TJES
ISSN: 1813-162X
Tikrit Journal of Engineering Sciences
available online at: http://www.tj-es.com

TRAFFIC FLOW ANALYSIS FOR INTERSECTION USING COMPUTER SIMULATION AASIDRA SOFTWARE: A CASE STUDY IN BANGI MALAYSIA

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ABSTRACT
A computer simulation is important for the analysis geometry of freeways and urban streets systems. Transportation specialists can study the formation and removal of congestion on roadways. The intersection is one major cause that has a significant effect on travel time, delay, level of service, queues, stop, performance index, degree of saturation and capacity. The target of this paper research is to analysis the geometry and intersection classification of traffic flow to provide useful information for engineers to design the roads with the shortest travel time and enhance the capacity of road networks and relieve the congestion in cities.
The data required for the study were mainly collected from through video filming technique also the calculation and evaluation are constructed with the aaSIDRA software in the 2011.
KEYWORDS: Analysis, Geometric**,** Intersection, Simulation, aaSIDRA**.**

تحليل انسيابية جريان سير المرور لتقاطع باستخدام المحاكاة بالحاسوب ببرنامج أسدرا : حالة دراسة في بانكي ماليزيا

الخلاصة
أصبحت المحاكاة بالحاسوب مهمة جدأ للتحليل الهندسي للطرق السريعة وانظمة الشوارع الحضرية ، اختصاصيوا النقل يمكن ان يدرسوا تشكيل وازالة الازدحام على الطرق .أن التقاطع هو سبب رئيسي له تاثير على زمن الرحلة ،التأخير ،مستوى الخدمات ،الطوابير ،التوقف،دليل الاداء،درجة الاشباع ،والسعة . ان هدف هذا البحث هو للتحليل الهندسي وتصنيف تقاطع انسيابية جريان المرور لتزويد المعلومات المفيدة للمهندسين لتصميم الطرق بمدة الرحلة الاقصر وتحسين قدرة شبكات الطرق وتخفف من الازدحام في المدن.
البيانات التي تطلبت للدراسة جمعت بشكل رئيسي من خلال تقنية تصوير الفيديو كذلك الحساب والتقييم مبني على اساس برامج الاسدرا في 2011.
الكلمات الدالة: تحليل ،هندسي ، التقاطع ،المحاكاة ، أسدرا.

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.

INTRODUCTION

Bandar Baru Bangi (BBB) city is located between Kajang and Putrajaya and is about 25 km away from the capital city, Kuala Lumpur. The planning for (BBB) is based in structure plan, Local and action area plan, Town centre urban plan and the Town park plan.(BBB) included to education institutions, national institutions and agencies, corporate institutions, factories and industrial training centers and universities[1]. Frequently observed that traffic congestion and long queues at intersections occur during peak hours [2]. This problem is mainly due to the poor coordination between adjacent traffic signal controls, resulting in inefficient progressive traffic flows (or commonly known as the unattainable 'green wave effect') [3]. The problem with car-dependence on societies lies with its large impact on the environment[4] .Other problems are the inability of existing sensors to determine actual traffic demand and the conventional control methodology is unable to determine suitable green time split whenever the traffic demand exceeds capacity. In addition, suitable strategies to disperse congested traffic in major towns and cities cannot be formulated due to the unavailability of experienced traffic experts [5].

Traffic signals are a common form of traffic control used by State and local agencies to address roadway operations [5]. 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 [6].

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 [7].The dual objectives of mobility and safety conflict [7]. To meet increasing and changing demands, one element may need to be sacrificed to some degree to achieve improvements in another [5]. In all cases, it is important to understand the degree to which traffic signals are providing mobility and safety for each of transportation. Assuring the efficient operation of the traffic signal is becoming an increasingly important issue as agencies attempt to maximize vehicle roadway capacity to serve the growing demand for travel. "Quick fixes" and low-cost treatments are increasingly limited [2].

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, Version 1.0. 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 [10, 11 , 12].

The mean of aaSIDRA is (**A**kcelik &**A**ssociates **S**ignalized **I**ntersection **D**esign and **R**esearch **A**id) software is for use as an aid for design and evaluation of the following Intersections types, signalized intersections (fixed-time/pre timed and actuated),roundabouts, two-way stop sign control, all-way stop sign control, and Give-way (yield) sign-control.

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 [13]. 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[14].

aaSIDRA expanded its functionality to cover range problems. **I**t's now uses one of the most advanced methodologies of any traffic design package [15].

It can be used 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,[16] 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 [17] .

In using aaSIDRA can prepare data and inspect output with ease due to the graphical nature of aaSIDRA input and output, Specify data at intersection , approach road , lane and movement levels, obtain output including capacity, timing and performance results reported for individual lanes, individual movement (or lane group), movement groupings (such as vehicles and pedestrians). Control the amount of output by selection individual output tables, with options for summery and full output. In your reports , present your data and results in picture and graphs form, compare alternative (gap-acceptance and "empirical") capacity estimation methods for roundabouts, calculate annual sums of statistics such as operating cost, fuel consumption, emissions, total person delay, stops and so on, and present demonstrated benefits of alternative intersection in a more powerful way. Carry out sensitivity analyses to evaluate the impact of changes on parameters representing intersection geometry and driver behavior. Calibrate the parameters of the operating cost model for your local conditions allowing for factors such as the value of time and resource cost of fuel [1,6].

Geometric delay is the delay experienced by a vehicle going through (negotiating) the intersection in the absence of any other vehicles. Geometric delay (dig) is due to a deceleration from the approach cruise speed down to an approach negotiation speed, travelling at that speed, acceleration to an exit negotiation speed, and then acceleration to the exit cruise speed. Thus, this delay includes the effects of the geometric characteristics of the intersection (negotiation radius and distance, and the associated speeds), as well as the effects of control characteristics (e.g. a stop-sign vs a give-way / yield sign) [4,8].

Methodology

Level of service (LOS) of 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 1**. Queue length in aaSIDRA offers the following options for queue length estimation for all types of intersection:

(a) The cycle-average queue,

(b) 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 [11].

Table 1. Using the ICU method in aaSIDRA criteria for all types of intersection [12]

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

Table 2. Movements in the queues screen of GOSID is based on the queue storage ratio. [12,13]

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

Table 3. Movements in the Degree of Saturation screen of GOSID [13]

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 4. Movements and approaches in the Delay & LOS screen of GOSID [12]

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

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 [12]

$$PI = Tu + w1\,D + w2\,KH/3600 + w3\,N' \quad ... (1)$$

$$Tu = qa\,tu \quad .... (2)$$

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 [11,13] 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[3] as shown table4.

RESEARCH METHODOLOGY

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 1, 2). 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 7:30 am and in the afternoon, begin peak hour 5:00 pm in 17-12-2011 as shown figure 1,2 . All computation is based on traffic flows in intersections, in this study the existing of cycle time each intersection also measured. The two Intersections will be improved to reduce existing congestion and accommodate future growth .The intersection1 is a primarily residential suburb located Bandar Baru Bangi. A residential neighborhood north and west of the intersection, and regional, highway and neighborhood development exists adjacent to the interchange as shown Figure 3. The directions configuration has the following in the four legs Intersections' with signalized included north business area and town centre. The northbound peak-hour through movement demand volume exceeds the capacity of the one provided through lane, which results in queues extending to the westbound ramps [21].East government office, recreational park, hotel and new housing scheme. The peak hour demand volume exceeds the approach capacity, which results in queues that extend more than half the distance to the freeway mainline. Due to limited sight distance (the narrow under crossing restricts the view of southbound through vehicles) right turn on red is prohibited for the eastbound approach, which further reduces capacity. 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 5:00 to 7:00 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 [20].An intersection will be congested because of the heavy traffic flow in every direction especially vehicle from (intersection2) 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 (industry area) [20].While in intersection three legs intersections' with signalized the current configuration has the following South government office, recreational park, hotel and new housing scheme. The southbound peak-hour through movement demand volume exceeds the capacity of the one provided through lane, which results in queues extending to the westbound ramps. East Housing Scheme, gate to Pusat Hentian Kajang and University Kebangsaan Malaysia (UKM) [4].

The peak hour demand volume exceeds the approach capacity, which results in queues that extend more than half the distance to the freeway mainline. West Business Areas 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 as shown Figure 2 and Figure 3.

Optimum Cycle Time.
The maximum cycle time will be 120 seconds

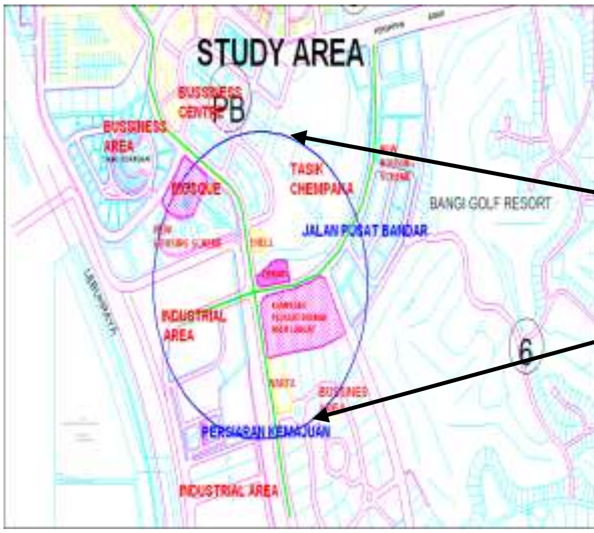

Fig 1. Plan View of Four legs intersections with signalized

Fig 2. Plan View of Three Legs Intersection in Bangi. [20]

Data Collection (Traffic Surveys)
The study consists of eight main activities as shown in Figure 4. 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 5:00 to 7:00 pm hourly counts were used as input data for analysis using aaSIDRA software [21].

Calculation 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 5

The Webster a formula is given as Follows [22].

$$C_o = \frac{1.5L + 5}{1 - \sum y} \quad \text{...............................} \quad (4)$$

Saturated Flow=1800*2=3600 pcu/h.. (5)
L= 4 directions (4 sec) = 16 sec
C0 = 1.5*16 +5/ (1- 0.585) = 70 sec

Cycle time = effective green time + Amber time + All red .... (6)
Amber for all = 3*4 =12 sec
All red = 1*4 =4 sec
Effective green time = 70 - (4+12) =54sec

From the table 8 will choose the largest cycle time to confirm as a cycle time for all intersections
C0 = 70 Sec.

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 [23] as shown Figure 5.

$$T_{ideal} = \frac{L}{S} - \left(Qh + Loss \right) \ldots\ldots\ldots\ldots\ldots (7)$$

RESULTS

This paper attempt to analysis geometrical and classification intersections to detection out which one is more capable to analysis of the roads in transferring the traffic in the BBB with each other to find out what is the best choice for the roads. Data collection for the traffic flow of the two intersections and between Jalan Pusat Persiaran Kemajuan Bangi and Jalan Pusat Bandar 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 peak hour from 7:00 to 9:00 am and in the afternoon, begin peak hour 5:00 to 7:00 pm.

Intersection1 Analysis Software for Jalan Pusat Persiaran with Kemajuan Bangi

It is indicated from table 10 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 good because the Intersection Level of Service (LOS) is(C), 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 Acceptable in the level (D) in four phases but in other phase is rating is very good in the level (A) shown figure7 .But at the Intersection level For the queues rating is very good in the level A in four phases but in other phase is rating is bad in the level F shown figure 8.While for the level stops rating is between (B, F, D) good, bad acceptable, in all phases shown figure 9. Finally for the level degree of saturation rating is between (A, B) very good, Furthermore, for all the phases has been good as shown figure 10.

Intersection2 Analysis Software for Jalan Pusat Bandar

It is indicated from Table 11. it's obvious that having the intersection 2 is better than the intersection1 is very good result for analysis geometric the Level of Service, Average intersection delay, Degree of saturation, stops, queues. Based on the data analyzing from aaSIDRA, For the Delay and LOS rating is between (A, D, F) very good, acceptable and bad in the three phases shown fig 12 But at the Intersection level for the queues rating is very good in the level (A)in the three phases shown fig 13.While for the level stops rating is between (D, B, A) acceptable, good, and very good in all phases shown figure 14. Finally for the Level degree of saturation rating is between (A, B) very good, Furthermore, for all the phases has been good as shown figure 15.

CONCLUSIONS

The aaSIDRA method emphasizes the consistency of capacity and performance analysis geometry methods for Intersections, sign-controlled, and signalized intersections through the use of an integrated modeling framework. Intersections are two critical places that have a significant role in conducting the traffic and some software are produced to design and analyzing the situation of the roads. A case study performance of a theoretical intersections with that of the existing traffic signal show a significant improvements in terms of stops, queue length and level of service and can be improve The cycle time been reduced into shorter time, To make the turn right lane become longer and improves the capacity of the leg, change the phasing sequences, using intelligent traffic control system. AaSIDRA was used as the tool for analyses geometric, the results indicate that to properly use the program, there is a need to calibrate it to reflect local traffic situation. However, based on values of performance indicators, it is clear that intersection2 performs better than the signalized intersection1.

Future Studies

In this case forecasting the future and the increase that will get to grow in the Bandar Baru Bangi (BBB) by the total population will be growing the Results will be within the limits permissible.

Acknowledgment

Special thanks to Associated Professor Amiruddin Ismail and Professor Riza Atiq O.K.Rahmat and staff for Sustainable Urban Transport Research Centre laboratory for their guidance, Department of Civil and Structural Engineering, Faculty of Engineering and Built Environment, The National University of Malaysia (UKM), Selangor Malaysia.

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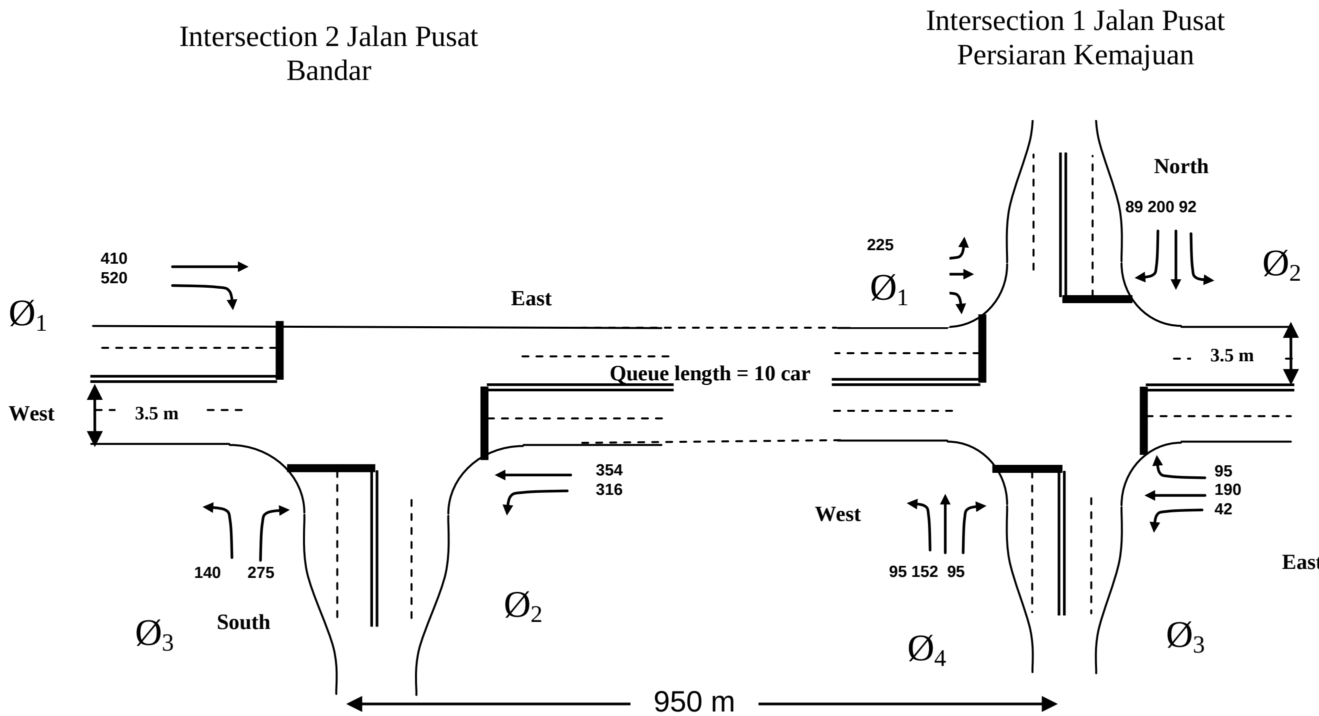


Fig.3 an illustration of two signalized intersections between Jalan Pusat Bandar And Persiaran Kemajuan

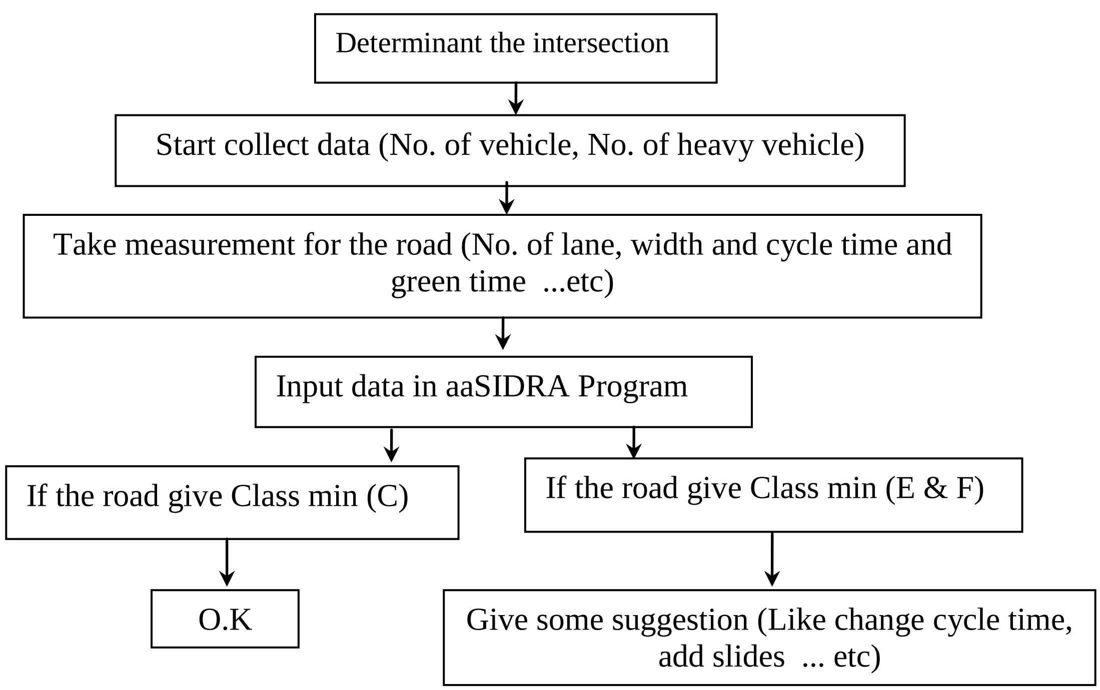


Fig. 4 Flow chart showing the Main Procedure analysis

Table 5 Estimate the effective green time in Intersection1

Phase	Left	Straight	Right	Total Actual Flow (a)	Saturated Flow pcu/h (v)	Y=a/v
Ø1	313	374	321	1008	3600	0.28
Ø2	111	172	117	400	3600	0.111
Ø3	130	80	140	350	3600	0.097
Ø4	61	144	145	350	3600	0.097
						Y=0.585

Table 6 Classification effective green for each intersection

Phase	Y=a/v	Effective green time (sec)
Ø1	0.28	26
Ø2	0.111	10
Ø3	0.097	9
Ø4	0.097	9
	Y=0.585	54

Table 7. Estimate the effective green time in Intersection 2

Phase	Left	Straight	Right	Total Actual Flow (a)	Saturated Flow pcu/h (v)	Y=a/v
Ø1	520	410	-	930	3600	0.25
Ø2	316	354	-	670	3600	0.123
Ø3	224	236	-	460	3600	0.092
						Y=0.574

Table 8. Classification effective green for each intersection

Phase	Y=a/v	Effective green time (sec)
Ø1	0.25	23
Ø2	0.123	11
Ø3	0.092	8
	Y=0.574	42

Table 9. choose the largest cycle time

Intersection	Cycle time (sec)
Intersection 1	70
Intersection 2	54

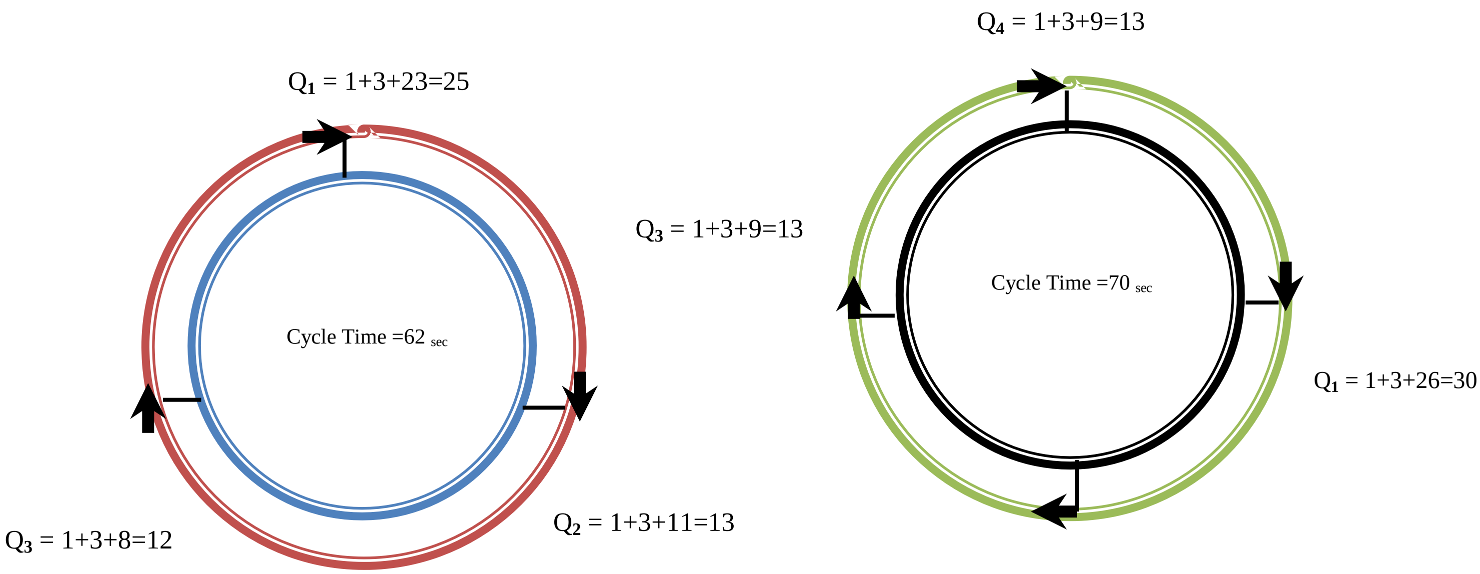


Fig 5. Signal Controller Setting

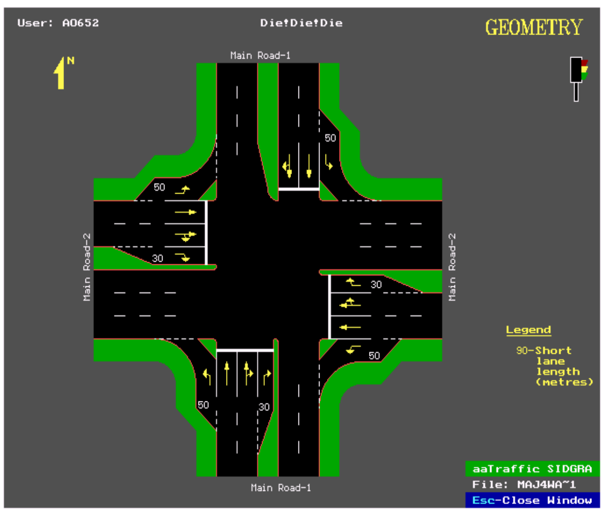


Fig.6 Intersection road Persiaran Kemajuan (main road)

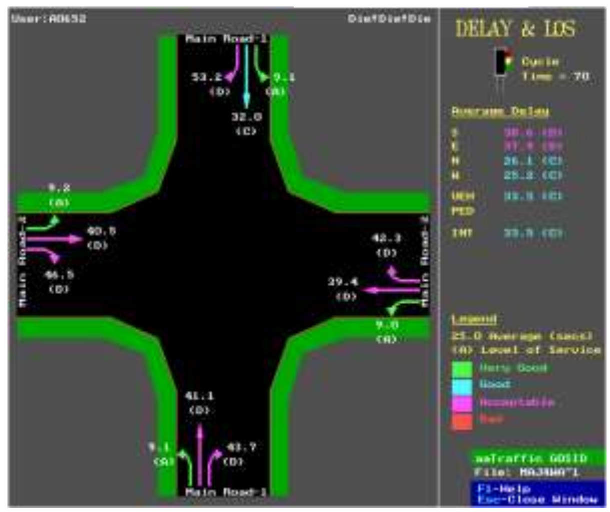
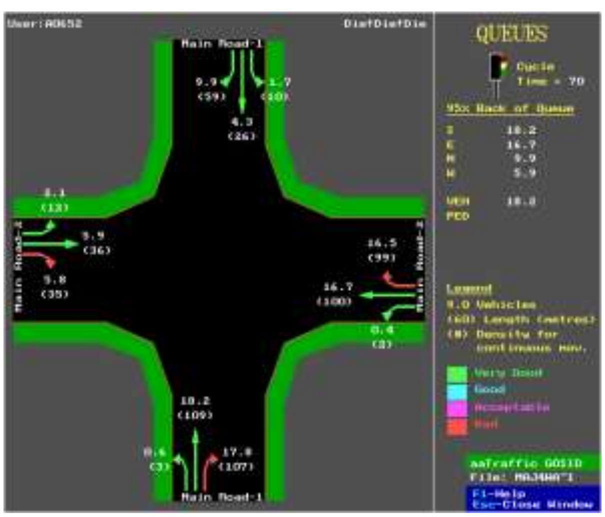


Fig 7. Description delay and Level of Service (LOS)



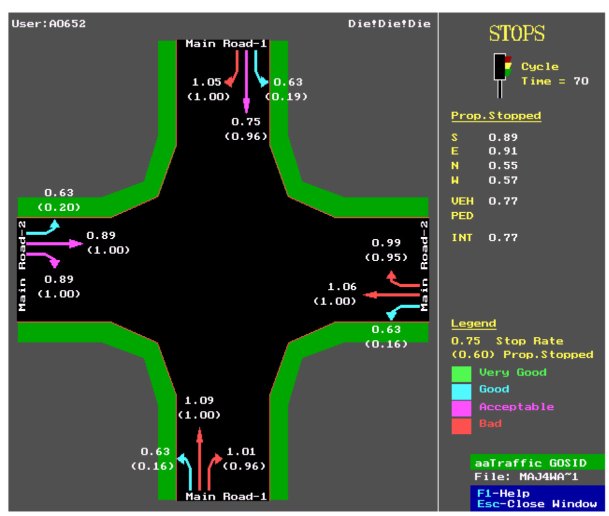


Fig 8. Description of Existing Condition - Queues at the Intersection **Fig 9.** Description of Existing Condition Stops at the **Intersection**

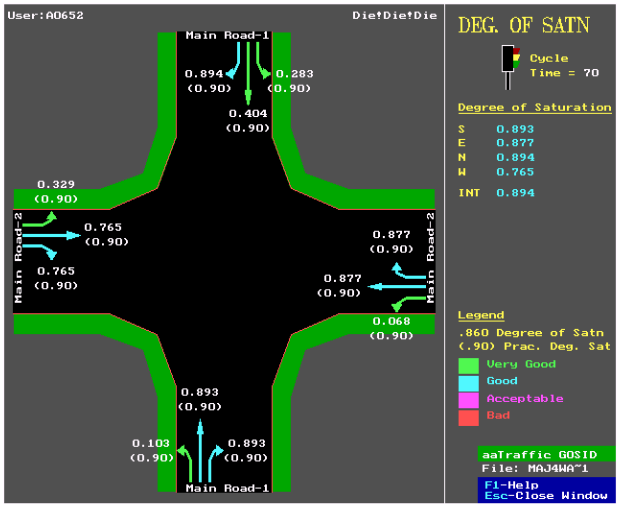


Fig10: Description of Existing Condition degree of saturation at the intersection

Table 10 Result For Case Study 1(Jalan Pusat Persiaran Kemajuan)

Intersection Parameters	
Cycle Time:	= 70
Intersection Level of Service	= C
Worst movement Level of Service	= D
Average intersection delay (s)	= 33.5
Largest average movement delay (s)	= 53.2
Largest back of queue, 95% (m)	= 109
Performance Index	= 157.91
Degree of saturation (highest)	= 0.894
Practical Spare Capacity (lowest)	= 1 %
Total vehicle capacity, all lanes (veh/h)	= 8203
Total vehicle flow (veh/h)	= 3619
Total person flow (pers/h)	= 5429
Total vehicle delay (veh-h/h)	= 33.68
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
Total cost ($/h)	= 1845.87
Total fuel (L/h)	= 299.1
Total CO2 (kg/h)	= 747.66

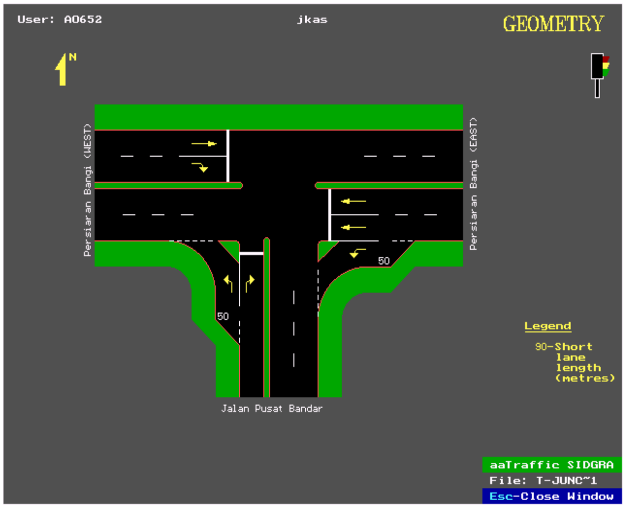


Fig.11 intersection Jalan Pusat Bandar

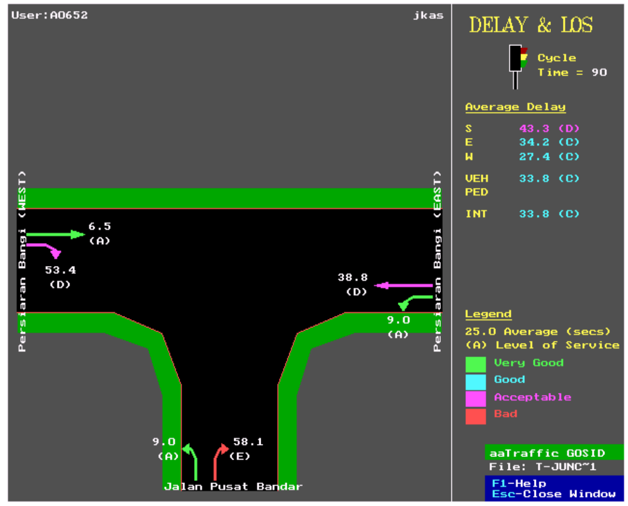


Fig 12 Description delay and Level of Service (LOS)

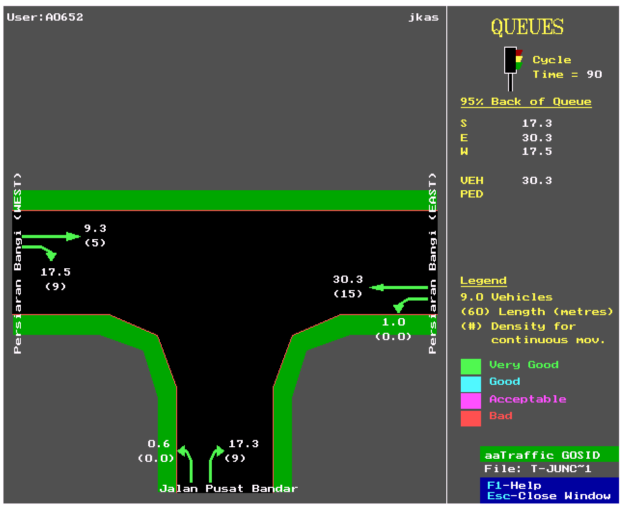


Fig 13. Description of Existing Condition – Queues at the Intersection

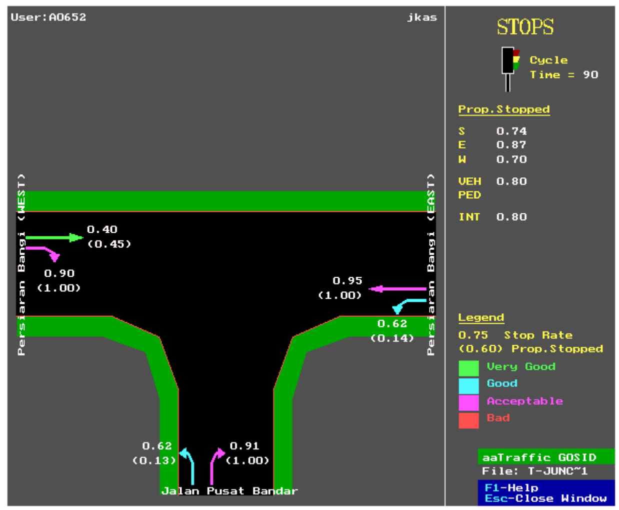


Fig 14. Description of Existing Condition - Stops at the Intersection

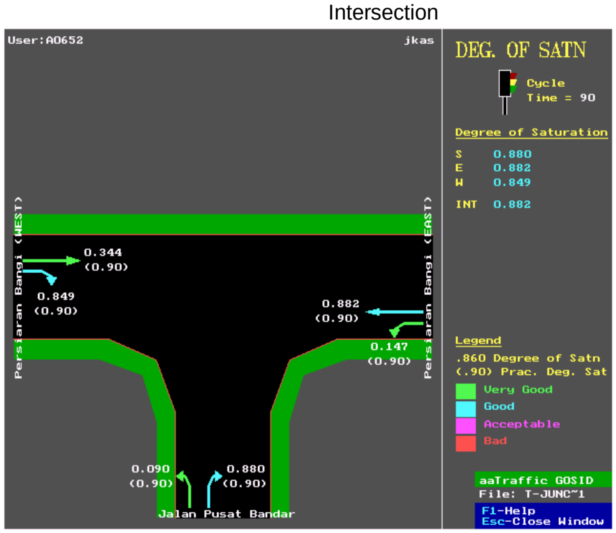


Fig. 15 Description of Existing Condition - degree of saturation at the Intersection

Table 11 Results For Case Study 2(Jalan Pusat Bandar)

Intersection Parameters	
Cycle Time:	= 90
Intersection Level of Service	= B
Worst movement Level of Service	= B
Average intersection delay (s)	= 32.6
Largest average movement delay (s)	= 43.7
Largest back of queue, 95% (m)	= 60
Performance Index	= 110.57
Degree of saturation (highest)	= 0.945
Practical Spare Capacity (lowest)	= 11 %
Total vehicle capacity, all lanes (veh/h)	= 2060
Total vehicle flow (veh/h)	= 1793
Total person flow (pers/h)	= 3706
Total vehicle delay (veh-h/h)	= 15.73
Total person delay (pers-h/h)	= 40.68
Total effective vehicle stops (veh/h)	= 2346
Total effective person stops (pers/h)	= 3764
Total vehicle travel (veh-km/h)	= 2040
Total cost ($/h)	= 2496.74
Total fuel (L/h)	= 654.7
Total CO2 (kg/h)	= 536.22