Simulation of traffic flow in unsignalization intersection using computer software SIDRA in Baghdad city

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Abstract. Computer simulation is a vital means for the examination of expressways and urban lanes and streets. Transportation experts concentrate on the arrangement and dissemination of traffic jams on roadways. The objective of this study is to calculate and analyses the travel time, delay time, degree of saturation, and level of service and travel speed in Jordan intersection in Baghdad, Iraq using Sidra software. The number of vehicles passing Jordan intersection was recorded by the author of this work from 7am to 3pm for four days. A simulation model has been used to assess the performance of the current intersection. Results demonstrated that the level of service (LOS) for Jordan intersection is D with (35 sec/veh) average delay and degree of saturation (0.996 v/c). It was concluded that Jordan intersection needs further developments like using intelligent transportation system application (ITS) to regulate traffic signals, whereby reducing traffic jam, using closed circuit TV (CCTV) might assist traffic office in identifying jam point to reduce traffic jam.

1 Introduction

Traffic jam happens when a volume of Traffic produces demand for more space as compared to the accessible street limit; this point is generally expressed as the degree of saturation. There are various particular circumstances that cause traffic jams; the vast majority of them decrease the limit of a street at a given point or over a specific length. Around half of U.S. traffic jam is repeating [2], and is ascribed to sheer weight of traffic; a major of the other half is attributed to the movement to traffic. Ali used SIDRA software to assess the traffic flow in Roundabout and intersection in Bandar Baru Bangi [2], Al-Mimany, used Sidra to analyze and assess the traffic network in Kirkuk city [3]. Ibrahim investigated the assessment of Models for roundabout capacity and performance estimation for using SIDRA, ARCADY, RODEL, SYNCHRO models and Highway Capacity Manual model (HCM 2010) to carry out the analyses [4]. Examined the evaluation and enhancement of traffic operation for Al-Zeoat Intersection in Al-Ramadi city, using SIDRA traffic program [5]. investigated the urban street network in kut city, using geometrics techniques like (GPS, GIS) for detecting the traffic flow patterns of the selected network [6]. HCM (Highway Capacity Manual), HCS and SYNCHRO 6 computer program for operational analysis of Wadi-Saqra signalized intersection in Amman [7]. used aaSIDRA computer Software to Optimize the Traffic Flow in Bandar Baru Bangi Roundabout and intersection in Selangor, Malaysia [9].

The Jordan intersection in Baghdad city, which connects Al-Mansour quarter and Hay Al -Jameeah quarter could be described as the busiest intersection with the maximum traffic jams intersections in Baghdad connects the most vital areas in Baghdad nearby 14th Ramdhan intersection which is a commercial district having numerous shopping centers, governmental facilities like passports office, Iraqi citizenship office, and traffic office. Therefore, it encounters massive jams in the day. Besides, Jordan intersection is linked with Al-Nessor roundabout which is a congested area.

2 Data collection

Data has been collected from the field using a video camera with high storage capacity (80 GB) and a long-life battery (battery charging lasts for 10 hours). This camera has been installed on the alrashed bank building. a good vantage points for collecting data. The time of recording started from off-peak (7:00 AM) till another off-peak (3:00 PM) and was evaluated every 15 minutes during two periods the day which is (7am-12pm) and (12pm-3pm). Table1: shows the traffic volume data expressed by a number of cars for all direction, Table1 shows the input worksheet required for analysis of the existing geometric, traffic, and signalized conditions so this data was conducted over three days. Fig 1and 2 shows the existing peak traffic flow determined by SIDRA computer program.

SIDRA computer software has been created by the

Australian Road Research Board (ARRB), Transport Research Ltd., as a guide for outline and assessment of crossing points, for example, signalized convergences, roundabouts, two-way stop control, and caution sign control crossing points [10,11,12]. In assessing and comparing behavior of roundabouts, there are a few advantages that the SIDRA model has over some other programming model; it gives solid appraisals of geometric delays and related breakdown impacts for the different crossing point sorts. This property of the software is essential to the computation of new options for the intersection treatments consistently.

Table 1. Traffic Volume at Jordan Intersection for all Approaches each Quarter Hour.

Time	From Street Jordan Road			From Yarmouk Road			From Baghdad Tower Road			Total
	L	S T	R	L	S T	R	L	S T	U T U R N	
7:00-7:15 am	30	33	35	41	33	38	29	50	65	354
7:15 - 7:30	115	55	60	67	62	71	77	70	78	655
7:30-7:45	179	196	211	122	178	183	197	211	198	1675
7:45-8:00	280	379	97	250	250	259	240	269	324	2348
8:00-8:15	178	154	165	170	154	169	187	187	203	1567
8:15-8:30	103	120	172	133	155	134	130	150	102	1199
8:30-8:45	64	77	73	65	68	69	72	77	71	636
8:45-9:00	69	66	65	55	64	63	71	72	77	602
9:00-9:15	62	60	69	72	72	71	68	55	59	588
9:15-9:30	58	49	66	52	45	55	63	68	70	526
9:30-9:45	55	34	51	58	42	52	58	55	79	484
9:45-10:00	44	49	54	53	48	47	58	59	66	478

10:00-10:15	49	66	77	69	73	66	68	65	62	595
10:15-1:30	42	55	63	61	65	63	69	70	72	560
10:30-10:45	45	44	59	67	72	67	65	59	60	538
10:45-11:00	48	48	53	55	69	56	58	64	60	71
11:00-11:15	44	44	32	44	59	66	70	79	75	74
11:15-11:30	40	40	37	42	61	68	76	80	79	76
11:30-11:45	47	47	41	52	58	61	74	79	81	79
11:45-12:00 pm	19	19	46	55	59	65	77	83	85	87
12:00-12:15	39	39	50	54	61	68	79	86	86	75
12:15-12:30	41	53	57	67	60	84	83	89	88	622
12:30-12:45	55	57	60	70	68	80	83	86	83	642
12:45-01:00	46	55	62	73	71	82	86	83	79	637
01:00-01:15	49	60	69	70	74	78	88	90	93	671
01:15-01:45	47	66	55	73	70	77	84	85	89	646
01:45-02:00	49	66	55	73	70	79	83	85	85	645
02:00-02:15	47	68	53	69	73	70	84	88	79	631
02:15-02:30	45	70	55	74	70	73	83	85	89	644
02:30-02:45	44	72	55	75	70	69	81	85	89	640
02:45-3:00	89	87	98	77	88	71	79	86	94	769

Fig. 1. Jordan intersection study area.

Fig.2. Existing Peak Traffic Flow as Shown by SIDRA

Table 2. Level of service definitions based on delay hcm (for vehicles) [11]

LOS	Control Delay (signalized) sec/veh	Delay sec/veh (unsignalized)
A	≤ 10 sec	≤ 10 sec
B	10-20	10-15
C	20-35	15-25
D	35-55	25-35
E	55-80	35-50

F	>80	>50
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3 Results and discussion

3.1 Peak hour volumes

Traffic flow shown in Table 1 was analyzed using excel program to identify the peak hour. The peak hour at Jordan intersection observed at 8:00 a.m. The total traffic volumes within this hour were recorded as (4023 pc/h) whereas the least number of vehicles passing Jordan intersection were observed at 10:00 am where the total traffic volumes at that hour were (962 pc/h) as shown in Fig.3. Total traffic flow percentage is illustrated in Fig.4. Total traffic flow percentage is evaluated by dividing the number of cars in each direction by the total number of cars. Total traffic flow from Yarmouk Street approach is 33%, from Baghdad Tower is 37% and from Jordan intersection is 30%.

Fig.3. Total traffic volumes at Jordan intersection each one hour

Fig.4. Total traffic flow Percentage at Jordan intersection

Table 3. Traffic Volume At Jordan Intersection For All Approaches Each Half Hour

Time	From Street Jordan	From Yarmouk Road	From Baghdad Tower Road	Total
07:30 am	328	312	369	1009
08:00	1342	1242	1439	4023
08:30	892	915	959	2766
09:00	414	384	440	1238
09:30	364	367	383	1114
10:00	287	300	375	962
10:30	352	397	406	1155
11:00	304	389	379	1072
11:30	239	400	463	1102
12:00 pm	260	394	494	1148
12:30	294	419	507	1220
01:00	335	444	500	1279
01:30	346	442	529	1317
02:00	338	434	504	1276
02:30	341	431	512	1284
03:00	274	236	259	769

The data was collected for each line for all the directions (left, right and through) and summed up during half an hour to recognize the number of cars passing the intersection during half an hour, the total number of cars passing Jordan intersection was 1,342 cars at 8:00 am whilst the total number of cars passing the intersection at 1:30 pm was recorded as 346 cars, while the number of cars passing al Yarmouk street was around 1,242 cars at 8:00 am , while the number of cars passing the same street was 444 cars at 1:30 pm. The number of cars passing Baghdad Tower at 8:00 am was 1,439 cars, whilst in 1:30 pm were recorded as 529 cars as shown in Table 3.

The percentage of cars passing the intersection each half an hour was calculated from Table 3 by dividing the total

number of cars passing Yarmouk Street, Baghdad Tower and Jordan intersection during half an hour by the total number of cars shown in Table 3 to arrive at the percentage of cars passing

Table 4. Traffic percentage volume at Jordan intersection for all approaches for each in half an hour

Time	From Street Jordan	From Yarmouk Road	From Baghdad Tower Road	Total
07:30 am	33%	31%	37%	100%
08:00	33%	31%	36%	100%
08:30	32%	33%	35%	100%
09:00	33%	31%	36%	100%
09:30	33%	33%	34%	100%
10:00	30%	31%	39%	100%
10:30	30%	34%	35%	100%
11:00	28%	36%	35%	100%
11:30	22%	36%	42%	100%
12:00 pm	23%	34%	43%	100%
12:30	24%	34%	42%	100%
01:00	26%	35%	39%	100%
01:30	26%	34%	40%	100%
02:00	26%	34%	39%	100%
02:30	27%	34%	40%	100%
03:00	36%	33%	39%	100%
Max	34%	36%	43%	
Mini	22%	31%	34%	
Average	29%	33%	38%	

the intersection. It was demonstrated that the highest percentage was recorded from 7:30 am to 9:30 am with 33%, while the percentage of cars passing Jordan Street were as high as 36% at 3:00 pm. However, the percentage at Yarmouk Street was significantly different as the highest percentage was recorded at 11:00 am with 36% and 35% at 1:00 pm. The percentage of cars passing Baghdad Tower was 42% at 11:30 am and 40%

at 1:30 pm and 2:30 pm as shown in Table 4. The percentage of vehicle passing the intersection each half hour for 8 hours is indicated in Fig.5

Fig.5. %Vehicles per Half hours for 10 hours' direction

Table 5. PHF values for Jordan intersection approaches

Approach	Movement	PHF
From Street Jordan Road	L	0.2
	St	0.032
	R	0.3
From Yarmouk Road	L	0.3
	St	0.3
	R	0.3
From Baghdad Tower Road	L	0.4
	St	0.3
	U turn	0.3

Peak Hour Factor (PHF) is the ratio between total volume and the maximum volume per 30 min rate of flow within the hour [Garber 2010]. Table 5 show PHF values for all approaches at both squares

Table 6. Results of the analysis by SIDRA

Approach	Average Delay sec/veh	LOS
From Street Jordan Road	36.0	D
From Yarmouk Road	4.3	A
From Baghdad Tower Road	61.6	E

3.2 Existing LOS at Jordan intersection

Level of Service (LOS) Method is described based on the US Highway Capacity Manual (HCM) a subjective measure used to relate the efficiency of traffic flow. LOS is utilized to dissect highway by sorting traffic flow and doling out quality levels of movement in view of execution measure like speed, density [Highway Capacity Manual HCM, 2010]. LOS definitions based on delay HCM (for vehicles) is indicated in Table 6. Existing LOS was investigated in this study using Computer Simulation Sidra Software. Results illustrated that Jordan Street LOS is (A) while the Yarmouk Road LOS is (E). However, Baghdad Tower LOS of the intersection is (D) as shown in Fig.6, hence it is might be described as unstable flow. Speed is adversely correlated with traffic flow. Average delay is computed using SIDRA software and is related with LOS as given in Table 6

Fig.6. LOS for Jordan intersection approaches

Fig.7. Details of LOS for Jordan intersection approaches

Fig.8. Results for average delay for Jordan intersection approaches

Fig.9. Relation between average delay and follow up headway

3.3 Average delay

The average delay is a crucial factor in forecasting travel time. Results for the delay is indicated in Fig.8 which shows that both Jordan Street and Yarmouk Street have two colours red and green, red refers to LOS F and green refers to LOS A which has the minimum delay. Delay is adversely related to LOS when the delay is minimized LOS is enhanced [Turley, 2007]. Whilst, Baghdad Tower Road has two colours orange and green, green refers to LOS A and orange refers to LOS E. Relation between average delay and follow up headway is illustrated in Fig.9. It is obvious to note that the follow up heady increase with the increase of average delay. Total delay for Jordan intersection was recorded as 35.4 sec

3.4 Degree of saturation

The level of saturation (%) is a proportion of demand to limit on each lane to deal with the intersection, with an estimation of 100% implying that demand and limit are equivalent and no further movement can advance through the intersection. Values more than 85% are normally viewed as torment from movement clog, with lines of vehicles starting to shape. according to colour code based on a degree of saturation. Each degree has a specific colour. Results for the degree of saturation is clarified in Fig.10. Green colour refers to less than 0.6 degrees of saturation, it was observed that Al Yarmouk Street has pink colour means that degree of saturation approach (0.8-0.9), whilst Baghdad Tower road has an orange colour, which refers to (0.9-1) degree of saturation. A relation between Degrees of Saturation and follow up headway is illustrated in Fig.11. The degree of saturation for Jordan intersection is 0.996 v/c

Fig.10. Results for degree of Saturation for Jordan intersection approaches

Fig.11. Relation between Degree of Saturation and follow up headway

Fig.12. Results for Travel Speed for Jordan intersection approaches

Fig.13. Relation between travel speed and follow up headway

3.5 Travel speed

Results for travel speed is indicated in Fig.12. According to colour code based on Speed Efficiency light blue colour and dark blue colour that the Speed Efficiency Ratio between (0.8-0.9) and (0.7-0.8). It was noted that Yarmouk Road has red colour and a pink colour which means the Speed Efficiency Ratio is between from (0-0.3) and (0.5-0.7) respectively. Whereas, Baghdad Tower road has a yellow colour and Light blue colour which means that the Speed Efficiency Ratio is between (0.3-0.5) and (0.8-0.9) as shown in Fig.12. A relation between travel speed and follow up headway is illustrated in Fig.13. It is significant to observe that the travel speed is adversely correlated with follow up headway when the travel speed increases the follow-up headway decreases. Travel speed for Jordan intersection is 29.3 km/h sec.

4 Conclusions

Conclusions based on the investigation done in this study are below:

- The peak hour at Jordan intersection was recorded at 8:00 am with (4023 pc/h).
- The average delay is adversely correlated with LOS. Total delay for Jordan intersection was recorded as 36 sec; hence LOS of Jordan intersection is D.
- The degree of Saturation increases with follow up headway. The degree of saturation for Jordan intersection is 0.996.
- Travel speed is adversely correlated with follow up headway. Travel speed for Jordan intersection is 29.3 km/h sec

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