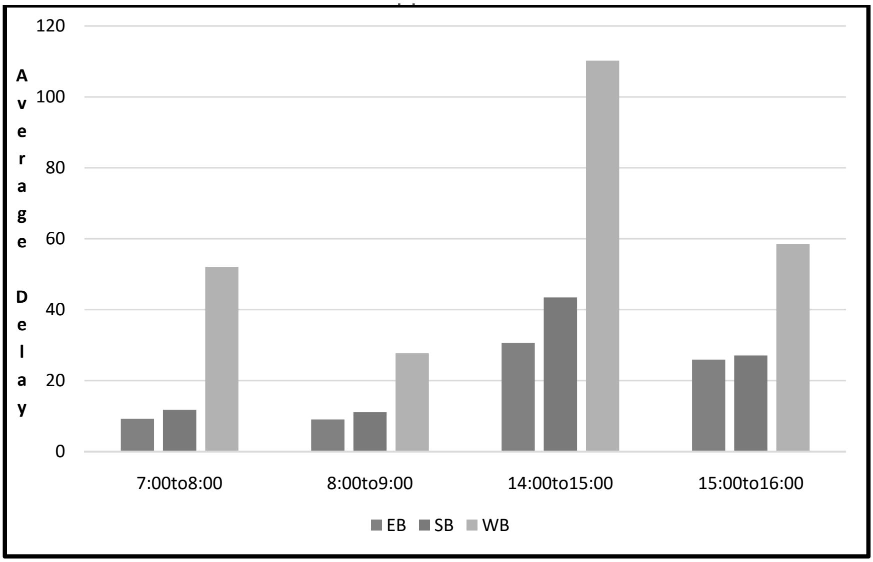

Figure (14): The average delay outputs of alteration No.1 for Baghdad Fair roundabout for vehicle traveling from NB to all approaches.

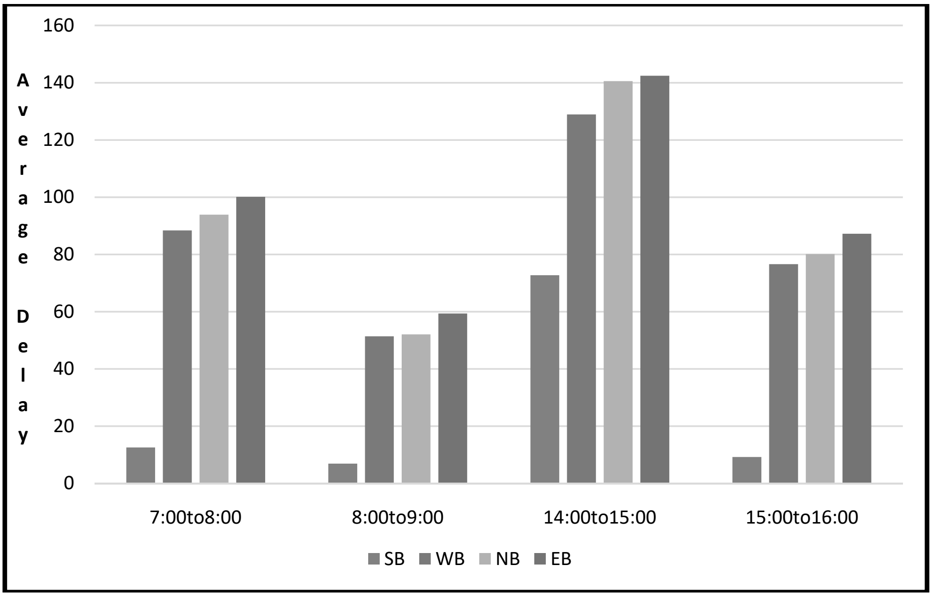

Figure (15): The average delay outputs of alteration No.3 for Baghdad Fair roundabout for vehicle traveling from EB to all approaches.

Comparison

According to Figure (4-53) for Baghdad Fair roundabout, alteration No.3 is better than the original alteration No.1 delay in 75% of time. But when traffic volume increases for more than thirteen thousand vehicles per hour (Appendix A), the No.1 alteration could better handle the roundabout operation than all the other alternatives as a result, to overcome the negative effects of the unbalanced flows in Baghdad fair Roundabout, it is recommended to implement alteration No.1 for this roundabout in the case of fix signal.

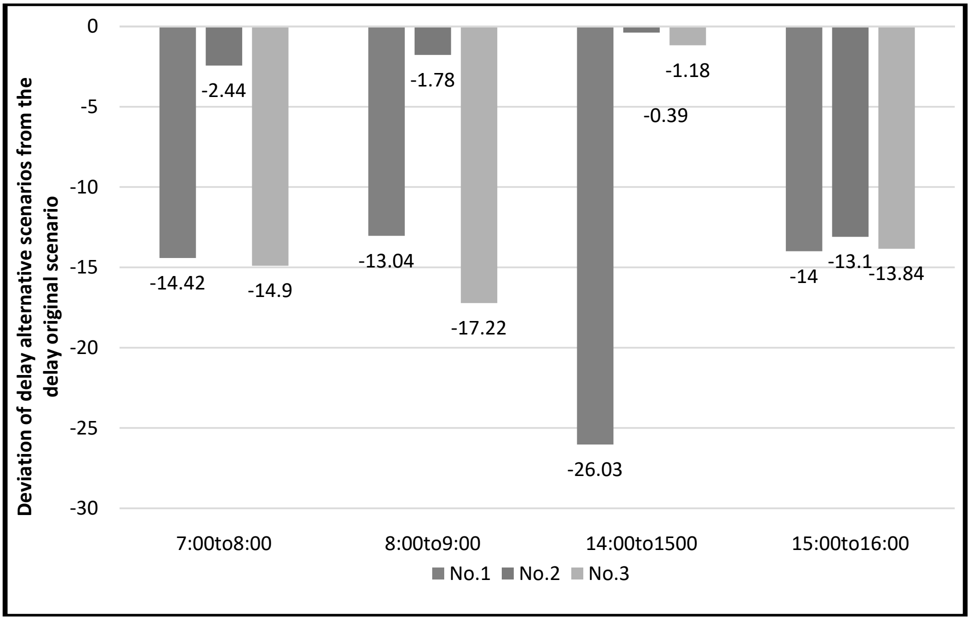

Figure (17): Comparison between original alteration delay and alternative alteration delay for Baghdad Fair roundabout.

5 - CONCLUSIONS

5.1. The phase of data analysis

1. Micro-simulation software VISSIM has the most powerful capability in modeling congested traffic networks in comparison with other simulation techniques. It has the capacity to simulate traffic queuing conditions; therefore, it is more realistic and close to actual traffic conditions.
2. Depending on circulating volumes and the geometric design configuration of many signalized roundabout, the studied roundabouts (Baghdad Fair) have different capabilities to handle traffic, and could have more than 13000 veh/hr with less delay in comparison with other roundabouts (Khilani) which have only maximum volume of 6000 veh/hr.
3. The best signalized roundabout configuration and design could be found in Baghdad Fair signalized roundabout, in which the direct path between SB and NB has the ability of highly decreasing the volume of circulating vehicles.
4. It has been found out that, the best suggested scenario for the studied roundabouts (signalized roundabout, signalized intersection and meter roundabout) that could handle the current traffic volumes of all the studied roundabouts is the signalized roundabout scenario with optimum cycling time.
5. It can be concluded that, if the heaviest approach volume has more than 40% of the total roundabout volume: the meter roundabout scenario (signalize the heaviest volume approach only) could be the best control mode that provides the best performance.
6. The use of suitable configuration that could reduce the circulating flow is very important to enhance the performance and reduce the delay.
7. In Baghdad Fair signalized roundabout and from observed simulation results, the best location for an over pass or under pass is to link the SB with NS this improvement can reduce the delay of the entire roundabout at peak hour by 23%.

5.2 Recommendations for Further Works

The following subjects can be suggested for future studies:

1. The effects of converting other roundabouts in Baghdad from unsignalized to signalized roundabouts.
2. Sensitivity of roundabout delay estimates in relation to geometric features.
3. The effect of signalized roundabout on safety in Baghdad city
4. Conducting a study to find which improvement measure is the best, traffic signal or a flyover bridge to resolve congestion at roundabout intersections.

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