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# Evaluating the Performance of Traffic Flow in Four Intersections and Two Roundabouts in Petaling Jaya and Kuala Lumpur Using Sidra 4.0 Software

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**Graphical abstract**

**Abstract**

Delays represent one of the indirect costs in terms of frustration, loss of time and discomfort to the drivers. On the other hand, it represents a direct cost in terms of fuel consumption/wastage on road networks during idleness and inactivity. Extreme delay at signalized intersections reflects the incompetence in the signal timing because of consecutive signalized intersections on the particular site. The traffic parameters performance is not a feasible method or practice. Furthermore, one of the significant ways to improve the performance of the network is by coordinating traffic signal in intersections. This study was done to highlight the ability of improving the level of service (LOS) of four intersections; two of them with four legs and two with three legs as well as two roundabouts in Kuala Lumpur and Petaling Jaya using SIDRA software version 4.0. In addition, the study aims to compare the results between each peak hour in terms of percentage of change in the variables and the delay. Moreover, consideration of geometric delay should be taken into account when comparing delays in peak hours in the morning and the evening peak hours. The results obtained show that the morning period is better than the evening period for the value of delay, queue, journey time and speed that was obtained from practical measuring in the study area. The average reduction of delay in the study area before and after optimization of SIDRA software is from 3489 Sec to 1571 Sec in the morning period as well as 5093 Sec to 1663 Sec in the evening period. The percentage of reduction was about 45% and 33% -respectively.

*Keywords*: Delay; fuel consumption; signalized intersections; Level of Service (LOS); SIDRA software



## 1.0 INTRODUCTION

Computer simulation is very essential for the analysis of freeway and urban street systems. Specialised engineering in simulation can study the formation and dissipation of congestion on roadways, assess the impacts of control strategies and compare alternative geometric configurations [1]. Developments in traffic flow theory and computer technology have led to the widespread creation and use of traffic simulation models by traffic engineers and transportation designers involved in the planning operations and design of transportation facilities [2]. Prior to the development of traffic simulation, model studies for planning and improving roadway facilities was typically undertaken by computational methods that could estimate capacity, delay level of service and other parameters for a given set of roadway conditions [3]. Traffic simulation models are able to provide these measures of effectiveness and also provide an added dimension to the ability to analyse roadway traffic conditions. Because simulation models track the movements of vehicles on an individual basis, they allow the analyst to test a wide range of roadway configurations and operational conditions that far exceed the limits of more conventional analysis tools [4]. Highway traffic congestion is one of the major problems that challenge developed countries around the world. As a result of traffic congestion at intersections in Malaysia, delays and long queues are observed repeatedly during peak hours due to the poor strategies of road networks [5]. In recent decades in Malaysia , an explosive growth in the demand for transport vehicles and the total number of recorded motor vehicles in Malaysia has grown up to 15 million and hence, increasing the number of vehicles cause traffic congestion, resulting in slower travel speed [6]. Highway traffic rules/regulations are required to develop better traffic capacity by controlling the high volume of traffic flow and at the same time expect the rise of future traffic flow volume. Therefore, a need to find out an applicable modern software have arised, to avoid the overcrowding of traffic congestion at intersections.

Traffic flow through intersections has great influence on traffic performance of a roadway network. All around the world, many types of traffic control are used at intersections such as; stop signs, yield signs, signals and roundabouts. It is known that traffic signals are used to provide safety and efficient traffic flow through intersections. Moreover, traffic signals reduce certain types of accidents, enhance safety and reduce traffic delay while increasing the traffic handling capacity of an intersection and improving the orderly movement of traffic [7].

The Signalized Intersection Design and Research Aid (SIDRA) Software is an intersection-based platform established by the Australian Road Research Board (ARRB) in Australia as an assistance for timing, capacity, and performance analysis of isolated intersections. SIDRA is a very powerful analytical program for signalized intersections [8]. The SIDRA intersection software is used as an aid in the design and evaluation of signalized intersections (fixed-time/pretimed and actuated), signalized pedestrian crossings, roundabouts, single point interchanges, roundabout metering, two-way stop sign control, all-way stop sign control, and give-way/yield sign-control. The flexibility of SIDRA Intersection permits its application to many other situations, including uninterrupted traffic flow conditions and merging analysis [9]. SIDRA Intersection is an advanced micro-analytical traffic evaluation tool that employs lane-by-lane and vehicle drive-cycle models coupled with an iterative approximation method to provide estimates of capacity and performance statistics (delay, queue length, stop rate). SIDRA intersection provides various facilities for this purpose. The use of HCM version of SIDRA Intersection is based on the calibration of model parameters against the highway capacity manual [10].

## 2.0 STUDY AREA

The selection and identifying the study area is considered one of the biggest challenges, especially in the big and crowded urban centers such as Kuala Lumpur and Petaling Jaya To ensure that the selected study area chosen, is the region which experiences traffic congestion at peak hours at intersections, several field visits have been made to determine the overall situation of congestion. The study was carried out at four intersections; two four-leg intersections, two three-leg intersections and two roundabouts. As shown in the figures below, Figure 1 shows the suggested four leg intersection in Ampang, Kuala Lumpur, and Figure 2 shows suggested three legs intersection in Bukit Bintang and Kuala Lumpur. Figure 3 and 4 show the study area proposed four and three legs intersections in Petaling Jaya. Finally Figure 5 and 6 shows both roundabouts in Petaling Jaya.


**Figure 1** Proposed study areas in Ampang, Kuala Lumpur. *Source:* Google Earth 2014


**Figure 2** Proposed study areas in Bukit Bintang, Kuala Lumpur. *Source:* Google Earth 2014


**Figure 3** Proposed study areas in university, Petaling Jaya. *Source:* Google Earth 2014

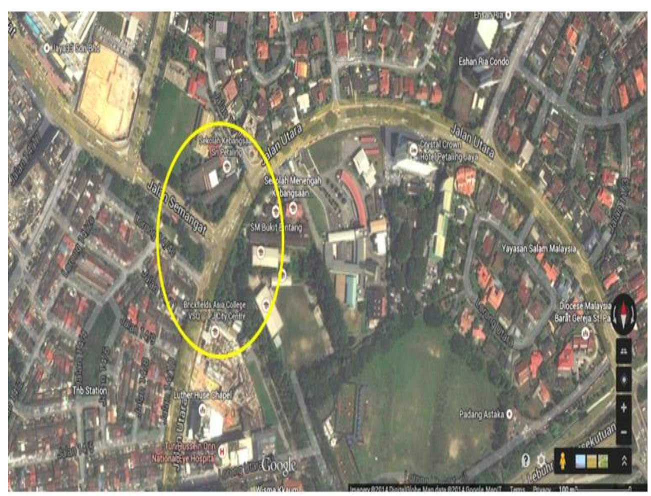


**Figure 4** Proposed study areas in university, Petaling Jaya. *Source:* Google Earth 2014

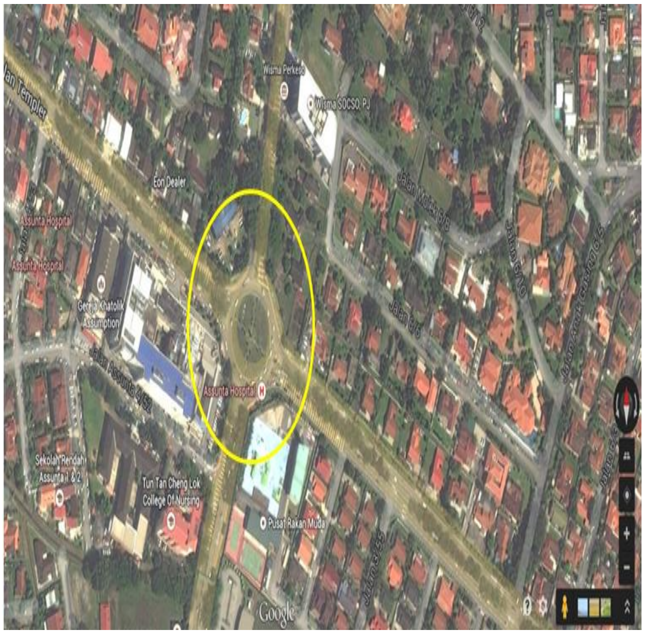

**Figure 5** Proposed study areas in university, Petaling Jaya. *Source:* Google Earth 2014

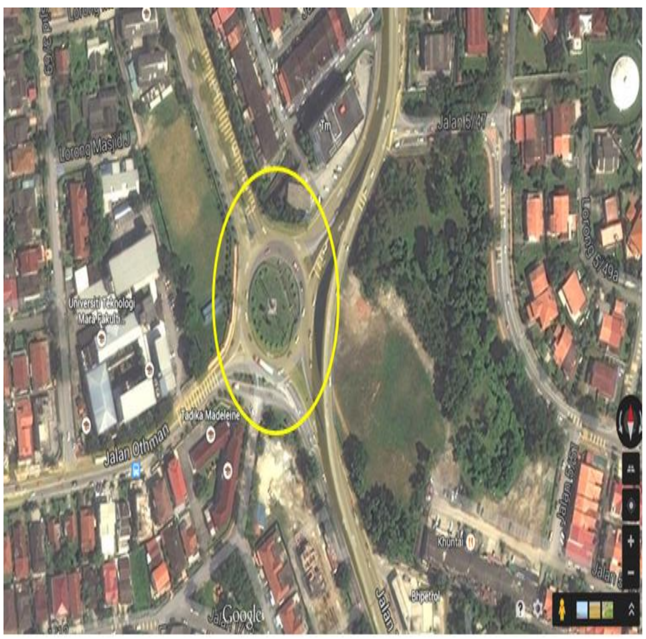

**Figure 6** Proposed study areas in university, Petaling Jaya. *Source:* Google Earth 2014

## ■3.0 METHODOLOGY

The collected data were used as inputs for SIDRA 4.0 software. The results obtained were compared using graphs. The variables were collected from the field; traffic flow volume, the cycle time, phase movement of intersections and queue length. Once data are collected, they were expanded and analyzed. The methodology of this study was divided into four main steps; Data collection, data analysis by software SIDRA 4.0, result optimization and conclusion and selecting the appropriate intersections that normally experience traffic congestion.

## ■4.0 DATA COLLECTION

Data were collected for a total of six hours at four signalized intersections and two roundabouts in the study areas. These areas were considered potential by looking at the plots of traffic capacities and being able to determine different levels of traffic volumes; high, moderate and low, in order to cover a wide range of data. Data were collected during normal working days, using a video camera in order to record the whole movement of vehicles at intersections and roundabouts. The peak hours' time has been noted after several field visits from 5:30 Pm to 7:30 Pm or the evening period..

## ■5.0 RESULTS AND DISCUSSION

### 5.1 Existing Site of Study Area

The delay, queue, journey time and speed obtained from practical measuring at the site were evaluated and graded. The said grades show the level of service (LOS) in the case study and range from D to F. Drivers experienced long delays, long travel time and slow speed traffic. The Table 1 below shows the existing situation of LOS of study areas.

**Table 1** Existing site of the level of service (LOS) in the study area

| INTERSECTION | LOS AM | LOS PM |
|---|---|---|
| INTERSECTION 1 | F | E |
| INTERSECTION 2 | D | E |
| INTERSECTION 3 | D | E |
| INTERSECTION 4 | E | F |
| ROUNDABOUT 1 | F | F |
| ROUNDABOUT 2 | F | F |

The results obtained also show the average LOS for Intersections and Roundabouts in Morning period and Evening period. The grades range between D and F, thus the current situation needs to improve in order to reduce the traffic jam as well as to try control traffic at Intersections and Roundabouts.

### 5.2 Results Improvement

The steps to improve the results by software SIDRA 4.0 is first, to adjust the cycle time; second is increasing the shoulders of the Intersections and lastly, working with added new lines to increase the capacity of the intersections.

### 5.3 Results After Improvement

The percentage dissimilarity/discrepancy observed before and after improvement is shown in Table 2 and Table 3 shown level of service after improvement after we use these general points:

i. Increasing the cycle time of the intersection, according to the volume of traffic flow at the intersection.

ii. Opening slip lines (give way) to reduce the amount/volume of congestion and long queue
iii. Adding new lanes to increase the capacity of intersection or roundabout

**Table 2** Level of service after improvement morning period

| NO | LOS before improve | Delay (S) BEFORE | LOS after improve | Delay (S) AFTER |
|---|---|---|---|---|
| 1 | F | 940 | C | 380 |
| 2 | D | 252 | C | 141 |
| 3 | D | 231 | C | 146 |
| 4 | E | 913 | C | 398 |
| ROU1 | F | 301 | B | 249 |
| ROU2 | F | 764 | C | 257 |

**Table 3** Level of service after improvement evening period

| NO | LOS before improve | Delay (S) BEFORE | LOS after improve | Delay (S) AFTER |
|---|---|---|---|---|
| 1 | E | 806 | C | 345 |
| 2 | E | 454 | C | 196 |
| 3 | E | 401 | C | 152 |
| 4 | F | 1012 | C | 353 |
| ROU1 | F | 1380 | C | 343 |
| ROU2 | F | 1040 | C | 247 |

## 5.4 Results Comparison Diagrams

The results of a reduction percentage (%) of the study before and after optimization of SIDRA 4.0 revealed that the total travel time, total delay, total stops, fuel consumption, performance index and level of service. Comparison of the variable outcome from the SIDRA 4.0 program for morning period and evening period in Kuala Lumpur and Petaling Jaya is shown in Figure 6.

The average delay in the evening period is greater than the morning, probably/most likely due to the motorists going to work at different hours in the morning, but returns home all at the same time at the end of the day, causing heavy traffic congestion. The total average delay for the morning period as shown in Figure 6 is nearly 3489 Sec, but after the optimization of SIDRA software, it reduced down to 1571 sec. On the other hand, the average delay for the evening period as shown in Figure 7 is near to 5093 sec. After applying the SIDRA software, an improvement was seen and the average delay had reduced down to 1663 Sec. The percentage of reduction was about 45% and 33% respectively.

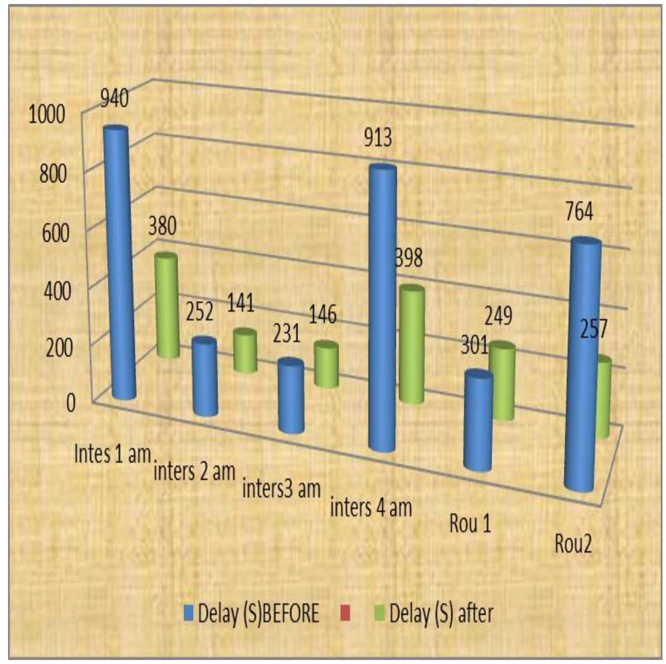


**Figure 6** Shows delay average for the morning period at intersection; 1 four legs KL, 2 three legs KL, 3 four legs PJ, 4 three legs PJ and Rou 1, Rou 2 are roundabouts

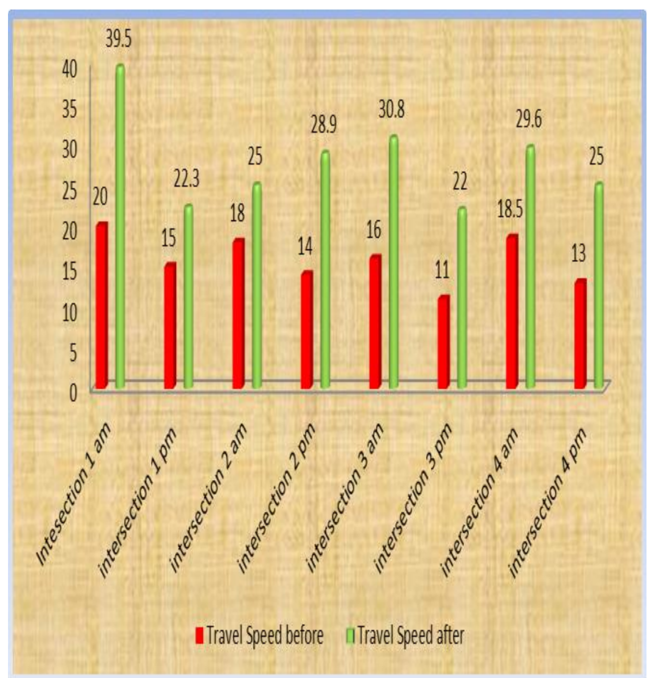


**Figure 8** Travel speed for morning and evening periods at intersections and roundabouts

It is known that the speed on the roads is in direct correlation with traffic congestion, and also note from the Figure 8 that the rate of speed is very slow, but with using SIDRA software optimization, the speed on the roads managed to improve up to 56 %.

Furthermore, the most important variable which affects the motorists' economy is fuel consumption i.e: more stops on intersections and frequent delays at road networks mean more fuel consumption. The recent standing situation in Figure 9 shows that drivers waste fuel during multiple stops and delay at intersections, but SIDRA software optimization succeeded to minimize the fuel consumption from 1039.9 Lit/hr to 453.7 Lit/hr in morning period and from 1133.9 Lit/hr to 460.8 Lit/hr in the evenings. Thus, the percentage of reduction is up to 44% and 41% respectively.

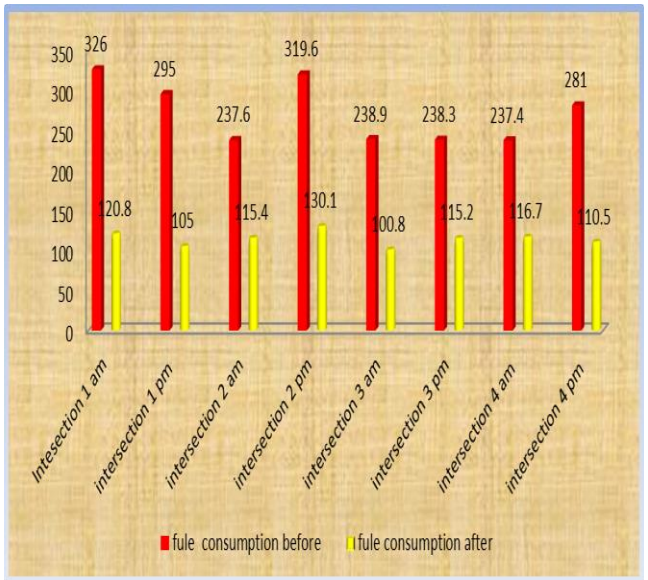


**Figure 9** Fuel consumption of morning and evening period at intersection and roundabouts

## 6.0 CONCLUSION

Improvement of traffic signal coordination and timing is one of the most important strategies for increasing travel speed and reducing delays and fuel consumption in urban areas. The assessment of the corridor or network optimization for pre-timed signal system using different software was done many times by many authors. Recently, the coordinated actuated corridor or network optimization became more necessary than before. But there were not many software that are able to deal with actuated coordinated signals. By using recent version of SIDRA 4 package, it was revealed that the total delay averages and fuel consumption has decreased, and the system travel speed has increased, thus, a great range of reduction has been observed from the results before and after optimization of traffic flow at the intersections. During this study the observations that have been recorded in the field of study areas are as follows:

i. The LOS in the morning period was better than the evening period, which means that the volume of traffic flows in the evening more than the morning period.
ii. The capacity of an intersection and roundabout was unable to absorb the huge volume of traffic flow at rush hours.
iii. Some intersections and roundabout need new lanes to be added to reduce the congestion and improve system speed.
iv. Some intersections couldn't have new lanes added to them. Therefore, alternative routes must be opened to reduce traffic jam at these intersections.

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## References

[1] J. Salzman, J. Ruhl, and K.-S. Song. 2002. Regulatory Traffic Jams. *Wyo. L. Rev*. 2: 253.
[2] W. Hook and M. Replogle. 1996. Motorization and Non-motorized Transport in Asia: Transport System Evolution in China, Japan and Indonesia. *Land Use Policy*. 13: 69–84.
[3] L. Oduwaye. 2007. Effects of Institutional Land Uses on Road Traffic in Metropolitan Lagos. *The Social Sciences*. 2: 255–263.
[4] J.-F. Akinbami and S. Fadare. 1997. Strategies for Sustainable Urban and Transport Development in Nigeria. *Transport Policy*. 4: 237–245.
[5] S. I. Albrka, A. Ismail, H. A. Yahia, and M. A. Ladin. 2014. Application of Transyt-7f on Signalized Road Junction Networks in Shah Alam and Petaling Jaya. *Jurnal Teknologi*. 69.
[6] N. M. Shariff. 2012. Private Vehicle Qwnership and Transportation Planning in Malaysia. In *International Conference on Traffic and Transportation Engineering*.
[7] B. H. Al-Omari and M. M. Ta'amneh. 2007. Validating HCS and SIDRA Software for Estimating Delay at Signalized Intersections in Jordan.
[8] H. Taale and H. Van Zuylen. 2001. Testing the HCM 1997 Delay Function for Dutch Signal Controlled Intersections. In *Proceedings of 80th Annual Meeting of Transportation Research Board, Washington DC*. 3.
[9] R. Akcelik and M. Besley. 2003. Operating Cost, Fuel Consumption, and Emission Models in aaSIDRA and aaMOTION. In *25th Conference of Australian Institutes of Transport Research (CAITR 2003)*. 1–15.
[10] H. C. Manual. 2000. *Highway Capacity Manua*l. Washington, DC.
[11] Google Earth 2014.