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# Improving the Traffic Flow for Kajang Town by using TRANSYT-7F Software

**Muhamad Razuhanafi Mat Yazid, Mohammed Naeem Abdulkareem, Nur Fatma Fadilah Yaacob, Muhamad Nazri Borhan, Aizat Mohd Taib**

***Abstract: The rapid population growth of Kajang town and the increase in the number of vehicles have caused an increase in the daily trips made on most streets and at the intersections of the town, especially during peak hours. This has worsened the traffic congestion on the road networks. This study aims to evaluate the existing level of service (LOS) and coordinate the traffic signals in order to enhance the efficiency of road junction networks in Kajang. The traffic data at 15 intersections were gathered via video recording during the morning peak hour. This study used the Traffic Network Study Tool Version 7F (TRANSYT-7F) software to analyzing and evaluating the performance of road junction networks based on simulation and signal timing optimization. The results show that the software was able to improve the performance of network intersections. The performance index (PI) increased to 44% and fuel consumptions (FUC) were reduced 25.7% and reduced average delay from 85.5 Veh/Sec to 28.9 Veh/Sec. Hence, the level of service (LOS), system speed and average delay were also improved by the coordination of the traffic signals.***

***Keywords: Level of Services, Performance Index (PI), Traffic Congestion, TRANSYT-7F.***

## I. INTRODUCTION

The worsening urban traffic congestion has inconvenienced countless number of motorists.

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***** Correspondence Author

**Muhamad Razuhanafi Mat Yazid***, Smart and Sustainable Township Research Centre (SUTRA), Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia (UKM), Bangi, Malaysia. E-mail: razuhanafi@ukm.edu.my

**Mohammed Naeem Abdulkareem**, Smart and Sustainable Township Research Centre (SUTRA), Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia (UKM), Bangi, Malaysia. E-mail: engmn1994@gmail.com

**Nur Fatma Fadilah Yaacob**, Smart and Sustainable Township Research Centre (SUTRA), Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia (UKM), Bangi, Malaysia. E-mail: cikfatma@yahoo.com

**Muhamad Nazri Borhan**, Smart and Sustainable Township Research Centre (SUTRA), Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia (UKM), Bangi, Malaysia. E-mail: mnazri_borhan@ukm.edu.my

**Aizat Mohd Taib**, Smart and Sustainable Township Research Centre (SUTRA), Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia (UKM), Bangi, Malaysia. E-mail: amohdtaib@ukm.edu.my

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It is a serious problem in Malaysia and has had significant impact on land use, travel behavior, and the economy [1] [2]. There is an urgent need for developing countries to closely monitor the operating conditions on current transportation facilities and formulate better policies to deal with the increase in traffic demand.

Analysis of the current traffic problems and evaluation of the feasibility of alternative systems requires for an assessment to be carried out on the performance measures for both users and system operators [3][4].

Traffic congestion is a state of traffic delay that occurs when the traffic volume exceeds the network capacity [5]. A good management of traffic flow is able to reduce traffic congestion, enhance road safety as well as improve mobility [6]. Network congestion happens when there is an increase in its use, and is typified by lower speeds, extended travel times and longer queues [7]. Traffic congestion has an impact on the quality of live; it is the major cause of transportation delays, accidents, and carbon emissions. It also contributes to higher fuel consumption, which has a financial impact on cars owners [8].

Intersections are the cause of bottlenecks in urban traffic flow, and is one of the most complex locations in a traffic system [9] [10]. One of the measures of intersection performance is delay. This in turn is dependent on factors such as signal timing plan, traffic stream composition, turning movement, traffic demands, intersection geometry, pedestrian volumes, temporal traffic variation, the headway distribution of each traffic stream, driver characteristics, weather, road surface condition, and visibility. Factors such as geometry and signal timing plan are unvarying whereas weather and traffic demands vary [11].

Intersections are a critical component in facilitating the flow of traffic on road networks as they designate the right of way between converging vehicles. The convergence of traffic markedly reduces the capacity of intersections in comparison to the capacity of unconstrained roadways. As a result, intersections frequently serve as an operational and safety choke point of roadway systems [12]. Signal control is commonly used to deal with capacity shortage in urban areas. A fairly precise method for estimating the saturation flow rate for signalized intersections is of critical importance to ensure an appropriate roadway design as well as efficient traffic management [13] [14].

The congestion influence needs to manage traffic flow by optimizing traffic signal timing, the last version of

TRANSYT-7F (traffic network study tool) has improvement in actuated signal simulation and optimization. The signal optimization in TRANSYT-7F can be used to reduce the performance index (PI) which is made up of a combination of stop and delay [15].

The software has been used to improve the performance of road junction networks, reduce fuel consumption,

increase system-wide travelling speed, and reduce the performance index in Shah Alam and Petaling Jaya, Malaysia [2]. The utilization of TRANSYT-7F model has been successfully used to save energy and reduce traffic congestion in Gaza city [8]. Ratrout & Reza [16] compared the performance of two models i.e. TRANSYT-7F and SYNCHRO, in optimizing urban arterial comprising three intersections and moderately high traffic in Dhahran, Saudi Arabia. The outcome of using TRANSYT-7F is better than that when using Synchro in terms of average delay and queue length.

This study focuses on the traffic congestion problem at 15 intersections in Kajang where traffic police often have to direct the traffic at the intersections during peak hours. This problem is caused primarily by the poor coordination of traffic signal control, substandard geometric design and poor road planning of most of the intersections inside the selected network have the primary effect on traffic flow and traffic congestion where the majority of the traffic activities still handle with individual cases without a thorough technique to manage transportation issues, these traffic conditions need to be evaluated and studied. Hence, this paper aims to assess the traffic performance in Kajang by evaluating the existing level of service (LOS) for the selected intersections by using TRANSYT-7F and propose the required traffic and geometric solutions for improving traffic flow.

## II. METHODOLOGY

In order to achieve the study objectives, the limits of the study area, the peak period for each intersection in the traffic network, and the specific input information for the TRANSYT-7F software were established. The collected parameters for the data are traffic volume, delay, queue length, and the time spent on the journey. The collected data were then calculated and analyzed. Following this the data were used to simulate a system by using TRANSYT-7F and the results generated by the system were compared. Due to the inability to calculate the number of vehicles because of the large influx of vehicles at the intersections, a camera and a timer were used to calculate the period for data collection. Flowchart of this study showed in Fig. 1.

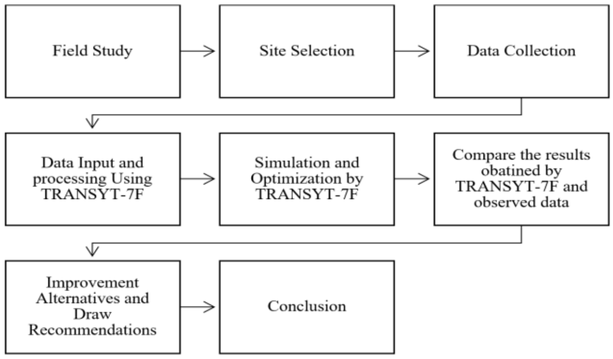


**Fig. 1.Traffic volume for each intersection in Kajang network.**

Google map was used to determine the initial study area, as well as to measure the distance between intersections. A true meter was used to measure dimensions such as the width of the lane at the intersections. The vehicles were classified into six categories, i.e. motorcycle, car, van, lorry, heavy lorry, and bus. The data was converted into percentage car unit (PCU) to obtain the flow volume for each lane, as shown in Table 1 [17].

**Table- I: Conversion into PCU**

| Type of Vehicle | Value in PCU |
|---|---|
| Motorcycle | 0.33 |
| Car | 1 |
| Van | 2 |
| Lorry | 1.75 |
| Heavy Lorry | 2.25 |
| Bus | 2.25 |

### A. Traffic Volume Data

The data for traffic volume was not gathered during bad weather and uncommon traffic conditions such as accidents, ceremonies or public events. The data were collected for the period of sixty minutes during the morning of the rush hours for 15 days (Fig. 2).

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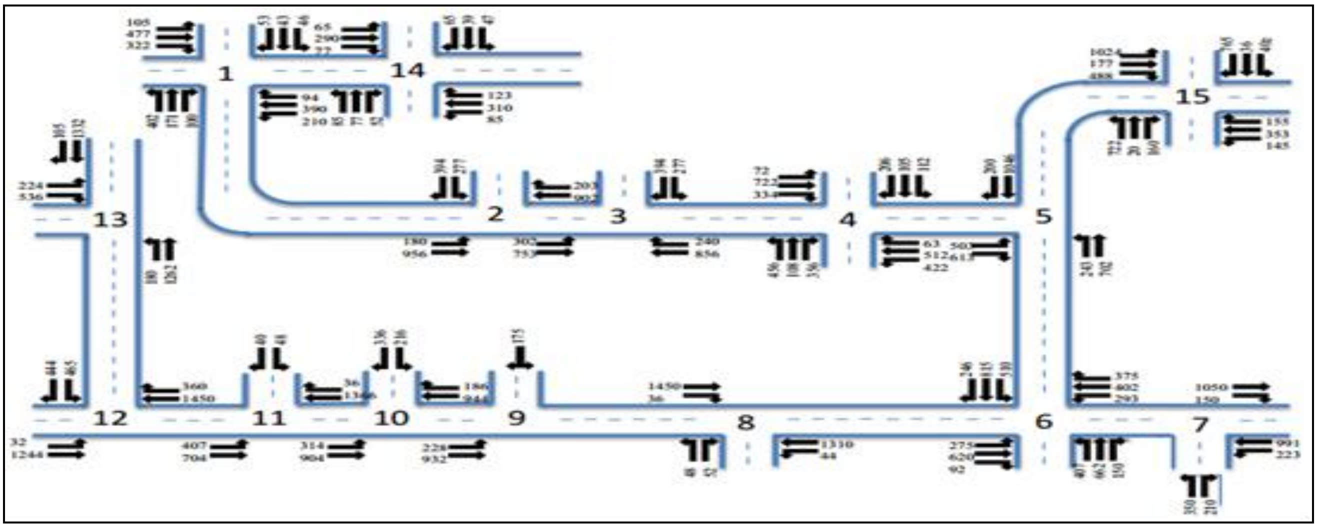

**Fig. 2.Traffic volume for each intersection in Kajang network.**

### B. Level of Services (LOS)

The quality of service on transportation systems and device or transportation infrastructures measures by level of service, the transportation engineers and planners uses LOS to evaluate the intersections, the range from A to F, level of (A) is the best when the driver is not influenced by other vehicles, level (F) is the worst when the driver influenced by the other vehicles. Table II shows the different levels of service [17]. The LOS at signalized intersection is based on the average stopped delay for each vehicle [18]. The LOS at signalized intersections is defined by the control delay since delay is a measure of the discomfort and frustration experienced by motorists; it also indicates the amount of lost travel time and fuel consumption.

**Table- II: Conversion into PCU data**

| LOS | Average Control Delay (sec/veh) | Basic Description |
|---|---|---|
| A | ≤10 | Free flow |
| B | >10-20 | Steady flow (slight delays) |
| C | >20-35 | Steady flow (reasonable delays) |
| D | >35-55 | Approaching unsteady flow (acceptable delay) |
| E | >55-80 | Unsteady flow (unacceptable delay) |
| F | >80 | Forced flow (jammed) |

### C. Level of Service (LOS) Application of TRANSYT-7F Software

TRANSYT-7F is an application used to established the optimal setting for fixed-time signal for a particular network having an established fixed traffic volume. The input for this application is the traffic volume at the end of the upstream of the links [15]. Fig. 3 shows a map view of the obtained level of service for the Kajang network subsequent to the re-running of the TRANSYT model. It shows that there is a need to improve the level of service at all intersections due to the unacceptable the levels at all networks.

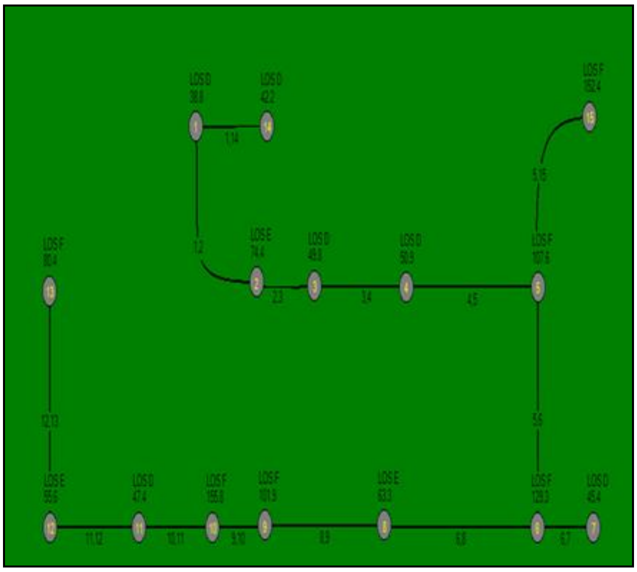

**Fig. 3.Map of view before improvement.**

### D. Implemented Improvements

This study has implemented several solutions at the selected intersections in order to improve traffic flow. The change cycle time of the signal, the addition of new phase movement and the addition or upgrading of lanes. A slight improvement was observed at some of the selected intersections after the cycle time of the signal lights was altered and a suitable cycle time was applied to achieve an acceptable LOS. Specific improvements were made for the internal phases of these intersections, such as at intersection two. Fig. 4 and Fig. 5 show the difference in cycle time at intersection 2 before and after the improvements were made. Manage cycle time like intersection 2 was done for most of the intersections such as 3, 4, 7, 8, 9, 10, 11, 12, 14 and 15. Optimized physical improvement is among the most effective ways for reducing the cost of vehicle operation and improving the traffic flow at urban arterial intersections.

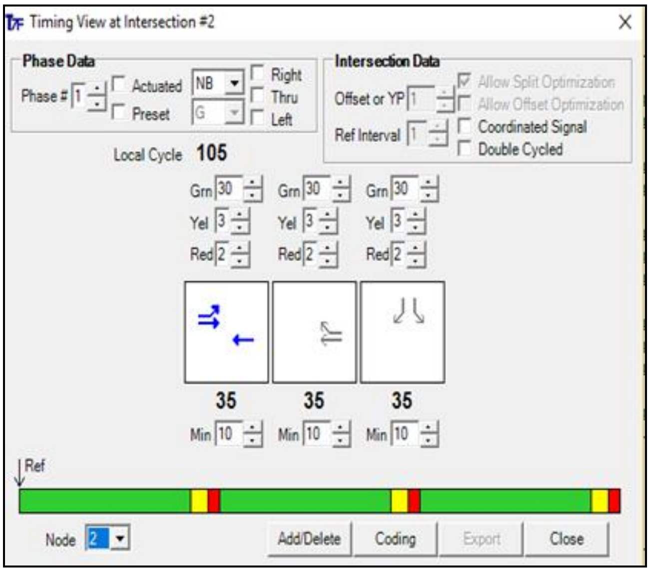


**Fig. 4.Timing view at intersection 2 before optimization.**

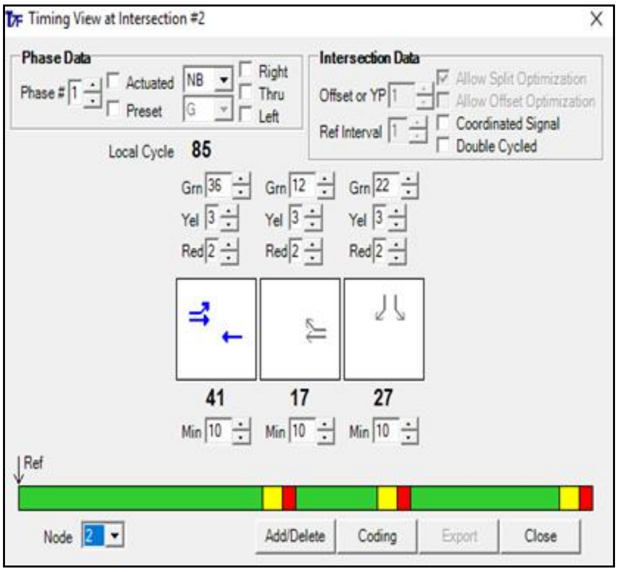


**Fig. 5.Timing view at intersection 2 after optimization.**

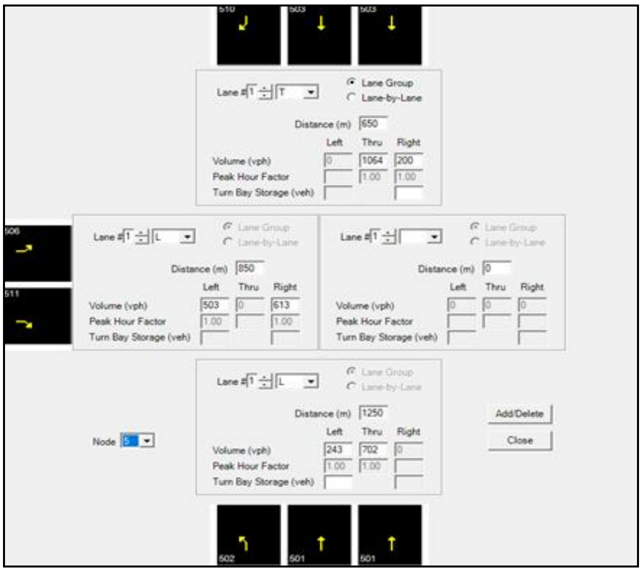

**Fig. 6.Lane Configuration at intersection 5 before optimization.**

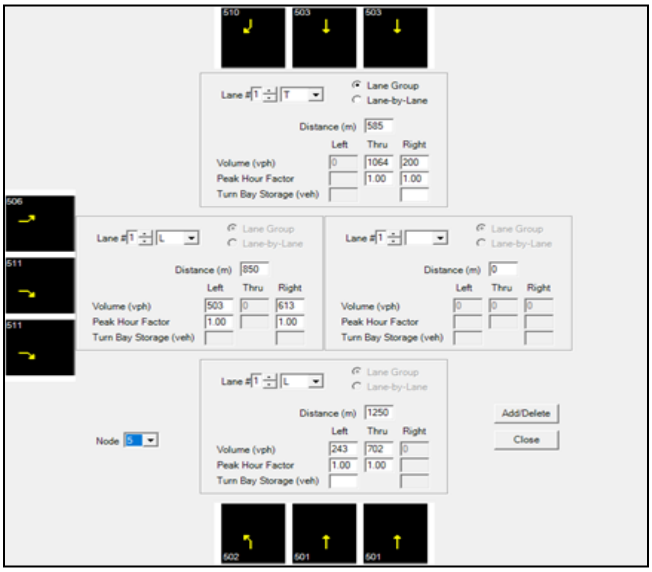

**Fig. 7.Lane Configuration at intersection 5 after optimization.**

Despite the effectiveness of geometric improvement method in improving the level of service at traffic intersections, the cost for its implementation is too high because it needs to effect field to accomplish. This proposal that most of the intersections that did not improve the level of service by changing the cycle times, improved with the addition of a lane for them. Additional lanes were constructed to improve the average level of service for intersections 1, 5, 6 and 13. Fig. 6 and Fig. 7 show the difference in the lane configuration for intersection 5 before and after the improvement.

## III. RESULT AND DISCUSSION

The application of TRANSYT-7F model for the selected network was able to enhance the level of service from unacceptable LOS (D, E, F) to the acceptable LOS (A, B, C). Moreover, the performance index for all intersection has been reduced, as can be seen in Table III.

**Table- III: PI, LOS Before and After Improvement**

| Intersection | LOS Before | PI Before | LOS After | PI After |
|---|---|---|---|---|
| 1 | D | 41.5 | C | 39 |
| 2 | E | 83.7 | C | 51.8 |
| 3 | D | 59.8 | C | 41.5 |
| 4 | D | 68.2 | C | 57.7 |
| 5 | F | 116.9 | C | 46.3 |
| 6 | F | 172.1 | C | 88.8 |

| | | | | |
|---|---|---|---|---|
| 7 | D | 53.2 | C | 45.2 |
| 8 | E | 68.8 | B | 37.6 |
| 9 | F | 73.5 | C | 55.3 |
| 10 | F | 133.4 | C | 47.3 |
| 11 | F | 54 | B | 34.4 |

The general network for the 15 intersections has been markedly improved. Table IV shows the performance measure for the network after optimization. The initial values of 1595 veh-km/hr total travel time and 84.5 sec/veh average delay have been improved to 877 veh-km/hr and 28.9 sec/veh, respectively. In addition, the system speed in Kajang town has been improved from 22.2 km/hr to 40.6 km/hr, which is a 45.3 percent improvement. TRANSYT-7F was also successful in saving energy and reducing pollution; fuel consumption has been reduced from 7537 Lit/hr to 5594 Lit/hr. The 44% improvement in performance index indicates that there is a significant reduction in the stops and delay in the selected network after the improvements were made.

**Table- IV: System-wide performance for Kajang**

| Performance Measure | System Unit | Before | After |
|---|---|---|---|
| Total travel time | Veh-hr/hr | 1595 | 877 |
| Total uniform delay | Veh-hr/hr | 696 | 317 |
| Total random delay | Veh-hr/hr | 411 | 65 |
| Total delay | Veh-hr/hr | 1107 | 382 |
| Average delay | Veh-hr/hr | 84.5 | 28.9 |
| Passenger delay | Pax-hr/hr | 1329 | 458 |
| Fuel consumption | Lit/hr | 7537 | 5594 |
| System speed | Km/hr | 22.2 | 40.6 |
| Performance index | DI | 1335 | 748.2 |

Delay is a critical parameter in ensuring optimal traffic signal timings and in predicting the level of service at signalized intersection approaches The map view in Fig. 8 shows the improvement in LOS and the delay at each intersection.

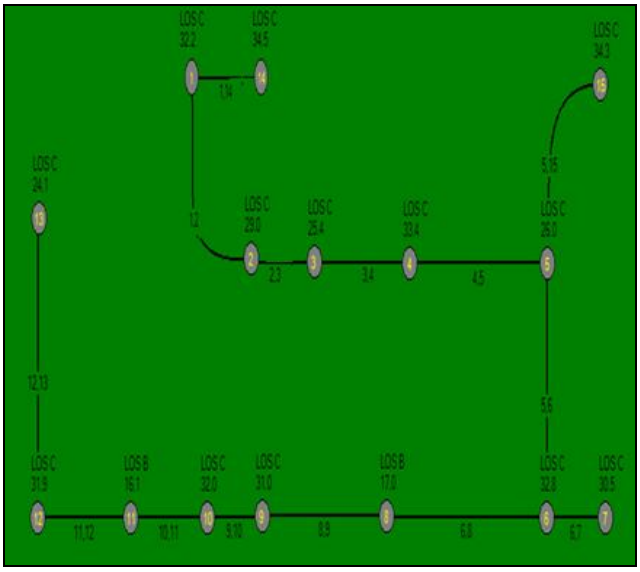

**Fig. 8.Map view after improvement**

## IV. CONCLUSION

A critical component in urban traffic control is timing. TRANSYT-7F was employed as a strategy to improve the road network in the town of Kajang considering that the intersections in this town are faced with traffic flow problems due to the high numbers of vehicles. Eleven (11) of the fifteen (15) intersections have shown a slight physical improvement. Geometric improvements were implemented at four intersections. All intersections in the network have shown an acceptable level of service. The performance of the road network system was improved through the coordination of traffic signals. Signal timing plans have a direct impact on the traffic control system. A badly timed signal could result in waste of time and fuel as well as financial losses. The stops and delay for the networks were improved by coordinating the signals. Finally, the percentage of improvements in fuel consumption, average delay and system speed are 25.7 %, 65.4%, and 45.3%, respectively.

In conclusion, this study found that the intersections are very close to each other sometimes causes disorder in the traffic flow. Even though green signal at the intersection but the vehicles are not moving or move slowly. Besides that, the signal timing plans directly affect the operation benefit of the traffic control system. Poorly timed signals can waste time, fuel, and money. All signalized intersections in the study area suffer from long cycle length that causes high delay time values. The TRANSYT-7F computer program showed that the most intersections have unacceptable level of service (D, E, F) because of there are many causes like narrow lane in some intersections, pavements distress and there is no plan to manage signal time in some intersections. Lastly, the results obtained from field study revealed that the travel time, delay and queue length, fuel consumption and operating costs decrease greatly if TRANSYT-7F software applied for Kajang city. Hence, TRANSYT-7F software proved that can solve traffic congestion problem in this study.

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## AUTHORS PROFILE

**Muhamad Razuhanafi Mat Yazid** obtained his B.Eng. (Civil Engineering) in 1997 from UTM, M. Eng (Transportation Engineering) in 2004 from USM and PhD from UKM in 2014. He started his academic carrier in Polytechnic Kota Bharu in 1998 after working as an engineer with Paximas Sdn.Bhd, Pahang and Keltrade Sdn.Bhd, Kelantan for 2 years. His current post in Smart and Sustainable Township Research Centre (SUTRA) (UKM) is the lecturer. His professional qualification includes being a professional engineer (Civil Engineers, Board of Engineers Malaysia) and member of Road Engineering Association of Asia and Australasia.

**Mohammed Naeem Abdulkareem** currently student at the Department of Civil and Structural Engineering, National University of Malaysia. Mohammed does research in Civil Engineering and Transportation Engineering.

**Nur Fatma Fadilah Yaacob** received Dip. (2013) in Geographical Sciences (Geographical Information System), B.Sc. (2016) in Architecture, Planning and Surveying and M.Sc. (2019) in Built Environment from Universiti Teknologi MARA. She is currently doing Ph.D in Engineering and Built Environment at Universiti Kebangsaan Malaysia. Her research interests include transport optimization, environment studies, road safety, expert system, Geographical Information System (GIS), and remote sensing.

**Muhamad Nazri Borhan** received the B.Sc. (2005) in civil and structural engineering, the M.Sc. (2008) and Ph.D. (2013) in transportation engineering from Universiti Kebangsaan Malaysia. He is currently a Senior Lecturer of Transportation Engineering with the Smart & Sustainable Township Research Centre (SUTRA), Universiti Kebangsaan Malaysia. His research interests include public transport optimization, travel behavior, expert system and pavement engineering.

**Aizat Mohd Taib** is currently a lecturer at the Faculty of Engineering and Built Environment of Universiti Kebangsaan Malaysia (UKM). Having graduated as a civil engineer from Universiti Malaysia Pahang, he continued his MEng in Universiti Teknologi Malaysia and received his doctoral degree from Newcastle University, UK. His research interest is primarily in geotechnical engineering cases particularly slope stability and the effects of climate change, utilizing field investigation, laboratory tests, numerical modelling and programming. He has been conducting research and works as an engineer professionally since 2011. Aizat actively engages in civil engineering undergraduate and postgraduate teaching, research, consultation as well as industrial works.