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Application of Transyt-7f on Signalized Road Junction Networks in Shah Alam and Petaling Jaya

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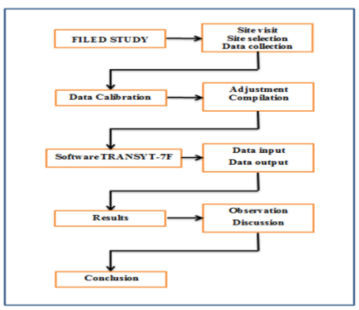
Graphical abstract



Abstract

Traffic Network Study Tool Version 7F software (TRANSYT-7F) is one of the traffic programs used in analyzing and evaluating the performance of road junction networks based on simulation and signal timing optimization. This paper describes the study conducted during evening peak periods in two cities in Malaysia: Shah Alam and Petaling Jaya. The main objectives of this study are to evaluate and compare the performance of road junction networks in Petaling Jaya and Shah Alam cities using TRANSYT-7F software, the performance of road networks such as; Total Travel Times (TTT), Average Delays (AVD), System Wide Travelling Speed (SWTS), Operating Cost (OPC), Level Of Service (LOS), Fuel Consumption (FUC) and Performance Index (PI). The results obtained have shown a clear indication that the software is able to improve the performance of road junction networks in Shah Alam and Petaling Jaya. TRANSYT-7F had increased the SWS in rush hours in various study fields, where the percentage of improvement in the Shah Alam city is up to 23% as well as the Petaling Jaya city is up to 41%. On the other hand, TRANSYT-7F had reduced the FUC up to 33% in Shah Alam and 54% in Petaling Jaya. Moreover, a reduction of PI is nearly 16% and 33% in both cities respectively.

Keywords: TRANSYT-7F; average delays; level of service; travelling speed; fuel consumption and performance index

1.0 INTRODUCTION

Road traffic congestions continue to be a major problem in many cities around the world, especially in developing countries where there have been massive delays, increased Average Delays AVD, Fuel Consumption FUC and Operating Cost OPC due to the poor strategies of road networks. Traffic congestion and long queues at the intersections occurred during rush hours repeatedly observed in Malaysia. It has observed a significant rise in the request of vehicles in recent years in Malaysia concurrent with speedy economic improvement [1]. The inability of the public transport system to accommodate the huge number of travelers in Malaysia has led to the flourishing private transports and increases of up to 24% of private transports noted between1985-2005 [2]. The entire quantity of recorded motor vehicles in Malaysia has grown to fifteen million and hence, the increased number of vehicles causes traffic congestion and slower travel speed [3]. Road traffic regulations are required to improve tidal traffic capacity by controlling concurrently the flow of traffic direction and estimate future increase as well as to find out applicable solutions to prevent traffic congestion on busy intersections.

TRANSYT-7F is a traffic software used for analysing and evaluating the performance of the road networks based on simulation and signal timing optimisation [4, 5]. TRANSYT-7F software used to evaluate the current performance standing of traffic signal, then optimising it to develop the quality of traffic signal system performance. The program optimises the performance of urban signal systems with respect to delay, number of intersection stops and FUC [6]. TRANSYT-7F software has been used to minimize the performance of signalized road networks and the percentage varies from 2.00% to 76.15% [7].

2.0 RESEARCH METHODOLOGY

The study focuses on traffic jam issues in Petaling Jaya and Shah Alam for a total of twenty six intersections, with the intersections performances analysed by using TRANSYT-7F software. The variables to be collected from the data are the cycle time, queue length, traffic flow volume and phase movement of intersections. Once data are collected, they will be expanded and analyzed. Data will be stratified to both cities and system simulates using TRANSYT-7F software and the results will be compared. Figure 1 shows the methodology of the study. The traffic volume data were not collected during the inclement weather or uncommon traffic conditions such as accidents, ceremonies or public events. Data were collected for the period of fifteen minutes in the evening of the rush hours; the rush hours were noticed from 7:30 am to 8:30 am in the morning and from 4:30 pm to 5:30 pm in the evening.

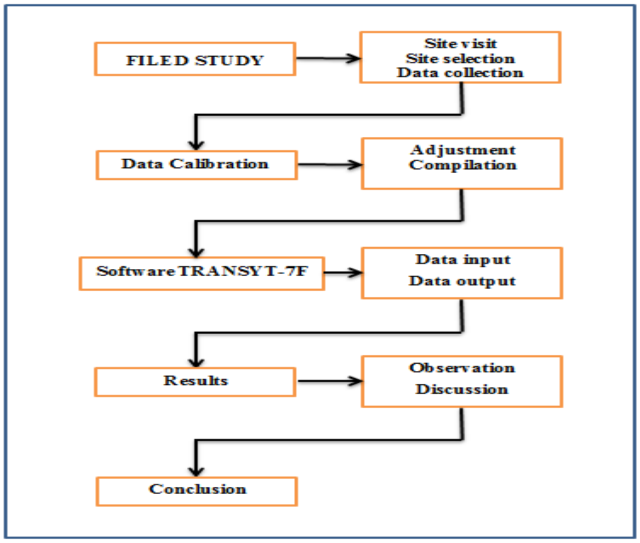


Figure 1 Methodology of study

■3.0 STUDY AREA

Petaling Jaya and Shah Alam are two large and rapidly growing cities in Malaysia. Petaling Jaya had a total population of over 619,925 people in 2013 and the city now is known as the leading growth center in Selangor [8]. On the other hand, the capital of Selangor state Shah Alam had a population of 652,103 people in 2013, witnessed many people travelling in their own vehicles, resulting in traffic jams especially during the peak hours [9]. The study areas in Petaling Jaya and Shah Alam are as shown in Figures 2, 3. The study considers certain regions in the most important urban areas in both cities in terms of their active traffic, which causes traffic congestion in the morning and evening peak hours. Thirteen signalized intersections were selected from each city after several field visits to all regions were conducted to select the appropriate intersections that normally experience traffic congestion.

Figure 2 Shown study field in Petaling Jaya. *Source:* Google earth 2012

■4.0 SUGGESTIONS FOR OPTIMIZATION

The intersections are a higher priority projects to widen roadways and increase the capacity of roads, avoiding the congestion and obstacles that have challenged the drivers at intersections. In fact, there are proposals laid out to improve the level of services in these intersections. The said intersection proposals are:

- The addition of new movement of phases.
- Added special lanes (slip) for the vehicles to turn left.
- Additional lanes to the road to estimate the large volume of traffic flow at rush hours.

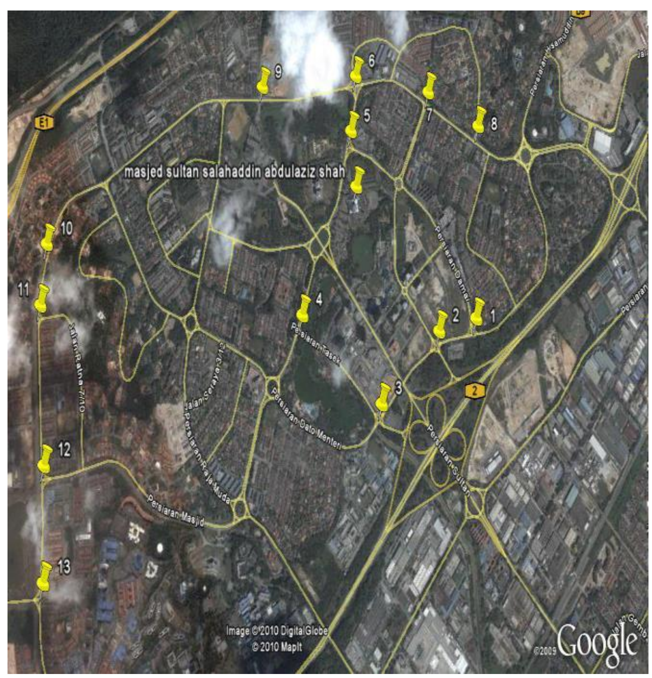


Figure 3 Shown field in Shah Alam. *Source:* Google earth 2012

5.0 RESULTS AND DISCUSSION

The growth of urban traffic congestion has been recognized as a serious problem in large metropolitan areas in Shah Alam, with significant effects on the economy, travel behavior and land use, as well as a cause of discomfort for hundreds of motorists. The traditional approach of widening roads to increase the capacity of vehicles as a solution is often seen as not possible and undesirable. Therefore, the percentage (%) of the reduction of results before and after enhancement by TRANSYT-7F application detects that the Total Travel Times TTT, total delay, AVD, total stops, FUC, OPC and PI had decreased while on other hand SWTS had increased.

5.1 Total Travel Times (TTT) and Average Delays (AVD)

The TTT of trips is very important to motorists; the length of the trip can cause fatigue and exhaustion resulting in accidents on the roads. In the following, Figure 4 we note that the amount of reduction of TTT after optimization was up to 41% in Petaling Jaya and 23% in Shah Alam, respectively.

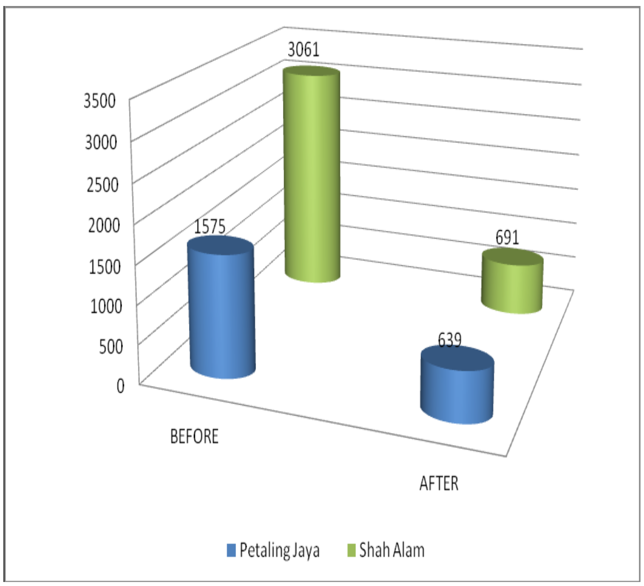


Figure 4 TTT before and after the optimization

Moreover, AVD estimates for each lane group established for the analysis. Therefore, delay measures are gathered for lines and for the whole intersection and determine the levels of service, where the improvement of AVD is related to the improvement of the Level of Service LOS. Furthermore, the amount of AVD from the results obtained was 115.2 Sec for Petaling Jaya and 317.1 Sec for Shah Alam, but after optimization by TRANSYT-7F this amount was reduced nearly to 25.2 Sec and 30.2 Sec. Figure 5 shows AVD for both cities before and after the optimization.

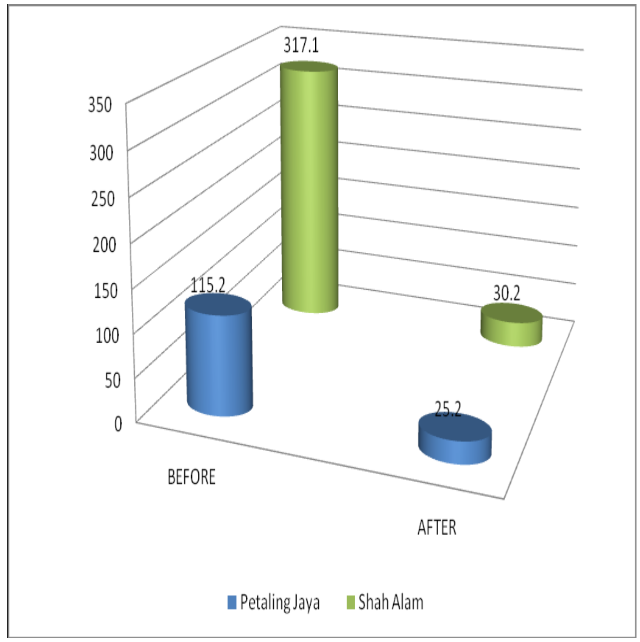


Figure 5 AVD before and after the optimization

5.2 System Wide Travelling Speed (SWTS) and Fuel Consumption (FUC)

The traffic flow speed and non-frequent stops of trips provides more comfort for drivers, which are reflected positively on their behavior on the roads. Evaluating the existing situation of SWTS, it noted in Figure 6 that very slow speed of vehicles on the roads and results in the traffic congestion occurring in the flow of traffic at the intersections. The current situation of SWTS is around 27.5 km/hr from Petaling Jaya as well as 30.6 km/hr for Shah Alam per trip. Moreover, the fuel consumed on the travel trips (trip time) has been excessive. It is due to the large number of stops on the intersections of the trip time. However, with TRANSYT-7F it is observed that the system's wide speed improved from 6.9 km/hr to 30.2 km/hr.

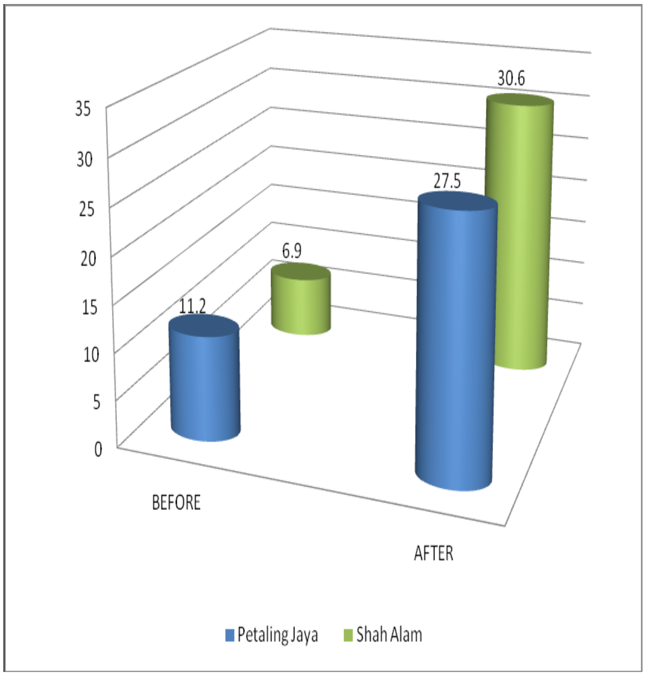


Figure 6 SWTS before and after the optimization

Contrastingly, the fuel consumption decreases from 9805 lit/hr to 3212 lit/hr after optimization as shown in Figure 7. Furthermore, the percentage of reduction of SWTS and FUC was nearly 41% and 54% in Petaling Jaya and 23% and 33% respectively.

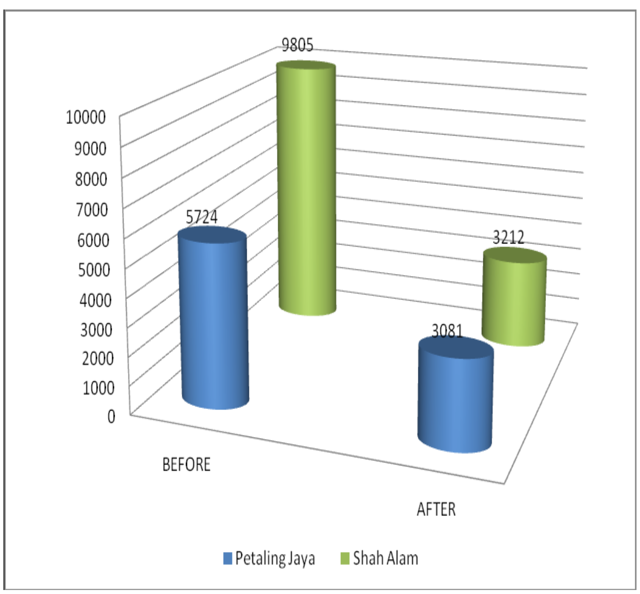


Figure 7 FUC before and after the optimization

5.3 Operating Cost (OPC) and Performance Index (PI)

The OPC of vehicles refers to costs that differ with the vehicle usage, including fuel, tires and maintenance. The factors that influence the OPC of vehicles are; travel time, traffic speed and delay on intersections. Figure 8 shows the OPC before and after the optimization of both cities. Therefore, with TRANSYT-7F optimization, the OPC was reduced up to 46% from 12579 RM/hr to 5815 RM/hr. Also, the PI improved after optimization by nearly 18% from 2109 DI to 382.5 DI in the study area in Shah Alam. In addition, the OPC in Petaling Jaya decreased as well, to up to 67% from 5695 RM/hr to 3081 RM/hr and PI improved nearly 33% from 1146 DI to 376 DI.

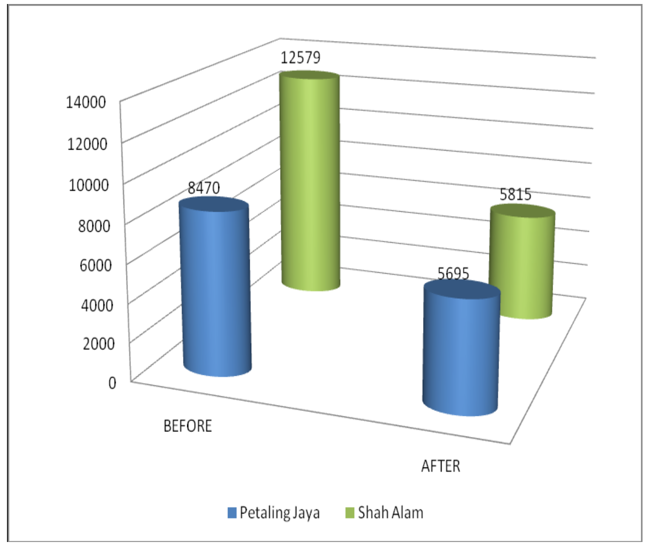


Figure 8 OPC before and after the optimization

5.4 Level Of Service (LOS)

The LOS is known in terms of the regular overall vehicle delay of the total movements through an intersection. Vehicle delay is a process of measuring numerous intangible aspects such as; lost travel time, frustration and motorist's discomfort. Table 1 shows the LOS standards for signalized intersections, as described in the Highway Capacity Manual [10].

Table 1 LOS criterion for signalized intersection. *Source:* Highway Capacity Manual 2000

LOS	AVD (Sec/ veh)	General description (Signalized intersection)
A	0-10	Free flow
B	10-20	Slight delays
C	20-35	Acceptable delays
D	35-55	Tolerable delay
E	55-80	Intolerable delay
F	80+	Jammed

One can derive the LOS from a road under different operating characteristics and traffic volumes. The factors affecting LOS can be listed as follows; SWTS, traffic interruptions or restrictions, freedom to travel with desired speed, driver comfort and OPC.

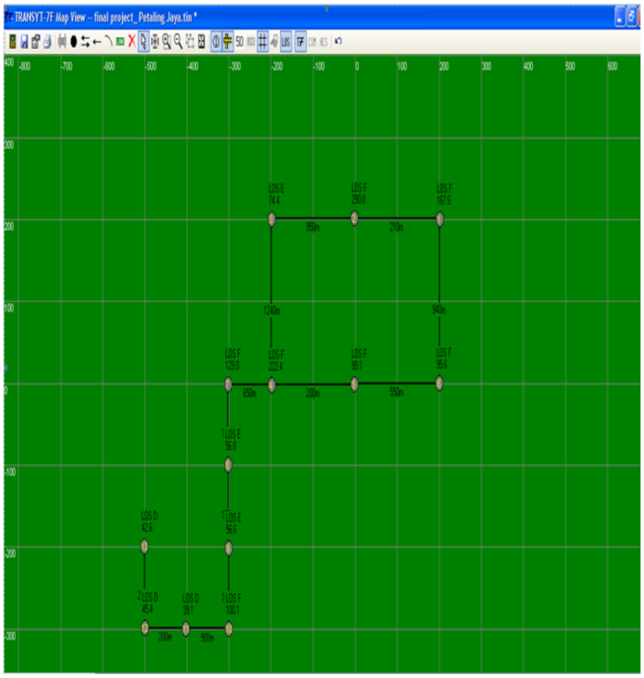


Figure 9 TRANSYT-7F map view screen LOS in Petaling Jaya

Most of the LOS in the study ranged from D unstable flow (the intolerable delay) to F forced flow (jammed) in Petaling Jaya which is as shown in Figure 9, and between C stable flow (acceptable delays) and F forced flow (jammed) in Shah Alam, as shown in Figure 10.

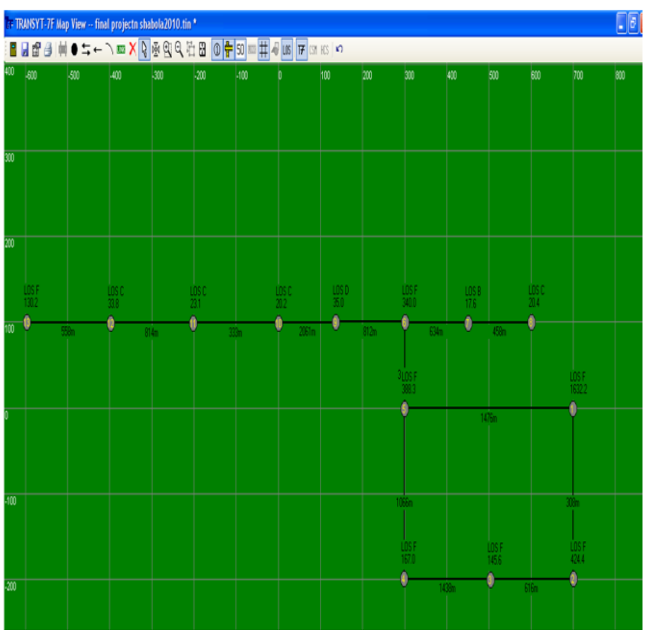


Figure 10 TRANSYT-7F map view screen LOS in Shah Alam

The results of the analysis of the standing uncoordinated pattern point a bad LOS D, E and F for most of the systems in the study areas. This indicates that Petaling Jaya and Shah Alam urban roads are highly congested. When the timing strategy and the coordination of signals are enhanced, a major improvement in the traffic performance is obtained. The LOS has been improved from levels D, E and F to levels C and B as shown in Table 2, 3.

Table 2 LOS, PI before and after improvement in Petaling Jaya

No of intersection	LOS before	PI before (DI)	LOS after	PI After (DI)	Reduction (%)
1	F	152.5	C	37	24
2	F	170.4	C	24.3	14
3	E	65.9	C	32.9	50
4	F	193.5	C	44.6	23
5	F	102.2	C	35	34
6	F	88.9	C	33.3	37
7	F	117.5	B	30.8	26
8	E	51.8	C	28.7	55
9	E	44.8	C	24.7	55
10	F	65.5	C	29.5	45
11	D	27.4	B	16.2	59
12	D	35.5	C	23	65
13	D	30.2	B	16	53

Table 3 LOS, PI before and after improvement in Shah Alam

No of intersection	LOS before	PI before (DI)	LOS after	PI After (DI)	Reduction (%)
1	F	966.1	C	226.8	23
2	F	248.2	C	37.3	15
3	F	108.1	C	31.1	29
4	F	137.2	C	36.5	27
5	F	237.2	C	32.3	14
6	F	248.6	C	50.7	20
7	B	14	B	14	0
8	C	15.2	C	13.5	89
9	D	24	C	21.4	89
10	C	14.1	C	11.1	79
11	C	12.5	B	10.2	82
12	C	18.5	C	18.5	0
13	F	64.4	C	17.7	27

6.0 CONCLUSION

Traffic stream is a widespread method of interactions amongst vehicles, drivers, and constitutes the geometric conditions of the highway. Therefore, to be able to design and operate a good, intelligent transportation system in an efficient way, it is essential to create a model between the most important various components of the traffic stream such as; traffic speed, traffic density and traffic flow. The delays experienced on the principal signalized streets are mostly related to the intersection where conflicting movements are separated and controlled by traffic signals. These traffic signals can operate under an inaccessible control policy, with the signal sets of each signal setting individually of the sets of adjacent signals.

The delay is known as the variance in travel time once the vehicles are unaffected by the controlled intersection and when vehicles are affected by the controlled intersection. This delay contains lost time due to the slowing down, stopped delay and acceleration. Accordingly, intersections delays assessments are directed towards estimating the stopped delay or total delay. This study was done to evaluate the adequacy of the widely used traffic simulation/optimization and the results obtained from the software reveal clear indication that it is able to develop the system networks performance in the study areas. Travelers on the study area road network, which is located in Petaling Jaya city and the Shah Alam city, tend to suffer from traffic congestion. The congestion is a result of ineffective traffic signal control. The signals on the road junction network in the study area are not coordinated; each intersection is treated as an isolated one.

Another reason that speaks on behalf of traffic congestion is that the timing setting (cycle time) of the intersection is normally developed without proper calculations, but it is generally assigned based on experience. This study intends to evaluate the existing uncoordinated timing plan for the arterial road, and then redesign a new timing plan, ensuring signal coordination using TRANSYT-7F. In short, TRANSYT-7F has successfully improved the performance of road junction networks as SWTP during peak hours in the field of study in Petaling Jaya and Shah Alam. Moreover, it has reduced the FUC as well as indicating a reduction for PI.

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