Enhancement of the Traffic Operation Performance of Al-Mansour Signalized T-Intersection in Baghdad City

Assit.Lecturer Mahmood Khalid Jumaah Al-Obaidi
Al-Farabi University College, Baghdad, Iraq.
E-mail:Eng_mahmood_k@yahoo.com

Abstract

The vehicles traffic volume has been increasing rapidly over last years in Iraq especially in central business districts (CBD) in Baghdad city. The increasing results in growing of congestion level, environmental pollution and time wasted during travel especially at the intersection points. The objectives of the study are evaluating the existing level of service (LOS) at Al-Mansour signalized T-intersection in Baghdad city and improving traffic performance by estimating the best alternatives to increase the traffic capacity of intersection. The traffic volume data were collected manually by group of engineers based on traffic operation of policeman. Assessment of existing intersection at study area is considered using HCS software (2010), also AutoCAD (2017) for display of all existing and proposal layouts. Study results showed that Al-Mansour Intersection currently behaves serious deterioration causing forced conditions LOS "F" with delay of 221.6 s/veh, therefore; instantaneous solutions is to be considered concerning the upgrading of serviceability based on trying many proposals considering the signal timing and geometrical changes with required number of lanes and phases. It showed that a suitable choice is to construct a tunnel (1 lane / direction) along 14-Ramadhan street with actuating two phases giving LOS "B" and delay of 11.1 s/veh.

Keywords: Traffic volume, LOS, PHF, signalized intersection, control delay

1. Introduction

An intersection is an area where join or cross at grade two or more roads, within which are contained the right of way of facilities for the movements of the traffic in that area. Each road is branched from an intersection making part of an intersection leg [7].
Another study defined the intersection as an area, composed of many roads which principal objective is to produce the variation in route direction. Intersections vary in their geometrical designs from a simple type, which has only two roads intersecting at a right angle to the most complex one, where three roads or more crossed in the same area [2].

Many studies have been found to solve problems of signalized congested intersections. The objective of the first study contains the assessment LOS and traffic operation of AL-Qudus signalized intersection in Baghdad city. The location of intersection is in a heavy traffic volume area where there are a lot of attractions near to the study area. All required traffic and geometrical data are gathered by many observers to evaluate the distribution of traffic in different directions. (HCS 2000) software are used to get the requirements of traffic analysis. It is found that the intersection is affected by many problems, the most of them is suffering from a high traffic load that lead to weakening the LOS to "F" with delay of 328.7 s/veh causes the traffic congestions; therefor some alternatives to be considered for improving the operation of this intersection. Several solutions in this study based on (O-D) planning studies due to considering of construction a new express and distributor roads that leads to decreasing the congestion traffic on AL-Qudus intersection [5].

Capacity and LOS are the main points of the intersections analysis and should be indicated in order to assess the generally operator of this facility. The objectives of this study include the assessment and development of the operation performance for AL-Mustanseriyah Intersection in Baghdad city and to choose the best alternative to support that performance. In order to accomplish these objectives, the estimated geometrical and traffic data in all movement directions to be needed were collected by many observers, while (HCS2000) is used for traffic analysis process. It has been recommended that the flyover between Al-Mustanseriyah University Street and Al-Talebia Street is the best alternative to develop the operation performance of Al-Mustainseriya roundabout Intersection [3].

Another study includes the assessment LOS and traffic operation of AL-Kafa'at signalized intersection in AL-Kut city. The location of intersection is in a heavy traffic volume area where there are a lot of attractions near to the study area. Geometrical data required are gathered manually by many observers, while traffic data are gathered using digital camera to evaluate the distribution of traffic in different directions. (HCS 2000) software are used to get the requirements of traffic analysis. It is found that the intersection is affected by many problems, the most of them is suffering from a high traffic load that lead to weakening the LOS to "F" with delay value of 105.1 s/veh causes the traffic congestions; therefor some alternatives to be considered for improving the operation of this intersection. Because of the reasons

above, it is important to enhance the performance of AL-Kafa'at Intersection by increasing the number of lanes to the right turn for Alhaidariya Approach. The results indicate that the intersection LOS is hanged to "D" with a cycle time of 91 sec and an intersection delay of 38.1 s/veh [1].

The purpose of this study is to assess and to improve the performance of the traffic operation at Al-Mansour signalized intersection in Baghdad. The study of the facility life has been achieved for assessing of existing serviceability at the present time and during the estimated future period.

2. Theoretical Background

The intersection is required to simplify traffic movements which result in minimization of the delay. This is done by chooses of the best geometric features that control the vehicle directions in the intersection. These precise priority so that all traffic directions occur with approximately fully safe. Each kinds of intersections aim to provide attention for vehicle drivers in a road section that will prevent confusion. The need for most driving flexibility needs the choice of best kind of intersections. Method of selection needs economical, environmental and operational effect on each suggested option assessed [8].

Three important factors of effectiveness are commonly used to assess the operation of signalized intersection: Capacity, volume-to-capacity (v/c) and delays. Capacity is a maximum volume for vehicles that pass on a given section during an hour under different prevailing conditions; its estimation by using HCS depended on initial hypothesized values for traffic flow saturation, then it would be corrected to simulate the realistic conditions. Capacity considered for highway conditions like the number of lanes, width of lane, grades, and the purpose of lane use, also, the evaluations of signalization. According to the procedure of highway capacity manual (HCM2000), capacity is assessed for critical lane groups, which require the highest amount of the green interval. The v/c ratios are depended on critical and non-critical lane groups that do not affect the traffic signal operation. It, also confirm to as traffic saturation degree, refers to the adequacy of the facility to be suitable for the demand of vehicles. A percent under 85% refers that enough capacity is to be found and expecting of vehicles are not estimation influencing queues, as well as; delays. When it approaches 100%, current traffic volume may be close to unstable condition, delay leads to make queuing case. While, if it to be more than 100%, volume is absolutely be in an unstable case

where superfluous delay occur which results in queuing case. According to all stated cases, vehicles aim to take more than one cycle of signal to cross the intersection which is called a failure of signal cycle [2].

Delay is the important key factors which is used in the optimization of stopped delay and other which associated with accelerating from a stop. Delay can be quantified in different ways. The most frequently used forms are stopped time delay, approach delay and travel time delay. Its values can be slightly different based on the cases at signalized intersection. **Fig. 1** expresses the differences among stopped time, approach and travel time delays for a vehicle crossing a signalized intersection. The required pathway of it, also the real successive of a vehicle, which contains a stop at a red time [6].

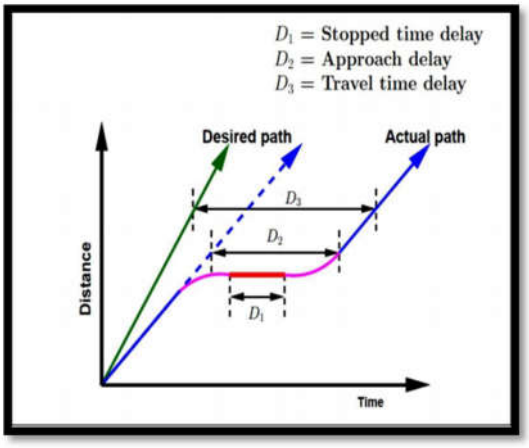


Fig. 1 Illustration of Delay Assessments (McShane, 2004)

timings of traffic signals. In addition, it is an important element in estimation LOS required to drivers at signalized intersections. It, also, is a factor that is inapproachable to be assessed because of containing delay related to decelerating to a stop, the

The experiencing of delays on the signalized arterials are mainline related to intersections where conflict directions are segregated and controlled by signals of traffic. It can operates at the disposal of a strategy of isolated control with the signal places of each signal set beyond to that of alignment signals. Delay is known as the variation in travel time when a vehicle is affected and unaffected by controlled intersection. It contains time that is loosed because of deceleration, acceleration and stopped delay. Hence, delay at intersection are directed toward evaluating total delay or simply stopped delay [6].

Control delay for the straight direction of vehicles is the proper one to know in assessment of an urban road. **Equation (1)** is used to compute the control delay. **Equations (2)** and **(3)** are shown to define the uniform and incremental delays, respectively according to (HCM2010):

Where,

$$d = d1(PF) + d2 + d3 \qquad (1)$$

$$d_1 = \frac{0.5C\left(1-\left(\frac{g}{C}\right)^2\right)}{1-\left[\frac{\min(1,X)g}{c}\right]} \quad (2)$$

$$d_2 = 900T(X-1) + \sqrt{(X-1)^2} + \frac{8KIX}{cT} \quad (3)$$

d = control delay (sec/veh);
d_1 = uniform delay (sec/veh);
d_2 = incremental delay (sec/veh);
k = adjustment for incremental delay for the actuated control; and
I = adjustment of incremental delay for the metering or filtering by Signals of upstream.

3. Study Area

Al-Mansour signalized intersection is one of the most important intersections which lies in the capital Baghdad in "Al-Karkh". It connects between Al-Mansour and 14th-Ramadhan Streets. The reason to choose it in this study is related to its significant and an important location near to center of Baghdad city. Furthermore, the existing of different public facilities and movements of mini buses resulted in a highly volume that cause delays especially at peak hour. **Fig. 2** illustrates the study area and main details by the GOOGLE MAPS.

d_3 = initial queue delay (sec/veh);
PF = progression adjustment factor;
C = cycle length (sec);
c = capacity of lane group (veh/hr);
X = ratio of v/c for the lane group (also termed Saturation degree);
g = effective green interval for lane group (sec);
T = duration of analysis interval (hr);

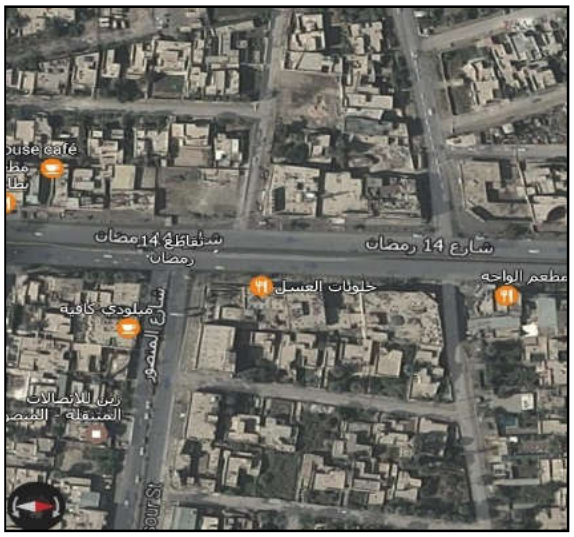


Fig. 2 Satellite image of the study area

4. Collecting of Traffic Data

To evaluate the traffic operation performance of intersection, field data containing volumes of the traffic should be gathered. Data collecting were gathered manually by many observers during the days of work, where the largest congestion, as well as; inadequate use of transportation take place at hours where flow is high.

The traffic volume data of intersection were collected (based on the evaluating of traffic policeman to vehicles movement since breaking down of traffic signals) at 2017 during different workdays distributed on the two months March and April for three times per day, [(7:00 - 9:00 A.M), (1:00 - 3:00 P.M) and (5:00 - 8:00 P.M)] as shown in **Table. 1**. Also, suddenly interviews are considered with interested people like traffic policemen, pedestrians and drivers of the road to help in selection of peak hour period. It is well known in most of traffic studies for evaluating and enhancement of the existing intersection, the following data as shown in **Tables. 1, 2** and **3** are needed:

- V (veh/hrs.): Demand volume by movement
- PHF: Peak-Hour Factor
- Hv (%): Percent of heavy vehicles

Vehicles are divided into small size which any of them moves on four tires contains passenger cars and mini buses, also large size which any of them moves on more than four tires.

Table. 1 Traffic Data Collected From Al-Mansour Street

From Al-Mansour Street	A.M		P.M				
	7:00-8:00	8:00-9:00	1:00-2:00	2:00-300	5:00-6:00	6:00-7:00	7:00-8:00
R (pcph)	76	92	127	100	52	70	58
R_{Hv} (vph)	5	3	0	0	0	0	0
R_{Hv} (%)	6.173	3.158	0	0	0	0	0
PHF	0.808	0.735	0.756	0.807	0.500	0.670	0.692
L (pcph)	78	44	96	83	170	291	187
L_{Hv} (vph)	6	0	0	0	3	0	0
L_{Hv} (%)	7.143	0	0	0	1.734	0	0
PHF	0.750	0.794	0.750	0.769	0.796	0.700	0.715

Table. 2 Traffic Data Collected From Al-Yarmuk Intersection

From AL-Yarmuk Int.	A.M		P.M				
	7:00-8:00	8:00-9:00	1:00-2:00	2:00-300	5:00-6:00	6:00-7:00	7:00-8:00
R (pcph)	161	122	141	191	293	586	492
R_{Hv} (vph)	0	0	0	0	0	0	0
R_{Hv} (%)	0	0	0	0	0	0	0
PHF	0.660	0.782	0.690	0.770	0.49	0.870	0.830
TH (pcph)	174	102	180	158	316	426	372

TH_{Hv} (vph)	0	0	0	0	0	0	0
TH_{Hv} (%)	0	0	0	0	0	0	0
PHF	0.790	0.670	0.738	0.580	0.850	0.840	0.795

Table. 3 Traffic Data Collected From 14th-Ramadhan Intersection

From 14th-Ramadhan Int.	**A.M**		**P.M**				
	7:00-8:00	**8:00-9:00**	**1:00-2:00**	**2:00-300**	**5:00-6:00**	**6:00-7:00**	**7:00-8:00**
TH (pcph)	59	83	124	89	123	287	243
TH_{Hv} (vph)	4	2	0	0	0	0	0
TH_{Hv} (%)	7.018	2.353	0	0	0	0	0
PHF	0.641	0.694	0.775	0.670	0.702	0.740	0.712
L (pcph)	24	58	59	67	459	606	594
L_{Hv} (vph)	0	0	0	0	0	0	0
L_{Hv} (%)	0	0	0	0	0	0	0
PHF	0.461	0.604	0.702	0.670	0.755	0.860	0.820

5. Analysis and Results

An excel sheet was prepared for analyzing the traffic data as shown in **Table 1** previously to appoint the peak hour. From the traffic accounts of the field survey, time interval of [(6:00 - 7:00 P.M)] were suggested to be the peak hour at the intersection. Summation of the traffic flows during this hour were 2266 vph as shown in **Fig. 3**.

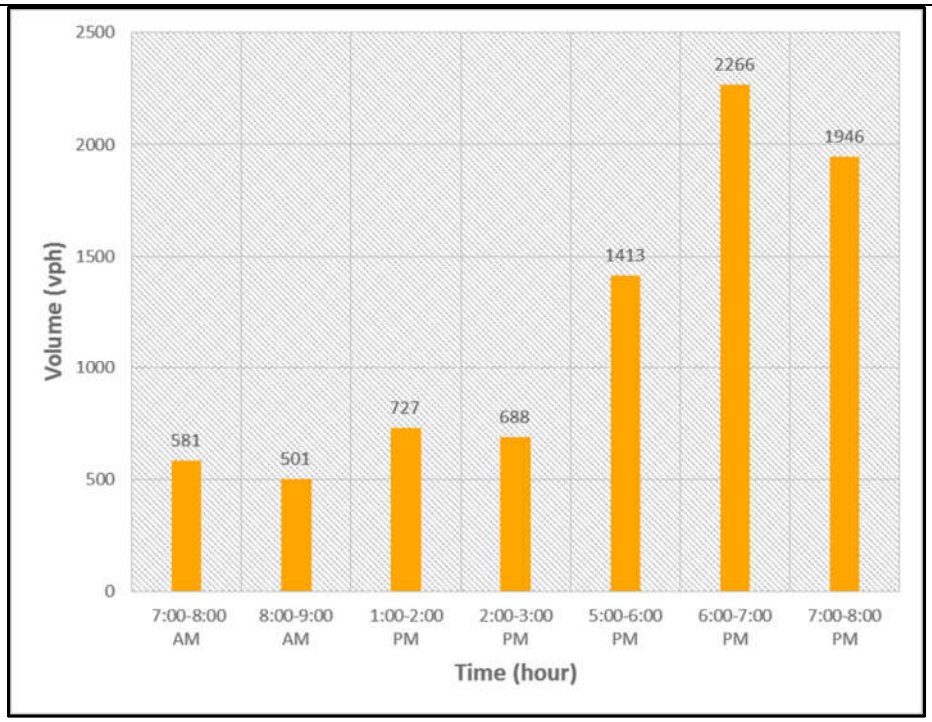
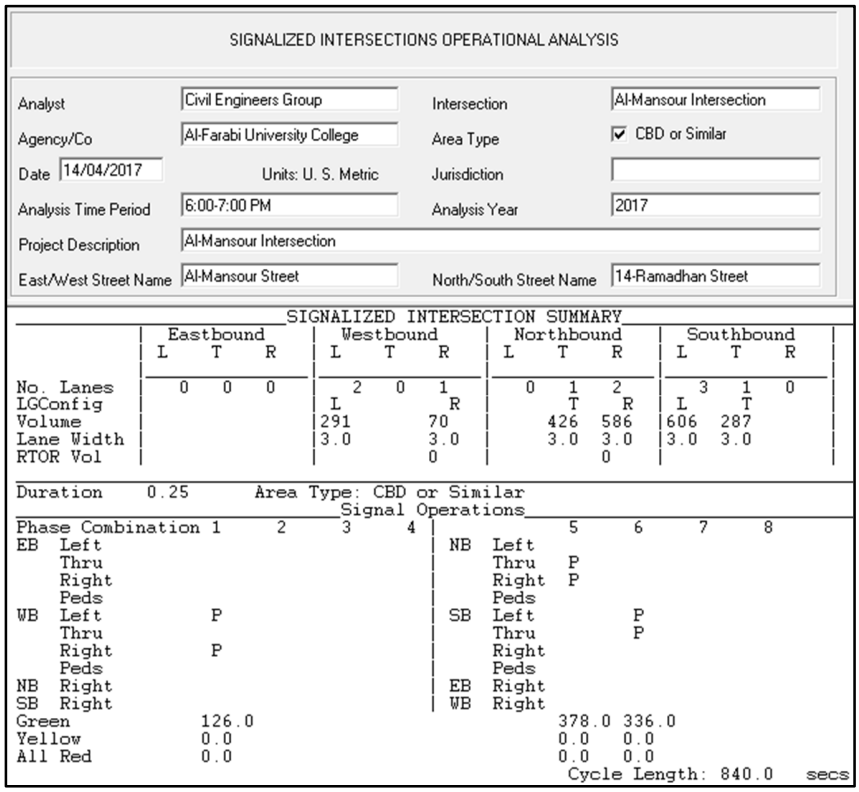


Fig. 3 Traffic Data of Al-Mansour Intersection

5.1 Evaluation of Existing LOS

The traffic data of existing intersection has been assessed on April 14, 2017 using HCS software (2010) as shown in **Fig. 4**. Since the Traffic signals were broken down during the interval of data collection, cycle length was assessed based on evaluation of the traffic policeman to the movement of vehicles during peak hour. The evaluation depended on actuating 3-phases (phase per approach). The cycle length at peak hour was 840 seconds distributed on all phases of approaches as shown in **Fig. 4**. Traffic volume data within cycle length has been analyzed, results give the LOS "F" with a delay of 221.6 sec/veh as shown in **Table. 4**. The geometric layout using AutoCAD software (2017) is as shown in **Fig. 5**.



SIGNALIZED INTERSECTIONS OPERATIONAL ANALYSIS

Analyst	Civil Engineers Group	Intersection	Al-Mansour Intersection
Agency/Co	Al-Farabi University College	Area Type	☑ CBD or Similar
Date	14/04/2017	Units: U. S. Metric	Jurisdiction	
Analysis Time Period	6:00-7:00 PM	Analysis Year	2017
Project Description	Al-Mansour Intersection		
East/West Street Name	Al-Mansour Street	North/South Street Name	14-Ramadhan Street

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	0	0	2	0	1	0	1	2	3	1	0
LGConfig				L		R		T	R	L	T	
Volume				291		70		426	586	606	287	
Lane Width				3.0		3.0		3.0	3.0	3.0	3.0	
RTOR Vol						0			0			

Duration 0.25 Area Type: CBD or Similar

Signal Operations

Phase Combination	1	2	3	4	5	6	7	8
EB Left					NB Left			
Thru					Thru	P		
Right					Right	P		
Peds					Peds			
WB Left		P			SB Left		P	
Thru					Thru		P	
Right		P			Right			
Peds					Peds			
NB Right					EB Right			
SB Right					WB Right			
Green		126.0				378.0	336.0	
Yellow		0.0				0.0	0.0	
All Red		0.0				0.0	0.0	

Cycle Length: 840.0 secs

Fig. 4 Operation Analysis of Existing LOS by (HCS2010)

Table. 4 Intersection Delay of Existing LOS by (HCS2010)

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound								
Westbound								
L	442	2944	0.94	0.15	383.7	F	374.4	F
R	204	1357	0.49	0.15	335.7	F		
Northbound								
T	718	1596	0.71	0.45	192.0	F	184.8	F
R	1080	2401	0.62	0.45	179.4	F		
Southbound								
L	1652	4130	0.50	0.40	189.7	F		
T	638	1596	0.52	0.40	194.3	F	191.0	F

Intersection Delay = 221.6 (sec/veh) Intersection LOS = F

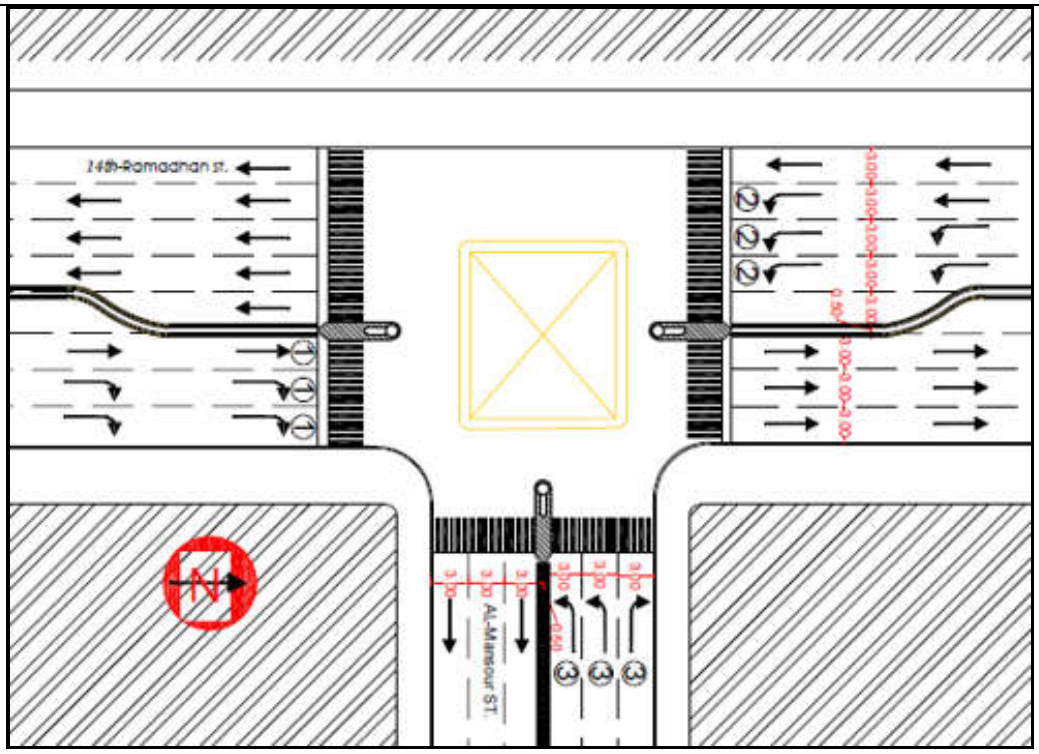


Fig. 5 Geometric Layout of Existing LOS and First Proposal

5.2 Proposal Design Alternatives

5.2.1 Design of Traffic Signal Timing

Two proposals of traffic signal timing design were suggested: The first proposal is to optimize the existing data using HCS software, the traffic signals are designed to be actuated on 3-phases with suggestions of design cycle length (more than or equal 30 seconds and less than or equal 120 seconds). Results give optimum cycle length of 100 seconds as shown in **Fig. 6**. In addition, it give the level of service "D" with a delay of 37.1 sec/veh as shown in **Table. 5**. The geometric layout of this proposal is as shown as in **Fig. 5**, previously. The carry out of this alternative will give a lower enhancement on the LOS, so; the second proposal was suggested.

The second proposal is to optimize the existing data using HCS software as shown in **Fig. 7**, the traffic signals are designed to be actuated on 3-phases too, but an exclusive right lanes are suggested for the vehicles travelling from Al-Yarmuk intersection towards Al-Mansour street and From Al-Mansour street towards 14-Ramadhan intersection. Design cycle length

(more than or equal 30 seconds and less than or equal 120 seconds) has been suggested too. Results give optimum cycle length of 70 seconds as shown in **Fig. 7**. In addition, it give level of service "C" with a delay of 24.8 sec/veh as shown in **Table. 6**. The geometric layout of this proposal is as shown as in **Fig. 8**.

This proposal is good for execution, but for more enhancing of the traffic operation, another two proposals were suggested concerning re-design of the geometric features of the intersection in addition to the traffic signal timing.

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	0	0	2	0	1	0	1	2	3	1	0
LGConfig				L		R		T	R	L	T	
Volume				291		70		426	586	606	287	
Lane Width				3.0		3.0		3.0	3.0	3.0	3.0	
RTOR Vol						0			0			

Duration 0.25 Area Type: CBD or Similar

Signal Operations

Phase Combination	1	2	3	4	5	6	7	8
EB Left					NB Left			
Thru					Thru	P		
Right					Right	P		
Peds					Peds			
WB Left		P			SB Left		P	
Thru					Thru		P	
Right		P			Right			
Peds					Peds			
NB Right					EB Right			
SB Right					WB Right			
Green		21.2				38.4	28.4	
Yellow		4.0				4.0	4.0	
All Red		0.0				0.0	0.0	

Cycle Length: 100.0 secs

Fig. 6 Operation Analysis of the First Proposal by (HCS2010)

Table. 5 Intersection Delay and LOS of the First Proposal by (HCS2010)

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
Westbound								
L	624	2944	0.67	0.21	41.7	D		
							40.8	D
R	288	1357	0.35	0.21	36.8	D		
Northbound								
T	613	1596	0.83	0.38	40.0	D	35.1	D
R	922	2401	0.73	0.38	31.5	C		
Southbound								
L	1173	4130	0.70	0.28	35.4	D		
T	453	1596	0.74	0.28	42.7	D	37.5	D

Intersection Delay = 37.1 (sec/veh) Intersection LOS = D

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	0	0	2	0	0	0	2	0	3	0	0
LGConfig				L				T		L		
Volume				291				426		606		
Lane Width				3.0				3.0		3.0		
RTOR Vol												

Duration 0.25 Area Type: CBD or Similar

Signal Operations

Phase Combination	1	2	3	4	5	6	7	8
EB Left					NB Left			
Thru					Thru	P		
Right					Right			
Peds					Peds			
WB Left		P			SB Left		P	
Thru					Thru			
Right					Right			
Peds					Peds			
NB Right					EB Right			
SB Right					WB Right			
Green		17.9				18.3	21.8	
Yellow		4.0				4.0	4.0	
All Red		0.0				0.0	0.0	

Cycle Length: 70.0 secs

Fig. 7 Operation Analysis of the Second Proposal by (HCS2010)

Table. 6 Intersection Delay and LOS of the Second Proposal by (HCS2010)

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
Westbound								
L	753	2944	0.55	0.26	25.5	C		
							25.5	C
Northbound								
T	794	3039	0.64	0.26	26.8	C	26.8	C
Southbound								
L	1286	4130	0.64	0.31	23.1	C		
							23.1	C

Intersection Delay = 24.8 (sec/veh) Intersection LOS = C

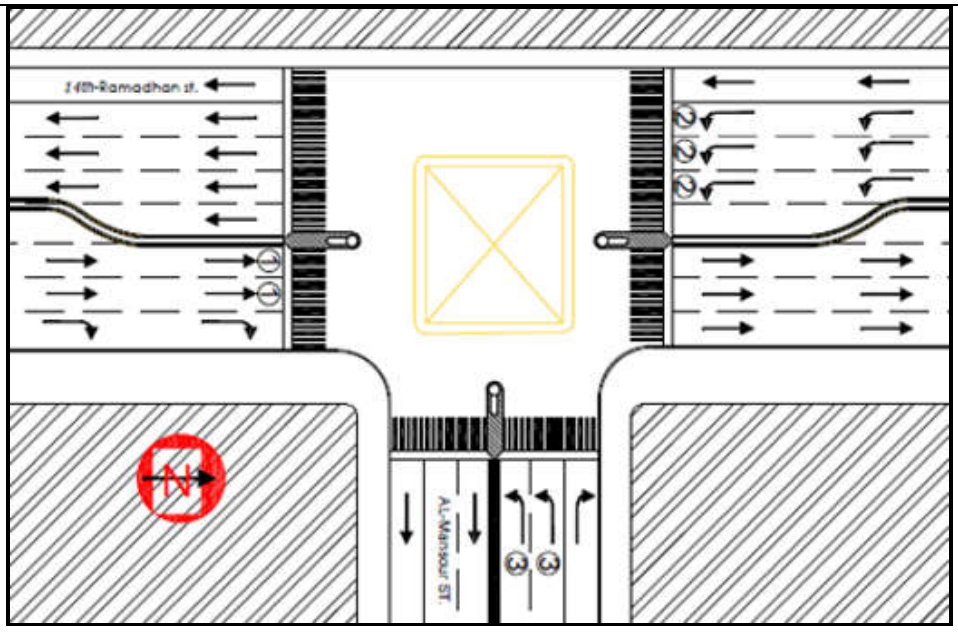


Fig. 8 Geometric Layout of the Second Proposal

5.2.2 Re-design of Geometric Features with Traffic Signal Timing

Two proposals related to change of the geometric features with traffic signal timing were suggested: The first proposal is assumed to construct underpass system (Tunnel) along the centerline of 14-Ramadhan street in two directions (one lane per direction). One of the most important reasons to choose underpass system instead of overpass system is due to aesthetical of the study area. After optimizing the existing data using HCS software, the traffic signals are designed to be actuated on 3-phases with suggestions of design cycle length (more than or equal 30 seconds and less than or equal 120 seconds). Results give optimum cycle length of 70 seconds as shown in **Fig. 9**. In addition, it give the level of service "D" with a delay of 36.5 sec/veh as shown in **Table. 7**. The geometric layout of this proposal is as shown as in **Fig. 10**. So, carry out of this alternative leads to a little enhancement on the LOS with considering the cost of construction, therefore; the other proposal was achieved.

The second proposal is divided into two assumptions, both of them are assumed to construct underpass system (Tunnel) along the centerline of 14-Ramadhan street in two directions, the first includes (one lane per direction), while the second includes (two lanes per direction). After optimizing the existing data using HCS software, the traffic signals are designed to be actuated on 2-

phases (phase number one for vehicles traveling from Al-Yarmuk intersection and Al-Mansour street and phase number two for vehicles traveling from 14-Ramadhan intersection) with suggestions of design cycle length (more than or equal 30 seconds and less than or equal 120 seconds). Results give optimum cycle length of 50 seconds for both of them as shown in **Fig. 11** and **12**. In the same time, it give the level of service "B" with a delay of 14 and 11.1 sec/veh respectively as shown in **Table. 8** and **9**. So, the second choice which includes (one lane per direction) is better than the first due to the same development on the level of service considering the lower cost of construction. The geometric layout of this proposal is shown in **Fig. 13**.

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	0	0	2	0	1	0	1	2	2	1	0
LGConfig				L		R		TR	R	L	LT	
Volume				291		70	0		586	606	0	
Lane Width				3.0		3.0	3.0		2.5	3.0	2.5	
RTOR Vol						0			0			

Duration 0.25 Area Type: CBD or Similar

Signal Operations

Phase Combination	1	2	3	4	5	6	7	8
EB Left					NB Left			
Thru					Thru	P		
Right					Right	P		
Peds					Peds			
WB Left		P			SB Left		P	
Thru					Thru		P	
Right		P			Right			
Peds					Peds			
NB Right					EB Right			
SB Right					WB Right			
Green		11.5				22.9	23.6	
Yellow		4.0				4.0	4.0	
All Red		0.0				0.0	0.0	

Cycle Length: 70.0 secs

Fig. 9 Operation Analysis of the First Re-Design Proposal by (HCS2010)

Table. 7 Intersection Delay and LOS of the First Re-Design Proposal by (HCS2010)

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
Westbound								
L	484	2944	0.86	0.16	46.2	D	43.6	D
R	223	1357	0.45	0.16	32.8	C		
Northbound								
TR	522	1596	0.00	0.33	15.8	B	40.1	D
R	739	2258	0.91	0.33	40.1	D		
Southbound								
L	993	2944	0.82	0.34	29.1	C		
LT	506	1501	0.00	0.34	15.4	B	29.1	C

Intersection Delay = 36.5 (sec/veh) Intersection LOS = D

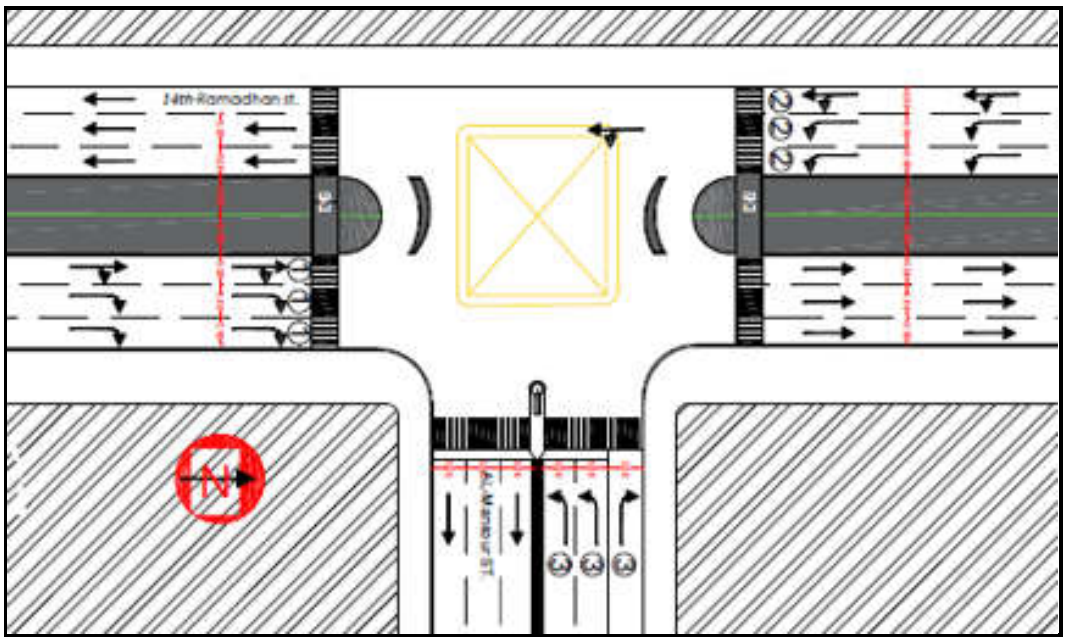


Fig. 10 Geometric Layout of the Second Re-Design Proposal

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	0	0	2	0	1	0	0	2	2	0	0
LGConfig				L		R			R	L		
Volume				291		70			586	606		
Lane Width				3.0		3.0			2.5	3.0		
RTOR Vol						0			0			

Duration 0.25 Area Type: CBD or Similar

Signal Operations

Phase Combination	1	2	3	4	5	6	7	8
EB Left					NB Left			
Thru					Thru			
Right					Right			
Peds					Peds			
WB Left	P				SB Left	P		
Thru					Thru			
Right	P				Right			
Peds					Peds			
NB Right	P				EB Right			
SB Right					WB Right			
Green	21.4				20.6			
Yellow	4.0				4.0			
All Red	0.0				0.0			

Cycle Length: 50.0 secs

Fig. 11 Operation Analysis of the First Re-Design Proposal (2 ln/Dir.) by (HCS2010)

Table. 8 Intersection Delay and LOS of the First Re-Design Proposal (2 ln/Dir.) by (HCS2010)

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
Westbound								
L	1260	2944	0.33	0.43	10.2	B		
							10.1	B
R	581	1357	0.17	0.43	9.5	A		
Northbound								
							15.8	B
R	966	2258	0.70	0.43	15.8	B		
Southbound								
L	1213	2944	0.68	0.41	15.0	B		
							15.0	B

Intersection Delay = 14.0 (sec/veh) Intersection LOS = B

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	0	0	0	2	0	1	0	0	3	3	0	0
LGConfig				L		R			R	L		
Volume				291		70			586	606		
Lane Width				3.0		3.0			2.5	3.0		
RTOR Vol						0			0			

Duration 0.25 Area Type: CBD or Similar

Signal Operations

Phase Combination	1	2	3	4		5	6	7	8
EB Left					NB Left				
Thru					Thru				
Right					Right				
Peds					Peds				
WB Left		P			SB Left	P			
Thru					Thru				
Right		P			Right				
Peds					Peds				
NB Right		P			EB Right				
SB Right					WB Right				
Green		21.4				20.6			
Yellow		4.0				4.0			
All Red		0.0				0.0			

Cycle Length: 50.0 secs

Fig. 12 Operation Analysis of the Second Re-Design Proposal (1 ln/Dir.) by (HCS2010)

Table. 9 Intersection Delay and LOS of the Second Re-Design Proposal (1 ln/Dir.) by (HCS2010)

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
Westbound								
L	1260	2944	0.33	0.43	10.2	B		
							10.1	B
R	581	1357	0.17	0.43	9.5	A		
Northbound								
							11.1	B
R	1487	3475	0.45	0.43	11.1	B		
Southbound								
L	1702	4130	0.48	0.41	11.8	B		
							11.8	B

Intersection Delay = 11.1 (sec/veh) Intersection LOS = B

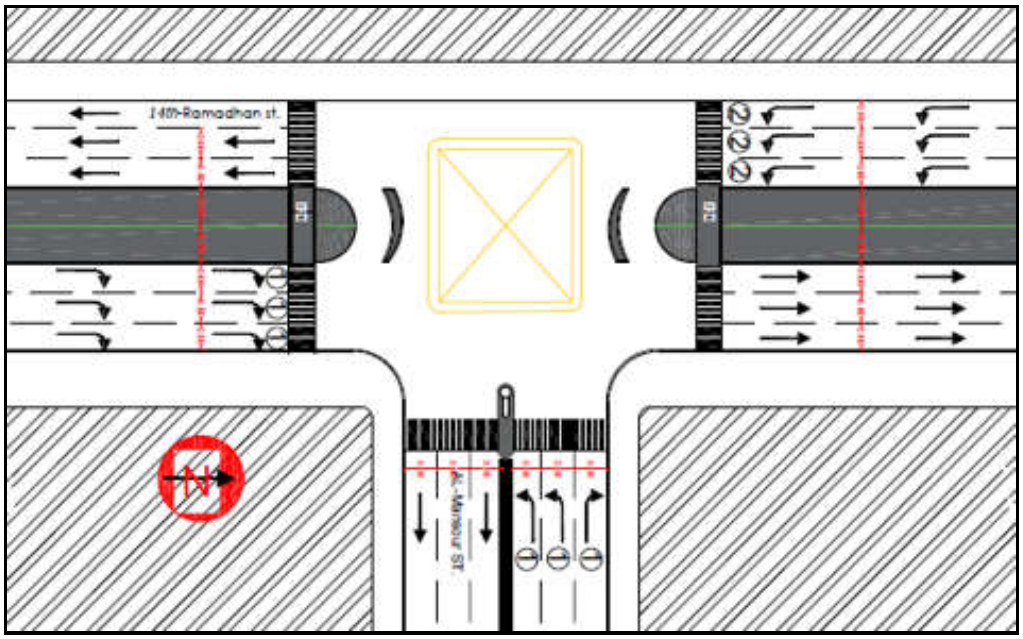


Fig. 13 Geometric Layout of the Second Re-Design Proposal

5.3 Analysis of Future Data

Predicted data has been analyzed using HCS software by calculation of traffic capacity, delay and LOS for all intersection approaches. As compared to the previous alternatives, the second Re-Design proposal has been taken in consideration for checking the predicted interval of the traffic capacity to be in saturation case. This proposal consists of construction the tunnel in two directions (one lane per direction) and the traffic signals are designed to be actuated on 2-phases as mentioned previously. Results showed that the saturation capacity will be occurred after 8 years later according to 3.5% of annual traffic growth rate as comply with [4], where the LOS and delay are "E" and 57.9 sec/veh respectively as shown in **Table. 10**.

Table. 10 Intersection Delay and LOS of the 2nd Re-Design Proposal by (HCS2010)

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
Westbound								
L	1260	2944	0.78	0.43	17.1	B		
							16.1	B
R	581	1357	0.40	0.43	12.0	B		
Northbound								
							58.4	E
R	1487	3475	1.07	0.43	58.4	E		
Southbound								
L	1702	4130	1.14	0.41	83.9	F		
							83.9	F

Intersection Delay = 57.9 (sec/veh) Intersection LOS = E

6. Acknowledgment

The author would like to express his gratitude to Al-Farabi University College for supporting this research.

7. Conclusions

- The traffic data of existing intersection has been assessed based on evaluation of the traffic policeman, Since the Traffic signals were broken down during the interval of data collection. Results give LOS "F" with a cycle length and delay of 840 seconds and 221.6 sec/veh, respectively.
- Results show that Al-Mansour intersection need enhancement to reduce delay and raise LOS, therefore; instantaneous solutions is to be considered concerning the upgrading of serviceability based on trying many proposals considering the signal timing (more than or equal 30 seconds and less than or equal 120 seconds) and geometrical changes with required number of lanes and phases (two or three phases).
- Two proposals of traffic signal timing design were suggested. Both of them were based on actuating of 3-phases with considering some different in direction movement. Cycle's length are concluded to be 100 and 70 seconds, respectively. Results show that the LOS for both of them are "D" and "C" with a delay of 37.1 sec/veh and 24.8 sec/veh, respectively.
- Two proposals of Re-Design geometric features with traffic signal timing were suggested. The first one is based on constructing tunnel a long 14-Ramadhan street in two directions (one lane per direction) considering of actuating 3-phases with some different in direction movement. Cycle length is concluded to be 70 seconds. Results show that the LOS for both of them are "D" with a delay of 36.5 sec/veh. The second proposal is divided into two assumptions, both of them are based as in the first proposal with actuating of 2-phases and some different in direction movement. The first assumption depend on two lane per direction, while the second one based on one lane per direction. Cycle length are concluded to be 50 seconds. Results show that the LOS for both of them are "B" with delays of 14 sec/veh and 11.1 sec/veh, respectively.
- Results show that the second proposal (second assumption) of the Re-Design geometric features which includes (one lane per direction) is better than the first due to the same development on the level of service (high LOS "B") with considering the lower cost of construction.
- For analysis of forecasting data of the best alternatives, results show that the saturation capacity will be took place after 8 years later according to 3.5% of annual traffic growth rate as comply with [4],

where the LOS and delay are "E" and 57.9 sec/veh respectively

8. Recommendations

- Evaluate the LOS for all approaches that meets at the intersection using HCS software.
- Use other methods of traffic data survey like video recording, GPS and GIS, and compare the results with the results of this study.

9. References

[1] Abbas Z. Khalaf, et al 2015. "Analysis of Traffic Operation for AL-Kafa'at Signalized Intersection in Al-Kut City". Journal of Engineering and Development", Eng. &Tech.Journal, Vol. 33,Part (A), No.2,, 431-439.

[2] Garber, N. J., and Hoel, L. A., 2009." Traffic and Highway Engineering", 4th edition, University of Virginia, United States of America.

[3] Israa F. J., 2012, "Improvement of Traffic Capacity for AL-Mustainsiriyah Intersection in Baghdad City", Al-Qadisiya Journal for Engineering Sciences, Vol. 5, No. 3, 235-252.

[4] Noor M. A., "A GIS-Assisted Optimal Route Selection Based on Transportation Network Design, Baghdad Metro Case Study", Doctoral dissertation, Ph. D thesis, University of Baghdad, 2015.

[5] Qais S. Kareem, 2012. "Assessing and development the performance of Al-Qodus Intersection in Baghdad City". Journal of Engineering and Development", Al-Mustansiriayah University, Journal of Engineering and Development, Vol. 15, No. 2, 19-48.

[6] Rogers, M., 2008, "Highway Engineering", Second Edition, Blackwell Publishing, Ireland.

[7] SCRB, State Corporation of Roads and Bridges, 2005: "Highway Design Manual", Republic of Iraq, Ministry of Housing and Construction, Baghdad, Iraq.

[8] Youn-Soo Kang, 2000, "Delay, Stop and Queue Estimation for Uniform and Random Traffic Arrivals at Fixed-Time Signalized Intersections", Ph.D. thesis, Virginia University, USA.

تحسين الأداء التشغيلي المروري لتقاطع المنصور ثلاثي المقتربات في مدينة بغداد

المدرس المساعد محمود خالد جمعة العبيدي

كلية الفارابي الجامعة، بغداد، العراق

الخلاصة

إزداد الحجم المروري للمركبات في الأونة الأخيرة في العراق وبالاخص في مدينة بغداد، حيث أنه أدى الى نمو في مستويات الاختناق المروري فضلا عن التلوث البيئي ومخاطر ضياع اوقات الرحلة والتنقل خصوصا في مقتربات التقاطعات. الغرض الرئيسي من الدراسة هو تقييم مستوى الخدمية الحالي لتقاطع المنصور ثلاثي المقتربات ذي الاشارات المرورية في مدينة بغداد، وتطوير أداء تشغيله المروري باقتراح مجموعة من الخيارات المناسبة لتحسين قابلية استيعابه.

تم جمع البيانات المرورية عن طريق مجموعة من المهندسين، حيث تم تقييم التقاطع بواقع حاله باستخدام البرنامج الحاسوبي (2010) لحساب استيعابية الطرق وتم توضيح التفاصيل الهندسية للتقاطع قبل وبعد التحسين باستخدام برنامج الرسم الهندسي (2017). بينت النتائج الحالية بأن التقاطع يعمل بمستوى خدمية F وبمعدل تأخير 221.6 ثانية\مركبة (بسبب عطل عمل الاشارات المرورية خلال فترة الدراسة فإن توقيت الاشارات الخضراء لحركة المركبات أعتمدت على تقييم رجل المرور)، لذلك حلول آنية متعلقة بتصميم الوقت الأمثل للإشارات المرورية او تغيرات هندسية يجب أن تقترح لرفع مستوى الخدمية لأداء التقاطع.

بعد تحسين التقاطع وبفرض تغيير تصميم الشكل الهندسي وأطوار الاشارت المرورية من ثلاثة الى طورين، بينت النتائج أن معدل التأخير هو 11.1 ثانية\مركبة ومستوى الخدمية تطور الى B بفرض إنشاء نفق يمر في التقاطع وعلى امتداد شارع 14 رمضان (بالاتجاهين وكل اتجاه يحوي على ممر واحد فقط).

الكلمات المفتاحية: الحجم المروري، مستوى الخدمية، معامل ساعة الذروة، تقاطه باشارات مرورية، التأخير المسيطر عليه.