# Using aaSIDRA Software for Traffic Flow to Evaluation Analysis Public Transportation in Iraq

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***Abstract*—Safety is a prime concern of transportation engineers. Traffic volumes have increased tremendously over the past years especially in Baghdad city. A computer simulation is more sophisticated for the analysis of freeways and urban street systems through simulation, transportation specialists can study the formation and dissipation of congestion on roadways. Intersection is one of the main reasons that have a significant effect on travel time. The aim of this paper is to analysis operational the traffic flow of the intersection to provide useful information for engineers to design the roads with the shortest travel time, The analyses Operational of existing in Al-jadryia intersection, near University of Baghdad by Utilization aaSIDRA and field measurements show that they can perform adequately despite relatively high traffic volumes in peak hours, The data required for the study were mainly collected through video filming technique also the calculation and evaluation are constructed with the aaSIDRA software. For general analyzing, this intersection is marked worst. This analyzing is indicated by "F" level which is mean the lowest value for the quality and quantity of this intersection.**

***Keywords*— Analysis, Traffic, Intersection, simulation, aaSIDRA***

## I. Introduction

Traffic signals are a common form of traffic control used by State and local agencies to address roadway operations [1]. They allow the shared use of road space by separating conflicting movements in time and allocating delay. They can also be used to enhance the mobility of some movements as, for example, along a major arterial [2]. Traffic signals play a prominent role in achieving safer performance at intersections. Under the right circumstances, the installation of traffic signals will reduce the number and severity of crashes. But inappropriately designed and/or located signals can have an adverse effect on traffic safety, so care in their placement, design, and operation is essential [3, 4]. The dual objectives of mobility and safety conflict [5]. To meet increasing and changing demands, one element may need to be sacrificed to some degree to achieve improvements in another. In all cases, it is important to understand the degree to which traffic signals are providing mobility and safety for each of transportation.

## II. Literature Review

In various cities, chronic traffic jam happens and traffic congestions lose billions hours and money, In order to reduce these losses, it is required to create an efficient method to resolve traffic congestion and reduce the delay time [6]. Vehicle fuel consumption increases approximately 30% under heavily congestion [7] on the other hand the dynamic vehicular delay at intersections is a major current concern, because the standard static network equilibrium formulation fails to capture essential features of traffic congestion [8]. Build up excessively during peak periods on all approaches of the major intersections. The effects of such queues on motorists are severe at intersections controlled by roundabouts. In order to direct the traffic at roundabouts more smoothly, to give better chances for mass crossings of traffic, and to have better control on queue length it is necessary to have the traffic on such intersections controlled by police [9]. The software used for data analysis is aaSIDRA. The Australian Road Research Board (ARRB), Transport Research Limited, developed the aaSIDRA package as an aid for design and evaluation of intersections such as signalized intersections; roundabouts, two-way stop control, and yield-sign control intersections [9].

The main SIDRA is (Akcelik &Associates Signalized Intersection Design and Research Aid) software is for use as an aid for design and evaluation of the following Intersections types , signalized intersections (fixed-time / pretimed and actuated), roundabouts, two-way stop sign control, all-way stop sign control, and Give-way (yield) sign-control[10].

In evaluating and computing the performance of intersection controls there are some advantages that the aaSIDRA model has over any other software model. The aaSIDRA method emphasizes the consistency of capacity and performance analysis methods for roundabouts, sign-controlled, and signalized intersections through the use of an integrated modeling framework. This software provides reliable estimates of geometric delays and related slowdown effects for the various intersection types. Strength of aaSIDRA is that it is based on the US Highway Capacity Manual (HCM) as well as Australian Road Research Board (ARRB) research results. Therefore aaSIDRA provides the same level of service (LOS) criteria for roundabouts and traffic signals under the assumption that the performance of roundabouts is expected to be close to that of traffic signals for a wide range of flow conditions[11].

It can be used aaSIDRA to obtain estimates of capacity and performance characteristics such as delay, queue length, stop rate as well as operating cost, fuel consumption and pollution emissions for all intersection types. Analyze many design alternatives to optimize the intersection design, signal phasing and timing specifying different strategies for optimization, Determine signal timing (fixed-time/pre timed and actuated) for any intersection geometry allowing for simple as complex phasing arrangements, Carry out a design life analysis to assess impact of traffic growth. Carry out a parameter sensitivity analysis for optimization, evaluation and geometric design purposes. Design intersection geometry including lane use arrangements taking advantage of the unique lane-by-lane analysis method of aaSIDRA,[12] Design short lane lengths (turn bays, lanes with parking upstream, and loss of a lane at the exit side),Analyze effects of heavy vehicles on intersection performance, Analyze complicated cases of shared lanes, opposed turns (e.g. permissive and protected phases, slip lanes, turn on red ),Handel intersection with more than 4 legs, Analyze oversaturated condition making use of aaSIDRA`s time-dependent delay, queue length and stop rate formula [13].

## III. Methodology

Level of service (LOS) aaSIDRA output includes results based on the concept described in the US Highway Capacity Manual (HCM) and various other publications. The HCM 97 uses the average control delay (overall delay with geometric delay) as the LOS measure for signalized and unsignalised intersections. aaSIDRA offers the following options for LOS determination: Delay (HCM method), Delay (RTA NSW method), Delay and degree of saturation using a method proposed (by Berry 1987), Degree of saturation only, and Degree of saturation (ICU method). The ICU (Intersection Capacity Utilization) method is used in the USA. Using the ICU method in aaSIDRA, the same degree of saturation criteria will apply for all types of intersection as seen in the table1 below. Level-of-service definitions based on degree of saturation using the Intersection Capacity Utilization (ICU) method as shown Table I. Queue length in aaSIDRA offers the following options for queue length estimation for all types of intersection: The cycle-average queue, the back of queue. The colour code used for movements in the Queues screen of GOSID is based on the queue storage ratio. The queue storage ratio is the ratio of the queue length (in meters or feet) to the available queue storage distance. The queue storage distance is set as the lane length (in meters or feet). For full-length lanes this equals the approach distance. For short lanes, the queue storage distance equals the short lane length [14].

TABLE I. Using the ICU method in aaSIDRA criteria for all types of intersection [15]

| Level of Service | Degree of saturation (x) All intersection types |
|---|---|
| A | x <= 0.60 |
| B | 0.60 < x <= 0.70 |
| C | 0.70 < x <= 0.80 |
| D | 0.80 < x <= 0.90 |
| E | 0.90 < x <= 1.00 |
| F | 1.00 < x |

The colour code used in Graphical Output System for Intersection Design (GOSID) is based on the following values of the queue storage ratio irrespective of the (LOS) definition or the intersection type as shown table 2, Performance Index (PI) is a measure which combines several other performance statistics, and therefore can be used as a basis for choosing between various designs options (the best design is the one which gives the smallest value of PI). The equation of the Performance Index is defined as [16].

$$PI = Tu + w1\,D + w2\,KH/3600 + w3\,N'$$

$$Tu = qa\,tu$$

TABLE II. Movements in the queues screen of GOSID is based on the queue storage ratio [16]

| Colour code | Rating | Queue Storage Ratio |
|---|---|---|
| Green | Very Good | Up to 0.75 |
| Blue | Good | 0.75 to 0.90 |
| Magenta | Acceptable | 0.90 to 0.95 |
| Red | Bad | Above 0.95 |

Degree of saturation (x) is defined as the ratio of demand flow to capacity, x = qa /Q (also known as volume/capacity, v/c, ratio). The movement degree of saturation is the largest degree of saturation for any lane of the movement. If there is no lane under-utilization, the degrees of saturation for all lanes and the movement (lane group). Movements in shared lanes will have the same degree of saturation except in the case of de facto exclusive lanes. The approach degree of saturation is the largest x value for any movement (or any lane) in the approach, and the intersection degree of saturation is the largest x value for any approach. That the colour code used for movements in the Degree of Saturation screen of GOSID (Graphical Output System for Intersection Design) is based on the following values irrespective of the LOS (level of service) definition or the intersection type [16] as shown table 3. The colour code used for movements and approaches in the Delay & LOS screen of GOSID is based on the LOS values given in Table 4[17] as shown Table IV.

TABLE III. Movements in the queues screen of GOSID is based on the queue storage ratio [16]

| Colour Code | Rating | Degree of Saturation |
|---|---|---|
| Green | Very Good | Up to 0.75 |
| Blue | Good | 0.75 to 0.90 |
| Magenta | Acceptable | 0.90 to 0.95 |
| Red | Bad | Above 0.95 |

TABLE IV. Movements and approaches in the Delay & LOS screen of GOSID [17]

| Colour Code | Rating | LOS |
|---|---|---|
| Green | Very Good | A or B |
| Blue | Good | C |
| Magenta | Acceptable | D |
| Red | Bad | E or F |

## IV. Research Methodology

### A. Study Area

The study is usually carried out to collect traffic data for all directional flow at four intersections in the study area along (intersection). In this study, the survey was carried out on working days. The counts were carried out at 15 minutes in the morning peak hour from 7:15 am and in the afternoon, begin peak hour 3:00 pm in 10-12-2014. All computation is based on traffic flows in pcu/hr, figure 3 and has been converted from classified vehicles into passenger car equivalent. In this study the existing of cycle time each intersection also measured. The Intersection will be improved to reduce existing congestion and accommodate future growth .The intersection is a primarily located aljadryia. Shown Figure 1. The directions configuration has the following in the four legs Intersections' with signalized. The northbound peak-hour through movement demand volume exceeds the capacity of the one provided through lane,. The peak hour demand volume exceeds the approach capacity, which results in queues that extend more than half the distance to the freeway mainline. The peak-hour demand volume for southbound through movement exceeds the approach capacity in the morning peak hour from 7:15 to 9:00 am and in the afternoon, begin peak hour 2:00 to 3:00 pm, which result in queues that extend to the drive intersection. To minimize southbound queues at this intersection from extending into the interchange, the green time for the eastbound approach is shortened, which results in long queues [13].An intersection will be congested because of the heavy traffic flow in every direction especially vehicle from (intersection) then exit to the highway. A long queue on north leg and east leg and lots of heavy vehicles especially busses going in the west leg (educational area) .While in intersection four legs intersections' The southbound peak-hour through movement demand volume exceeds the capacity of the one provided through lane. As shown Fig. 1.

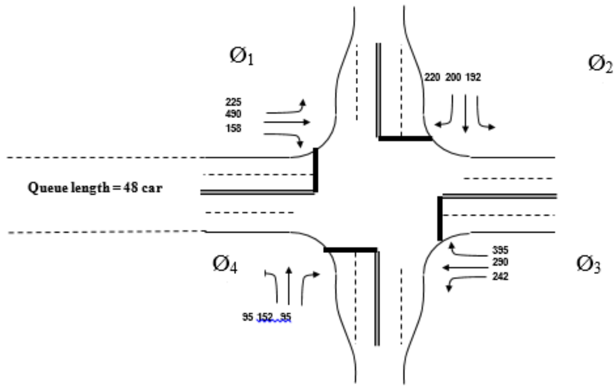


Fig. 1. An illustration of signalized intersections.

## B. Data Collection (Traffic Surveys)

The study consists of eight main activities as shown in Figure 1. The main activities are data collection, determination of phasing sequences, determination of optimum cycle by Webster a formula. In this phase the data was visually collected from the videotapes. All the videotapes were studied visually to extract the traffic volumes and turning movements for the analysis. Every vehicle coming from all the approaches for a period of 15 minutes was recorded on pre-prepared data collection sheets. The peak-hour demand volume for southbound through movement exceeds the approach capacity in the morning peak hour from 7:00 to 9:00 am and in the afternoon, begin peak hour 2:00 to 4:00 pm hourly counts were used as input data for analysis using aaSIDRA software.

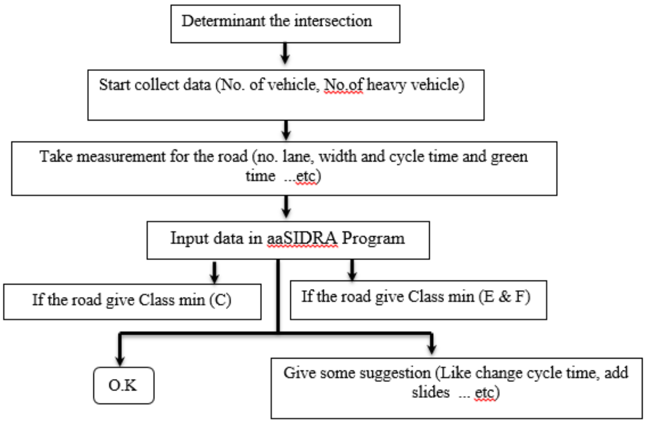


Fig. 2. Flow chart showing the Main Procedure analysis.

## C. Experimental Results for Optimum Cycle Time

Calculation the optimum common cycle time ,green time split for each intersection and offset time by assume amber for all =3 sec ,all red time = 1 sec , speed =36 km/h ,h=2 sec ,loss=2 sec as shown Table V.

## D. Optimum Cycle Time

The maximum cycle time will be 120 seconds .The Webster a formula is given as follows [20].

$$C_o = \frac{1.5L + 5}{1 - \sum y}$$

Saturated Flow=1800*2=3600 pcu/h (4)

L= 4 directions (4 sec) = 16 $_{sec}$

$C_0$ = 1.5*16 +5/ (1- 0.667) = 87 $_{sec}$

Cycle time = effective green time + Amber time + All red . (5)

Amber for all = 3*4 =12 $_{sec}$

All red = 1*4 =4 $_{sec}$

Effective green time = 87 - (4+12) =67

= 67 sec as shown table 6

TABLE V. ESTIMATE THE EFFECTIVE GREEN TIME IN INTERSECTION

| Phase | Left | Straight | Right | Total Actual Flow (a) | Saturated Flow pcu/h (v) | Y=a/v |
|---|---|---|---|---|---|---|
| Ø1 | 225 | 302 | 158 | 685 | 3600 | 0.190 |
| Ø2 | 220 | 200 | 192 | 612 | 3600 | 0.17 |
| Ø3 | 232 | 290 | 242 | 764 | 3600 | 0.212 |
| Ø4 | 95 | 152 | 95 | 342 | 3600 | 0.095 |
| | | | | | | Y=0.667 |

TABLE VI. CLASSIFICATION EFFECTIVE GREEN FOR EACH INTERSECTION

| Phase | Y=a/v | Effective green time (sec) |
|---|---|---|
| Ø1 | 0.190 | 0.190/0.667*67= 19 |
| Ø2 | 0.17 | 17 |
| Ø3 | 0.212 | 21 |
| Ø4 | 0.095 | 10 |
| | Y=0.667 | 67 sec |

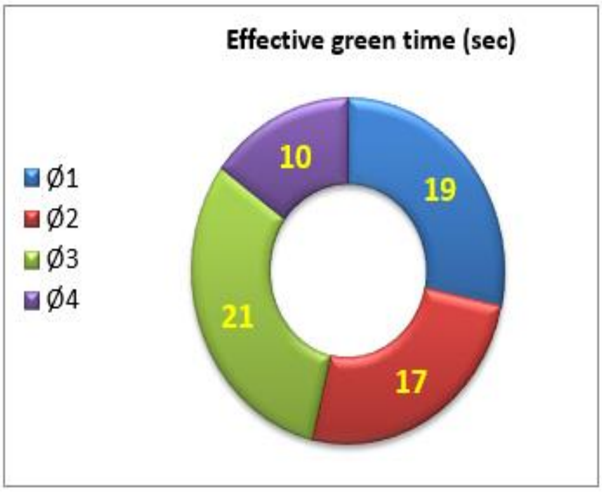


Fig. 3. Signal Controller Setting.

### E. *Offset Time*

Queue length is one the parameters required to determine the suitable offset time in a network of signalized intersections. As the queue becomes longer at the downstream intersection, the offset time becomes shorter as given in equation (7). The reduction in offset time is mainly to clear the queued vehicles before the platoon of vehicles from the upstream intersection arrive at the stop line [18, 19].

$$T_{ideal} = \frac{L}{S} - (Qh + Loss) \quad (6)$$

$T_{ideal}$ =400/10-(48*2+2)

= 58 sec

## V. Results

Analysis data collection for the traffic flow of the intersection in aljadrea. The data are collected from videotapes for the peak periods visually in 15-minute periods, and hourly data was then input to the aaSIDRA software for analysis. The data analysis was done separately for the AM and PM hourly volumes but the procedure followed was the same for both sets of data. This was done to see whether the results differed due to the differences in before and after traffic volumes for both AM and PM traffic counts, as there was more traffic during the PM period than during the AM period traffic counts, as there was more traffic during the PM period than during the AM period, peak hour from 7:00 to 9:00 am and in the afternoon, begin peak hour 1:00 to 4:00 pm.

There are several reasons that they are used for the intersection such as geometry, Delay and Loss, Queue, Stops, flow, movements and Degree of saturation. This paper tries to analysis the data the result with each other to find out what is the best choice for the roads.

Regarding to the table 7 there are some items that are shown the impact of the intersection on the traffic such as intersection geometry, level of service, average intersection delay, degree of saturation, Practical Spare Capacity (lowest), Total vehicle capacity, all lanes (veh/h), Total vehicle delay (veh-h/h) and some more items. From the above tables it's obvious that having the intersection is worst because the Intersection Level of Service (LOS) is (F), regarding the effects of various types of movements on aaSIDRA results all movements except dummy and movements are considered when determining the intersection degree of saturation (largest degree of saturation for any movement), For the Delay and LOS rating is bad in the level (F) in three phases but in other phase is rating is acceptable in the level (D) shown fig (5 ).But at the Intersection Level For the Queues rating is Bad in the level (F) in three phases but in other phase is rating is very good in the level(A) shown fig (6). While For the Level Stops rating is bad in the level (F) in four phases shown fig (7). Finally for the Level degree of saturation rating is bad in the level (F) in three phases but in other phase is rating is good in the level (C) as shown fig (8).

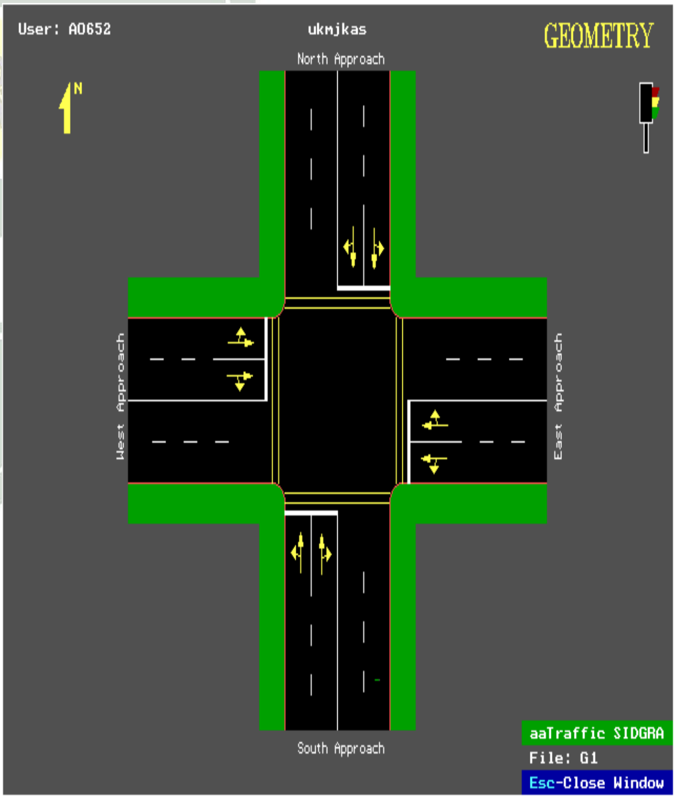


Fig. 4. Intersection road (main road).

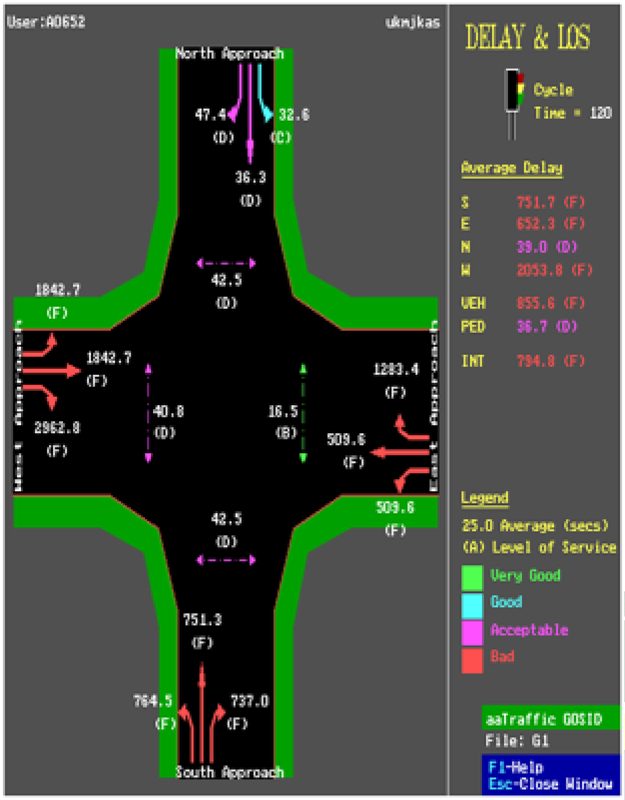


Fig. 5. Description delay and LOS.

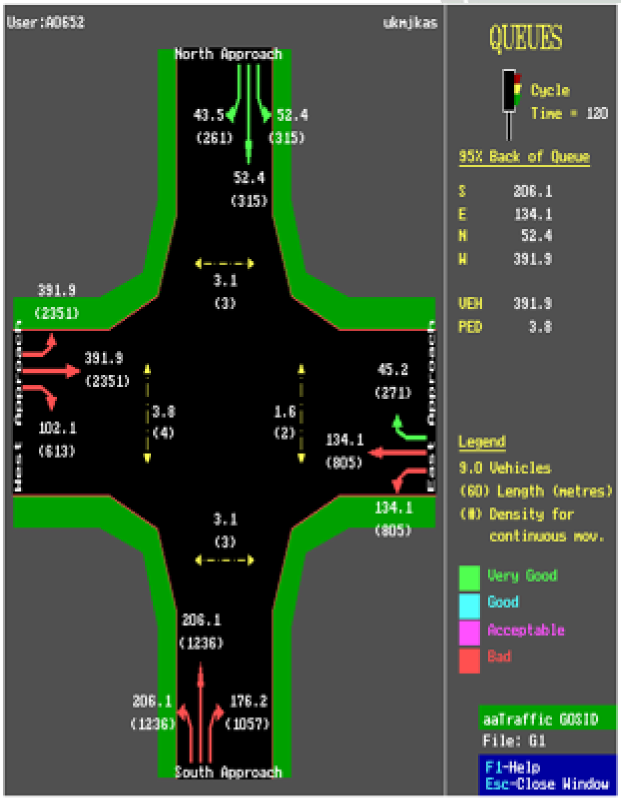


Fig. 6. Description of Existing Queues at the intersection.

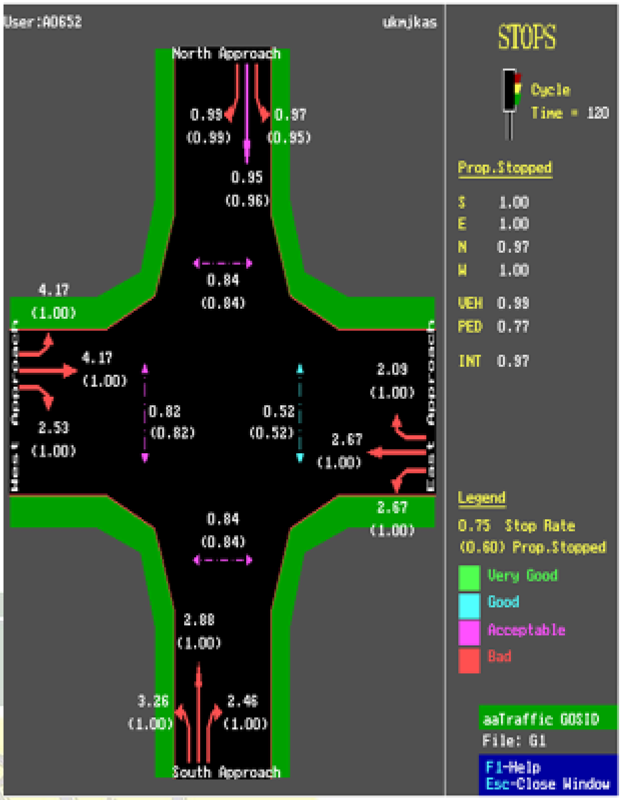


Fig. 7. Description of Existing Condition Stops.

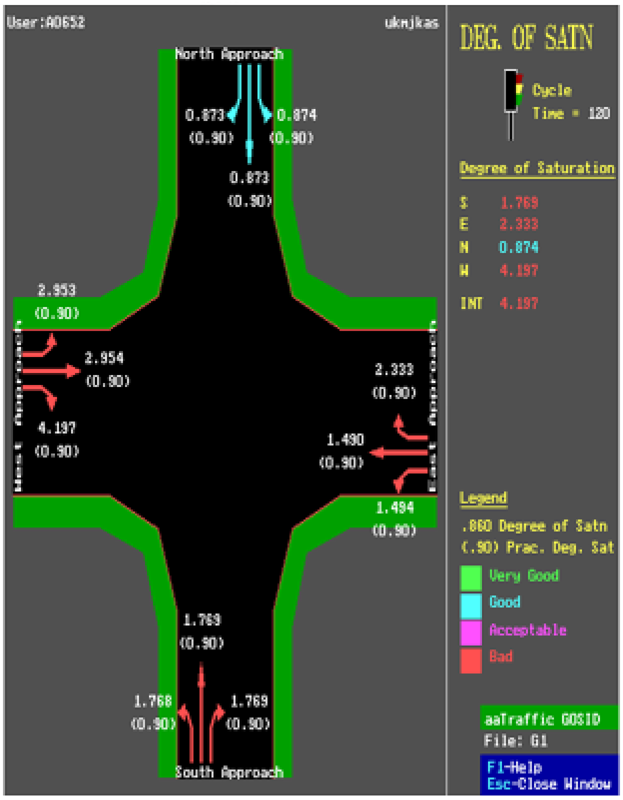


Fig. 8. Description of Existing Condition degree of saturation.

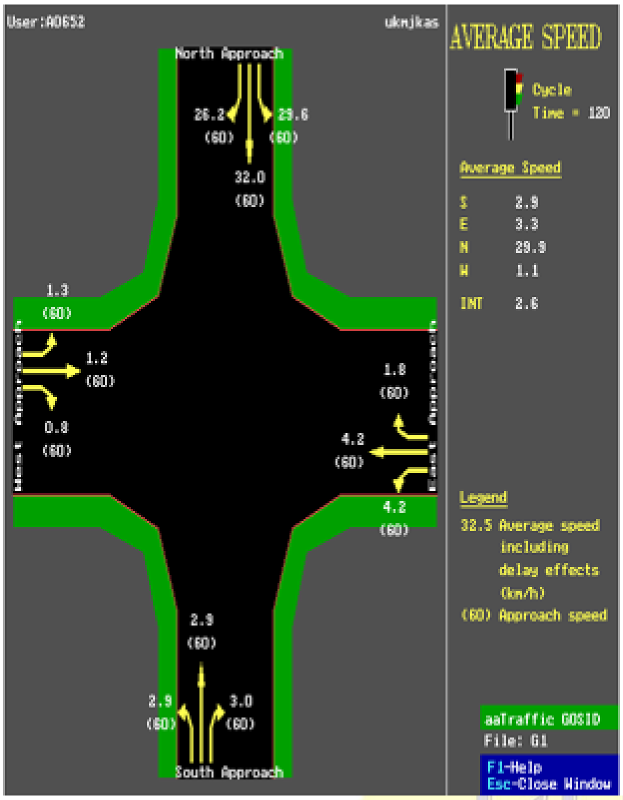


Fig. 9. Description of Existing Condition Avarge Speed.

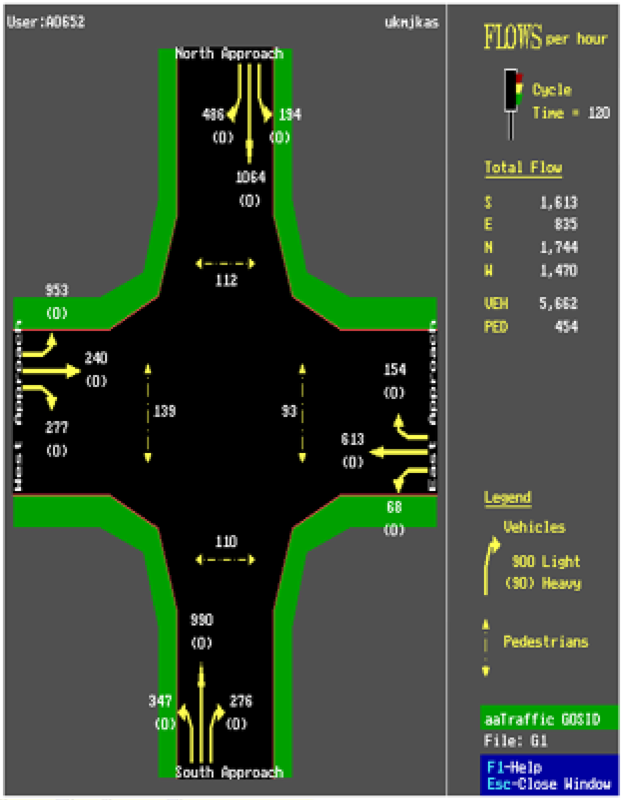


Fig. 11. Description of Existing Condition Flows per hour.

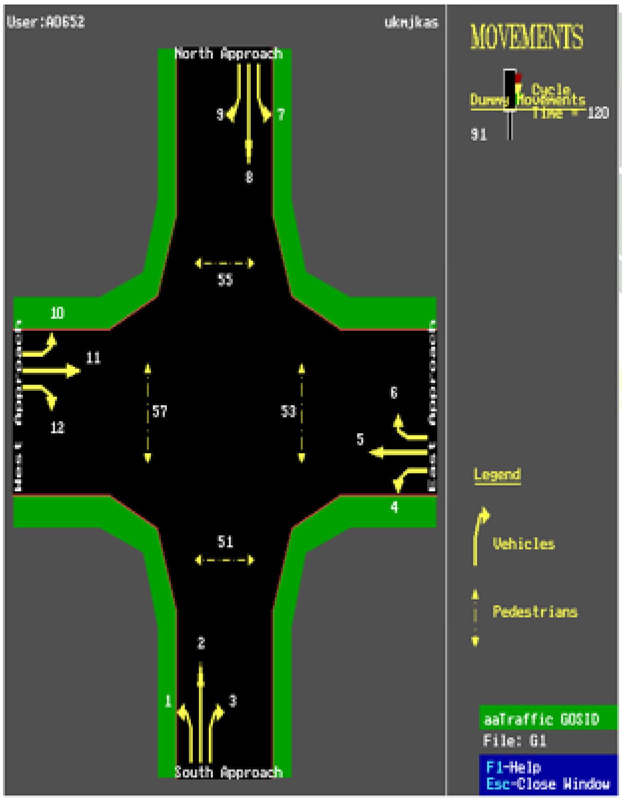


Fig. 10. Description of Existing Condition Movements.

TABLE VII. RESULT FOR C STUDY (INTERSECTION)

| Intersection Parameters | |
|---|---|
| Cycle Time: | = 87 |
| Intersection Level of Service | = F |
| Worst movement Level of Service | = F |
| Average intersection delay (s) | = 36.5 |
| Largest average movement delay (s) | = 74.2 |
| Largest back of queue, 95% (m) | = 109 |
| Performance Index | = 122.91 |
| Degree of saturation (highest) | = 1.0 |
| Practical Spare Capacity (lowest) | = 3 % |
| Total vehicle capacity, all lanes (veh/h) | = 8203 |
| Total vehicle flow (veh/h) | = 3619 |
| Total person flow (pers/h) | = 450 |
| Total vehicle delay (veh-h/h) | = 36.75 |
| Total person delay (pers-h/h) | = 50.52 |
| Total effective vehicle stops (veh/h) | = 3299 |
| Total effective person stops (pers/h) | = 4948 |
| Total vehicle travel (veh-km/h) | = 2350.6 |
| Total cost ($/h) | = 1845.87 |
| Total fuel (L/h) | = 299.1 |
| Total CO2 (kg/h) | = 747.66 |

## CONCLUSION

The aaSIDRA has a good result for analyzing the intersection starting delay, stops, queues, capacities, flows and also phase sequences. Based on the data analyzing from aaSIDRA, it is concluded generally that the direction. It might be caused by low queues value, which is mean the number of the vehicles that pass aljadriya site lower than another sites. And the other hands, the mobility of this site show the dynamic of changing vehicle movement. Besides, it also performs the good quality of air which is produced by the vehicles emission. For the Delay and LOS rating is bad in the level (F) in three phases but in other phase is rating is acceptable in the level (D) shown fig (5 ).But at the Intersection Level For the Queues rating is Bad in the level (F) in three phases but in other phase is rating is very good in the level(A) shown fig (6). While For the Level Stops rating is bad in the level (F) in four phases shown fig (7). Finally for the Level degree of saturation rating is bad in the level (F), for general analyzing, this intersection is marked worst. This analyzing is demonstrated by "F" level of this intersection.

## ABBREVIATIONS

$C_0$ : Optimum cycle time in second. D: Total delay due to traffic interruption (veh-h/h). H: Total number of stops (veh/h). h: Discharge head way seconds / vehicle. K: Stop penalty. L: Lost time in one cycle which includes all read time and starts up delay.Loss: Loss time associated with vehicle starting from rest at the first downstream signal ($2_{sec}$). N': Sum of the average queue length values for all lanes of the movement. Q: Number of vehicles queued per lane in number of Vehicle. qa: The arrival (demand) flow rate. S: Vehicle speed in m per second. $T_{(ideal):}$ Ideal offset in second. Tu: Total uninterrupted travel time (veh-h/h). tu: The uninterrupted travel time. $w_1$: Delay weight. $w_2$: Stop weight. $w_{3:}$ Queue weight. Y: Summation of critical flow ration with saturation Flows at all approaches.

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