Analysis of Traffic Operation for AL-Kafa'at Signalized Intersection in Al-Kut City

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ABSTRACT

Traffic Studies Aim (Traffic analysis) to estimate some of the important indicators to determine the level of service (LOS) at intersections in the cities. That's where the increase in traffic volumes at intersections is one of the main problems that makes the traffic difficult in these intersections and which raises congestion in these areas.
The objective of this research is to evaluate the operational capacity of intersection (AL-Kafa'at) in AL-Kut city and show better proposals to improve the performance in terms of capacity.

To achieve these objectives traffic information has been collected using digital camera to various directions for the purposes of analysis and traffic engineering while HCS traffic program is used for the purposes of traffic analysis process. The operational analysis of the existing conditions of this intersection indicates that the LOS is (**F**) with an intersection delay value of 105.1 sec. /vehicle .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** sec. /vehicle.

Keywords: Traffic Operation, Traffic volume, Saturation flow, Peak hour factor (PHF), Level of Service (LOS).

تحليل التشغيل المروري لتقاطع الكفاءات في مدينه الكوت

الخلاصة

تهدف الدراسات المرورية(Traffic analysis)الى تقدير بعض المؤشرات المهمة لتحديد مستوى الخدمة (LOS)على التقاطعات داخل المدن . حيث ان الزيادة في الحجوم المرورية في التقاطع هي احد المشاكل المهمة التي تجعل حركه المرور في هذه التقاطعات صعبه والتي تؤدي الى الازدحام في هذه المناطق .

ان الهدف من هذا البحث هو تقييم القدرة التشغيلية لتقاطع (الكفاءات) في مدينه الكوت وعرض افضل المقترحات لتحسين الاداء من حيث الطاقة الاستيعابية ولتحقيق هذه الاهداف فقد تم جمع المعلومات المرورية بواسطه كاميرا رقميه لمختلف الاتجاهات لأغراض التحليل المروري والهندسي بينما تم استخدام برنامج HCS

لأغراض التحليل المروري.حيث ان التشغيل المروري لهذا التقاطع يشير الى ان مستوى الخدمة يساوي (F) مع تأخير قدره 105.1(ثانيه /مركبه) ولذلك، ونظرا للأسباب المذكورة أعلاه، من المهم تحسين اداءهذا التقاطع بزياده عدد الممرات للجانب الايمن لشارع الحيدريه حيث اشارت النتائج الى ان مستوى الخدمة سيتغير الى (D) وبوقت دوره 91 ثانيه وبوقت تأخير38.1 ثانيه/مركبة.

INTRODUCTION

Transportation Engineering is the application of technology and scientific principles to the planning, functional design, operation, and management of facilities for any mode of transportation in order to provide safe, rapid, comfortable, convenient, economical, and environmentally compatible movement of people and goods.

Traffic engineering is that phase of transportation engineering which deals with the planning, geometric design and traffic operation of road, street, and high-ways, their network, terminals, abutting lands, and relationships with other modes of transportation [1].

An intersection is defined as the general area where two or more highways join or cross, including the roadway and roadside facilities for traffic movements within the area. Intersections are an important part of a highway facility because, to a great extent, the efficiency, safety, speed, cost of operation, and capacity of the facility depends on their design. Each intersection involves through- or cross-traffic movements on one or more of the highways and may involve turning movements between these highways. Such movements may be facilitated by various geometric design and traffic control, depending on the type of intersection [2].

The concepts of capacity, level of service and delay are central to the analysis of intersections, as they are for all types of facilities, therefore that both capacity and level of service must be fully considered to evaluate the overall traffic operation of the intersections [3].While the delay is one of problems that occurs in any facility of traffic.AL-Kafa'at intersection in AL-Kut city is an important congested intersection due to its critical location on major streets. This intersection has the following characteristics:

1. It has a very high traffic volume in two approaches.
2. It is located on Major Street which intersects with two minor streets.
3. Many activities are located around this intersection.

Study Area

AL-Kafa'at signalized intersection is one the most important intersections located in the center of AL-KUT city, AL-Kafa'at signalized intersection consists of three major streets:

1. Baghdad Street
2. AL-Kafa'at Street
3. Alhaidariya Street

AL-Kafa'at signalized intersection is a significant location and a highly volume. This can be related to:

1. AL-Kafa'at signalized intersection is located in an important location. It connects between main directions from AL-Kafa'at Street toward Alhaidariya Street.
2. The existing of different public activities near AL-Kafa'at signalized intersection. These activities resulted in a high traffic volume and lead to create a high delay especially at peak hour. Figure (1) shows a satellite image for AL-Kafa'at signalized

intersection and the boundary of the study area (directorate of statistics in the AL-KUT city, 2010).

Figure (1): Satellite Image for AL-Kafa'at Signalized Intersection in AL –KUT City

Objectives of the Study

The main objectives of this study are:

1. Specify the peak hour volume and calculate the peak hour factor (PHF) for all approaches at AL-Kafa'at signalized intersection.
2. Evaluate the existing level of service (LOS) at the studied intersection.
3. Evaluate all proposals, calculate the level of service for each proposal and select the best proposal that can solve the congestion problem and provide a good performance within the design period.

Data Collection:

Traffic volume

To determine the existing traffic volumes; a digital camera is used at AL-Kafa'at signalized intersection from (7:00 a.m up to5:00 p.m) during the workdays of the week from (22 February to 27 February) 2014. This survey aims to find the peak hour volume, which represents the design hourly volume.

The type of vehicles are classified into two types, they are:

- Passenger car: all vehicles, which have four tires only.
- Heavy vehicles: all vehicles, which have more than four tires.

The heavy vehicles were converted to passenger car by using a passenger car factor equal to (2.0) [3].

The volume for peak hour represents the design hour volume, which will be used in the analysis of this study. Table (1) shows the traffic account at nestle intersection for 15 min period from 7:00 a.m -5:00 p.m. While Table (2) shows the total volume for all approaches each 15 min.

Saturation Flow

Calculation of saturation flow rate depends on the headway data collected for queue vehicles at stop line for each approach at the time of departure on green time. Saturation flow represents one of the main parameters in which has a major effect in the capacity of intersection [4].The existing saturation flow is calculated by using HCS Software. Table (3) shows the calculated saturation flow at the stop line for all approaches in AL-Kafa'at signalized intersection by using HCS Software.

Table (1) :Traffic Volume At – Al-Kafa'at Intersection From 7:00 A.M To 5:00 P.M For All Approaches

Direction / Time	From Alhaidariya Street						From The Al-Kafa'at Street						From Baghdad Street					
	LEFT		THROUGH		RIGHT		LEFT		LEFT1		RIGHT		LEFT		THROUGHT		RIGHT	
	PC	HV	PC	HV	PC	HV	PC	HV	PC	HV	PC	HV	PC	HV	PC	HV	PC	HV
7:00-7:15	0	0	19	2	62	2	48	2	2	0	16	0	13	1	12	1	0	0
7:15- 7:30	1	0	40	0	67	2	80	4	1	0	27	1	14	0	14	2	0	0
7:30- 7:45	0	0	45	1	102	1	32	1	3		44	2	20	3	30	0	0	0
7:45- 8:00	1	0	63	1	125	7	127	2	0	0	50	0	21	3	39	4	0	0
8:00- 8:15	0	0	57	10	99	5	137	0	1	0	44	1	14	0	35	1	0	0
8:15- 8:30	0	0	69	2	110	6	126	8	2	0	55	3	23	0	39	0	0	0
8:30-8:45	0	0	62	4	86	4	99	6	0	1	46	2	23	0	39	0	0	0
8:45-9:00	0	0	73	2	103	7	103	7	0	0	39	2	13	0	35	0	0	0
9:00- 9:15	1	0	76	2	123	2	99	5	2	0	37	4	14	1	34	2	0	0
9:15- 9:30	1	0	49	4	85	7	126	4	0	2	52	1	10	2	40	0	0	0
9:30- 9:45	0	0	83	3	73	5	97	7	3	1	47	2	16	1	36	2	0	0
9:45- 10:00	0	0	64	2	94	4	107	9	1	0	51	1	28	0	42	2	0	0
- 10:15 10:00	0	0	73	5	104	7	122	6	1	0	49	1	21	0	52	0	0	0
- 10:30 10:15	0	0	69	0	83	5	129	4	2	0	51	4	31	0	32	1	0	0
- 10:45 10:30	2	0	67	4	77	13	94	3	2	0	44	2	24	0	28	1	0	0
- 11:00 10:45	1	0	50	3	107	7	110	2	4	0	36	2	22	2	42	1	0	0
- 11:15 11:00	1	0	49	3	110	6	97	7	2	0	35	2	26	1	59	1	0	0
- 11:30 11:15	3	0	53	4	108	2	114	3	1	0	34	0	23	1	56	2	0	0
- 11:45 11:30	3	0	41	6	90	5	92	3	3	0	33	1	18	2	67	3	0	0
- 12:00 11:45	3	0	49	1	111	10	92	8	1	0	32	1	29	1	56	1	0	0
12:00-12:15	1	0	61	2	123	4	114	8	2	0	49	3	26	0	55	4	0	0
12:15-12:30	1	0	60	1	111	11	101	8	2	0	36	1	26	1	62	1	0	0
12:30-12:45	0	0	58	6	110	4	93	3	3	0	32	0	25	2	57	3	0	0
12:45-1:00	1	0	52	4	93	8	55	11	2	1	28	4	21	1	43	3	0	0
1:00-1:15	0	0	52	2	82	1	89	5	4	0	30	1	25	1	40	7	0	0
1:15-1:30	1	0	47	2	110	3	105	7	7	5	33	0	27	0	43	0	0	0
1:30-1:45	1	0	54	4	83	8	52	0	1	0	31	1	34	2	43	5	0	0
1:45-2:00	0	0	49	6	60	0	84	4	1	0	29	1	23	3	53	5	0	0
2:00-2:15	2	0	53	1	93	2	105	3	4	0	23	0	18	1	51	6	0	0
2:15-2:30	1	0	42	3	87	2	88	4	3	0	30	0	21	1	50	3	0	0
2:30-2:45	0	0	45	3	85	5	86	2	3	0	19	0	19	1	42	4	0	0
2:45- 3:00	0	0	46	4	98	3	104	1	3	0	26	0	13	0	53	3	0	0
3:00- 3:15	2	0	45	1	109	5	80	0	0	0	23	0	15	0	62	3	0	0
3:15- 3:30	0	0	26	2	77	1	133	2	3	0	19	3	15	1	42	3	0	0
3:30 -3:45	0	0	58	2	92	7	85	1	2	0	19	1	17	2	83	4	0	0
3:45- 4:00	0	0	28	3	100	1	93	2	2	0	27	0	22	0	50	1	0	0
4:00- 4:15	0	0	42	1	118	2	114	4	6	0	21	1	18	1	53	0	0	0
4:15- 4:30	1	0	46	0	113	1	90	3	4	0	17	0	23	1	41	1	0	0
4:30-4:45	2	0	44	2	126	2	109	1	6	0	17	0	20	2	59	5	0	0
4:45 -5:00	4	0	62	1	120	2	93	2	4	0	19	0	18	0	63	2	0	0

Table (2): Traffic Volume At – Al-Kafa'at Intersection From 7:00 A.M To 5:00 P.M For All Approaches For Each (15min)

TIME	PC	HV	Total= (PC+2*HV)	TIME	PC	HV	Total= (PC+2*HV)
7:00-7:15	172	8	188	-12:15 12:00	431	21	473
7:15- 7:30	244	9	262	-12:30 12:15	399	23	445
7:30- 7:45	276	8	292	-12:45 12:30	378	18	414
7:45- 8:00	342	17	376	12:45-1:00	295	32	359
8:00- 8:15	387	17	421	1:00-1:15	322	17	356
8:15- 8:30	424	19	462	1:15-1:30	373	17	407
8:30-8:45	355	17	389	1:30-1:45	299	20	339
8:45-9:00	366	18	402	1:45-2:00	299	19	337
9:00- 9:15	386	16	418	2:00-2:15	349	13	375
9:15- 9:30	363	20	403	2:15-2:30	322	13	348
9:30- 9:45	355	21	397	2:30-2:45	299	15	329
9:45- 10:00	387	18	423	2:45- 3:00	343	11	365
- 10:15 10:00	422	19	460	3:00- 3:15	336	9	354
- 10:30 10:15	397	12	421	3:15- 3:30	315	12	339
- 10:45 10:30	338	23	384	3:30 -3:45	356	17	390
- 11:00 10:45	372	17	406	3:45- 4:00	322	7	336
- 11:15 11:00	389	20	429	4:00- 4:15	372	9	390
- 11:30 11:15	392	12	416	4:15- 4:30	335	6	347
- 11:45 11:30	347	20	387	4:30-4:45	383	12	407
- 12:00 11:45	373	22	417	4:45 -5:00	383	7	397

Table (3): Calculated Saturation Flow At AL-Kafa'at Signalized Intersection

Approach	Movement	Saturation flow pc/h
Baghdad Street	Th	1574
	L	1510
AL-Kafa'at Street	R	2355
	L	3878
Alhaidariya Street	Th	1610
	R	1554

Existing Geometric Design

To evaluate the level of service at nestle intersection it is very important to specify the number of lanes for each approach .The existing geometric layout for AL-Kafa'at intersection and its approach is show in Figure (2).

Analysis and Results:

Peak Hour Volume

By using Excel program, the traffic account shown in Table (1) was analyzed to specify the peak hour. From site investigation and traffic account, the following conclusions were observed:

a. It was found that the peak hour is limited between 12:00 P.M and 1:00 P.M. The total volume during this hour is (1691) pc/h.

b. The maximum traffic volume is concentrated in the approach coming from the Alhaidariya Street. This volume is (751) pc/h. while the lowest volume is (345) pc/h comes from Baghdad Street

c. The percentage of heavy vehicles for all approaches in AL-Kafa'at signalized intersection is a shown in Table (4).

d. The variation of traffic volume for each approach is shown in **Figure (3)** for 15 min interval while **Figure (4)** shows the total volume at the intersection for each (15) min.

Table (4): Percentage of Heavy Vehicles for All Approaches At AL-Kafa'at Signalized Intersection

Approach	% of heavy vehicles
Baghdad Street	9
AL-Kafa'at Street	13
Alhaidariya Street	11

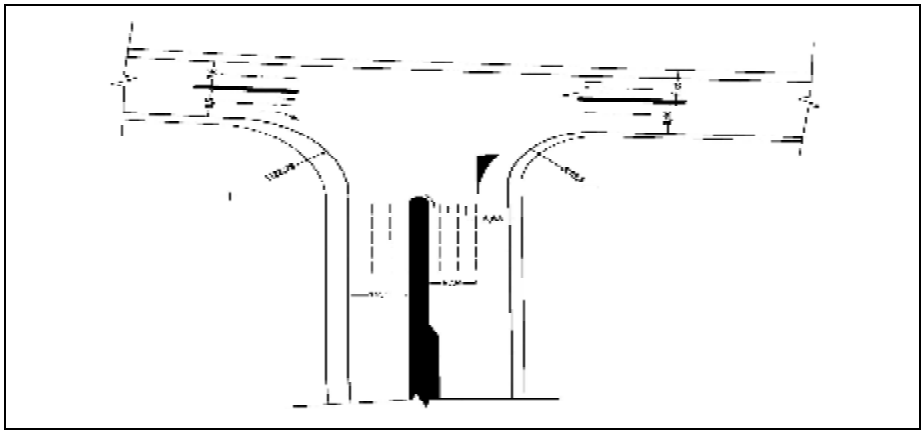

Figure (2): Existing Geometric Design for All Approaches in AL-Kafa'at Signalized Intersection

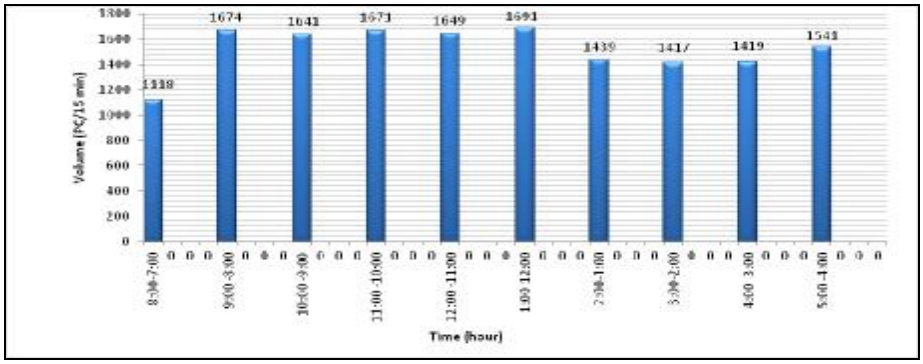

Figure (2): Total Traffic Volume AtAL-Kafa'at Signalized Intersection for Each (15) Min

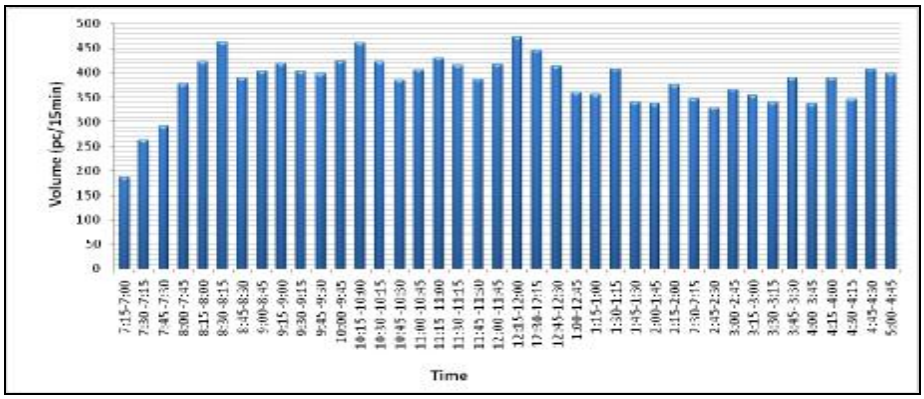

Figure (3): Variation of Traffic Volume for All Approaches at AL-Kafa'at Signalized Intersection

Peak Hour Factor:

The peak factor is defined as the ratio of total hourly volume to the maximum 15 – min rate of flow within the hour.

$$PHF = \frac{\text{Hourly volume}}{(\text{higher traffic volum for 15 min}) * 4}$$

The peak hour factor is calculated for each direction in AL-Kafa'at intersection using the data mentioned in Table (1) .Results of PHF are shown in Table (5) below.

Table (5): PHF for All Approach At AL-Kafa'at Signalized Intersection

Approach	PHF
Baghdad Street	0.96
AL-Kafa'at Street	0.80
Alhaidariya Street	0.96

Existing Los at AL-Kafa'at Signalized Intersection

The operational of the existing geometrical features and traffic volumes of AL-Kafa'at intersection is performed by using HCS 2000 .**Table (6)** illustrates the result of analysis. The result indicates that the intersection LOS is (F) with an average intersection delay of 105.1 sec/vehicle. Therefore, the enhancements are required to reduce the intersection delay and change the LOS.

Table (6): Existing Level of Service At Al-Kafa'at Signalized Intersection

Approach	Average delay sec/veh	Level of service (LOS)
Baghdad Street	40.90	D
AL-Kafa'at Street	23.90	C
Alhaidariya Street	206.90	F
Average Intersection delay	**105.1**	**F**

Proposal Enhancement of Traffic Performance*:*

In order to improve the traffic performance in the study area, improvement proposals will be explained in the following section.

Proposal No. 1: Increasing number of lanes in one direction:

In this proposal, changing of geometric design for the intersection by increasing the number of lanes in one approach for Alhaidariya is suggested to right turn. It was found that the LOS of the intersection became D with an overall delay of (38.1) sec/veh. Table (7) shows the result this proposal No.1

Table (7): Expected Level of Service at AL-Kafa'at Signalized Intersection with Adopting Proposal (1)

Approach	Average delay sec/veh	Level of service (LOS)
Baghdad Street	41.90	D
AL-Kafa'at Street	24.40	C
AlhaidariyaStreet	49.50	D
Average Intersection delay	**38.1**	**D**

Proposal No.2: changing the cycle length for the intersection

In this proposal, several cycle lengths are examined by using HCS program. From the result, it is noticed that the (LOS) for the intersection is (E) Therefore, the proposal is not good enough for the intersection. Table (8) shows the results for this proposal for the cycle time 98.1 sec. as an example. The results are based on existing traffic volume observed at the selected signalized intersection.

Table (8): Expected Level of Service at AL-Kafa'at Signalized Intersection with Adopting Proposal (2)

Approach	Average delay sec/veh	Level of service (LOS)
Baghdad Street	230.60	F
AL-Kafa'at Street	38.40	D
Alhaidariya Street	24.50	C
Average Intersection delay	**68.9**	**E**

CONCLUSIONS

AL-Kafa'at signalized intersection is one of the most important intersections in AL-kut city, and serves about 8000000 passages of vehicles yearly.

The operational analysis of the existing conditions of this intersection by the Highway Capacity Software (HCS2000) indicates that the LOS equal to (F) with an intersection delay value of 102.8 sec. /vehicle. Therefore, and because of the reasons above, two enhancement proposals were suggested. The study showed that increasing number of lanes to the right turn for Alhaidariya approach is the best solution to enhance the intersection performance.

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