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Simulation of Transyt-7F Software on Signalized Road Junction Networks in Bandar Baru Bangi

Azizah bt Tukiman [a]*, Noraziela binti Mokhtar [b]*, Herdawati binti Bohari [c]*

[a]Civil Engineering Department, Politeknik Port Dickson, Km 14 Jalan Pantai, 71050 Si Rusa, Negeri Sembilan, Malaysia.
[b]Civil Engineering Department, Politeknik Port Dickson, Km 14 Jalan Pantai, 71050 Si Rusa, Negeri Sembilan, Malaysia.
[c]Civil Engineering Department, Politeknik Port Dickson, Km 14 Jalan Pantai, 71050 Si Rusa, Negeri Sembilan, Malaysia.

Abstract

Traffic congestion and long queues at the intersections occurred during rush hours repeatedly observed in Malaysia. The rapid population growth of Bandar Baru Bangi 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. Furthermore, optimizes the signal timing for a network of junctions with traffic lights which controlled by fixed-time controller should be improve. The main objectives of this study are to evaluate the level of service (LOS) and to coordinate the traffic signals in order to enhance the efficiency of road junction networks in Bandar Baru Bangi using TRANSYT-7F software. In addition, the study aims to compare the results between 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). This study used Traffic Network Study Tool Version 7F software (TRANSYT-7F) to evaluating and analyzing the performance of road junction networks. The data required for the study were mainly collected through video filming technique. The result obtained have shown a clear indication that the software is able to improve the performance of road junction networks in Bandar Baru Bangi. An improvement was seen and average delay had reduce down 730.4 sec to 22.8 sec which the percentage of reduction was about 97%.On the other hand, TRANSYT -7F software optimization succeeded to minimize the fuel consumption (FUC) from 27414 L/hr to 1607 L/hr . Thus, the percentage of reduction is up to 94.1%. Morever, a reduction of PI, OPC, TTT and LOS also improve. With the help of the TRANSYT -7F computer package the 14 nodes intersection signal timing in Bandar Baru Bangi have been optimized.

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

1.0 INTRODUCTION

Malaysia and other developing counties are facing serious traffic congestion problem due to rapid motorization and rapid population growth in their cities and also has had significant impact on land, travel behavior and the economy (Albrka at el. 2013). Traffic congestion is a condition on transport networks that occurs as use increases, and is characterized by slower speeds, increased vehicular queuing and longer trip times. The most common example is the physical use of roads by vehicles. In many cases, traffic police has to control the intersection manually. This problem is mainly due to the poor condition between adjacent traffic signal controls, resulting in inefficient progressive traffic flow. The development strategy of City is important for the analysis of freeway and urban street systems. To reduce the congestion on roadway, furthermore design of transportation facilities and in large cities such as Bandar Baru Bangi, which witnessed people getting to own their vehicles, resulting in traffic jams, especially at peak hours of traffic intersection would require an improvement.

* Azizah Tukiman. Tel.: +0192676406 ; fax: 066622026
E-mail address: azizahabt77@gmail.com

The growth of in urban traffic congestion have been recognized as a serious problem in all large metropolitan areas in Bandar Baru Bangi with significant effects on the economy, travel behavior and land use, as well as a cause of discomfort for millions of motorists. Solutions to the congestion problems by traditional approach of simply adding more capacity is often not possible or desirable. Therefore, improving traffic signal operation (reduce delays, queues, and travel times) and reduce vehicle-operating costs (reduce fuel consumption) by optimizing signal timing plans is one of the most important solutions. Ratrout et al. (2014) stated that traffic signal timing optimization is one of the most cost-effective methods for reducing vehicle operating costs and improving traffic flow performance along urban arterials. This Study is to evaluate the adequacy one the widely used traffic simulation/optimization TRANSYT-7F.

1.1 PROBLEMS STATEMENT

Traffic congestion and long queues at the intersections occurred during rush hours repeatedly observed in Bandar Baru Bangi. It has been observed a significant rise in the request of vehicles in recent years in Malaysia concurrent with speedy economic improvement (Albrka at el. 2013). This problem is caused primarily by the poor coordination of traffic signal control, poor road planning of most of the intersections and substandard geometric design. So, these traffic conditions need to be evaluated and studied. Study by Muhammad Razuhanafi at el. (2020) stated that traffic congestion has an impact on the quality of live, accidents, carbon emissions, higher fuel consumption and financial impact on car owners.

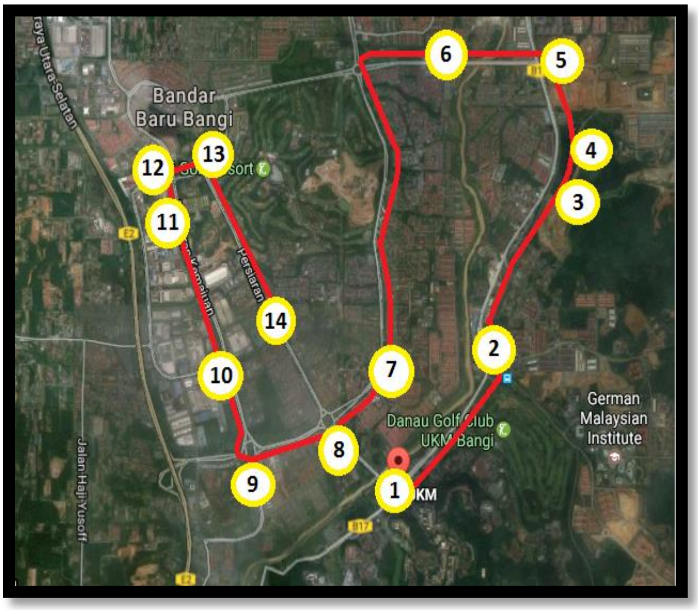
1.2 OBJECTIVES

The objectives of this study are:

1. To evaluate the level of services (LOS) of each junctions at Bandar Baru Bangi.
2. To coordinate the traffic signals in order to enhance the efficiency of road junction networks.

1.3 SCOPE

Bandar Baru Bangi is a growing city in Malaysia. The experiment was conducted in Bandar Baru Bangi involving fourteen (14) intersections. The schematic diagram for each intersection is given in Figure 1. The study considers certain regions in the most important urban areas in this city in terms of their active traffic, which causes traffic congestion in the morning and evening peak hours. The study area comprises of 14 intersections or nodes and they were selected due their suitability such the length of the links are not very long and not very short. In this study, there are three peak periods daily which normally start at 7:30 to 8:30 in the morning, at 1:00 to 2:00 in the afternoon and at 4:30 to 5:30 in the evening. The names of roads involved in this study are:



Intersection	Road’s name
1-2	Jalan Bangi
2-3	Jalan Reko
3-4	Jalan Reko
4-5	Jalan Reko
5-6	Persiaran Bangi
6-7	Persiaran Bangi-Persiaran Perkeliling
7-8	Persiaran Perkeliling
8-9	Persiaran Perkeliling
9-10	Persiaran Kemajuan
10-11	Persiaran Kemajuan
11-12	Persiaran Kemajuan
12-13	Persiaran Pusat Bandar 1
13-14	Persiaran Bandar

Figure 1.1 : Location of the study area and the 14 intersections

2.0 LITERATURE REVIEW

The key solution to reduce congestion and to save anergy is to use signal coordination, therefore to redesign and coordinate the traffic signal using TRANSYR 7F is the best solution (Almasri, 2014). The TRANSYT-7F is a microcomputer-based system and it is a traffic simulation and signal timing optimization program. The primary application of TRANSYT-7F is signal timing design and optimization. The original TRANSYT model was developed by the Transport Research Laboratory (formerly Transport and Road Research Laboratory) in the United Kingdom. TRANSYT, version 7 was "Americanized" for the Federal Highway Administration (FHWA and the original TRANSYT-7F manual were developed for the Federal Highway Administration (FHWA) under the National Signal Timing Optimization (NSTOP) (Ali, 2014). The main purpose of TRANSYT-7F is to help traffic engineers who are responsible for traffic signal systems to optimise their signals in order to reduce fuel consumption, delay and vehicle stops. Several adjustments have been made to the original TRANSYT-7F version in order to suit the US traffic signals system. Adjustments are made on the units of inputs and outputs, signal timings, input organisation, adding the fuel consumption estimation and plotting of the time-space diagrams.

The performance of the optimal signal timing plans developed by TRANSYT-7F and Synchro is compared using the microsimulation software PARAMICS. The study showed that the optimized plan by TRANSYT-7F gave better results than the plan by Synchro in terms of queue length and average delay. (Ratrout & Reza, 2014). The software also has been used to improve the performance of road junction networks, increase system-wide travelling speed, reduce fuel consumption, and reduce the performance index in Shah Alam and Petaling Jaya, Malaysia (Albrka at el. 2013). Furthermore, research by Mohammad Razuhanafi et. al (2020) at Kajang Town 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 using TRANSYT 7F software.

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 (Hale, 2009). The utilization of TRANSYT-7F model has been successfully used to save energy and reduce traffic congestion in Gaza city (Almasri, 2014). However, Budi Yuliato (2019) sateted that the minimum Performance Indicater Value (PI) is the best perfrormance of a signalize intersection and thus the optimum signal timings setting.

2.1 Level of Services (LOS)

The quality of service on transportation systems and device or transportation infrastructures measures by level of service. The transportation planners and engineers uses LOS to evaluate the intersections which the range from A to F, level of (A) is the best when the driver is not influenced by other vehicles however level (F) is the worst when the driver influenced by the other vehicles. Table 2.1 shows the different levels of service (Manual H.C.M, 2010). The LOS at signalized intersection is based on the average stopped delay for each vehicle. 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 2.1 LOS and 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)

3.0 METHODOLOGY

This study is to evaluate the adequacy one of the widely used traffic simulation/ optimization TRANSYT -7F. Early traffic signal control system operate on a fixed time basis, in which the timing plans are brought into operation at certain pre-specified times of the day. The calculation of timing plans is based on a set of previously surveyed by traffic volume at Bandar Baru Bangi. A typical and popular program to compute such signal timing plan is TRANSYT.

It is well known that an arterial network with fixed time signal plans (whether calculated by TRANSYT or other software) cannot cope with the timing traffic demand efficiently. A possible approach, as suggested in this study is to make TRANSYT demand responsive, to perform timing plan calculation and implement the new plans dynamically or close to real time. Here, the term dynamic TRANSYT means that TRANSYT bases its calculation on the traffic demand collected in the most recent time period (say 15 minutes), and implement the new timing plans for the subsequent time period.

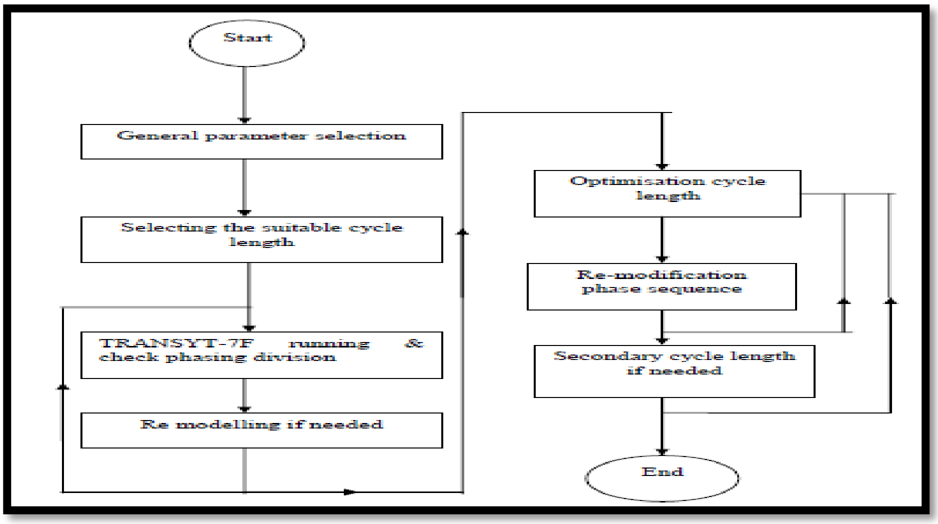


Figure 3.1 : Optimization plan for TRANSYT-7F

3.1 TRANSYT-7F INPUT DATA

3.1.1 New TRANSYT-7F Input File

This screen shows the input data file is simple software, which is the beginning of the program or the basics of the program such as the quality of the work of the steering wheel and units it as shown in the Figure 3.2 below. To get the best result of LOS , simulation data was conducted through try and error in Cycle Length Duration of Analysis, Lane Configuration Screen, Traffic Screen, Timing View Screen, Sat Flow View, Screen Feeders Screen and last process is generate report and analyze screen.

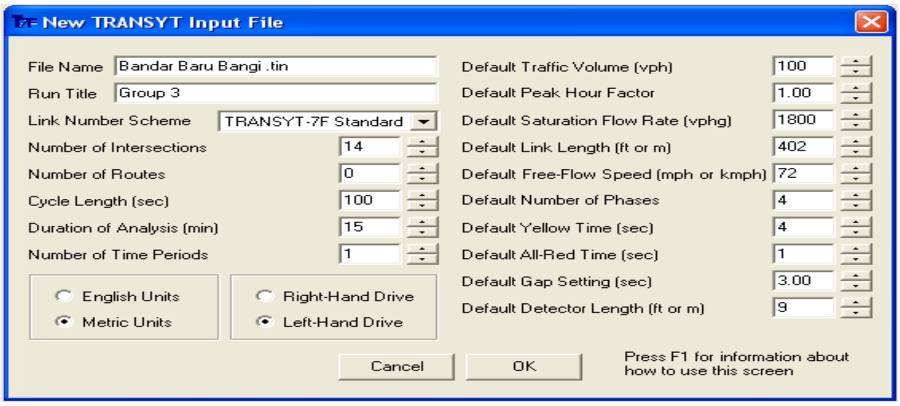


Figure 3.2 : New transit input

3.1.2 Software Results

At this time, after saving the data on the Analysis screen, it should be possible to run TRANSYT without getting any fatal errors. One can run the model either by clicking on the blue “T7F” icon, or by pressing <Ctrl> -R. it is possible to determine its levels of service at intersections, and what are the interruptions that need improvement, which shows the levels of service from A to F. Levels from A to D is acceptable, but levels of E to the F needs to be improved. As that one objectives of this study is to use economical solutions to improve the traffic flow at intersections. However, after re-running the TRANSYT model, the Map View shows that results of level of service of study at Bandar Baru Bangi below Figure 3.3, most all of intersections need improvement.

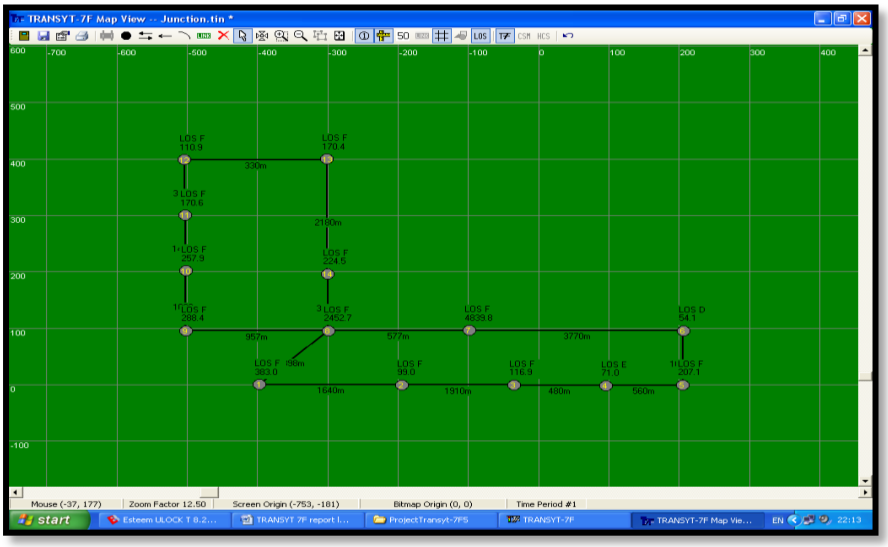


Figure 3.3: Map View screen shows the level of services

3.1.3 Transyt-7f Optimization and Implement Improvement

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. Fig. 4.4 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. 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. Additional lanes were constructed to improve the average level of service for intersections.

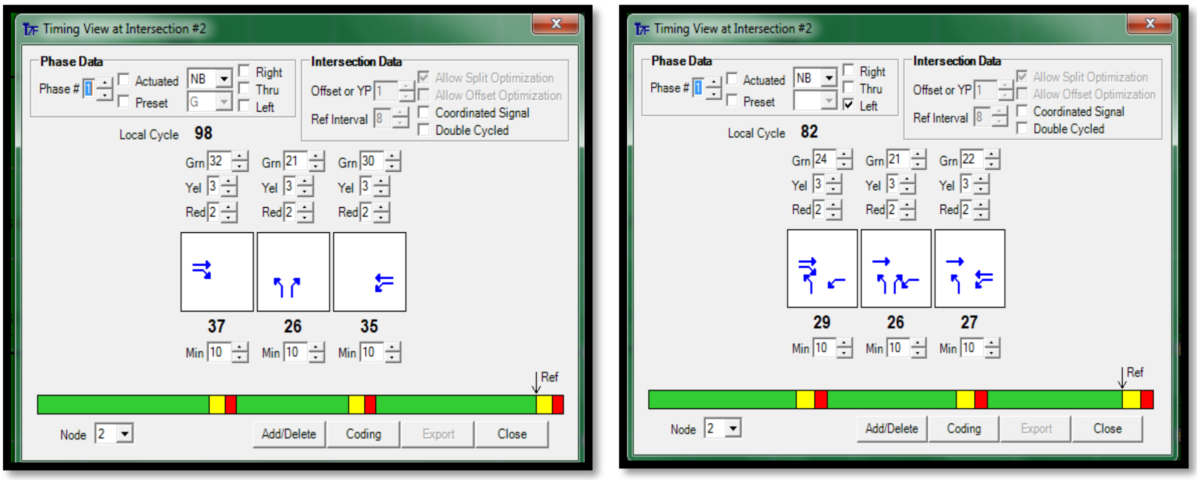


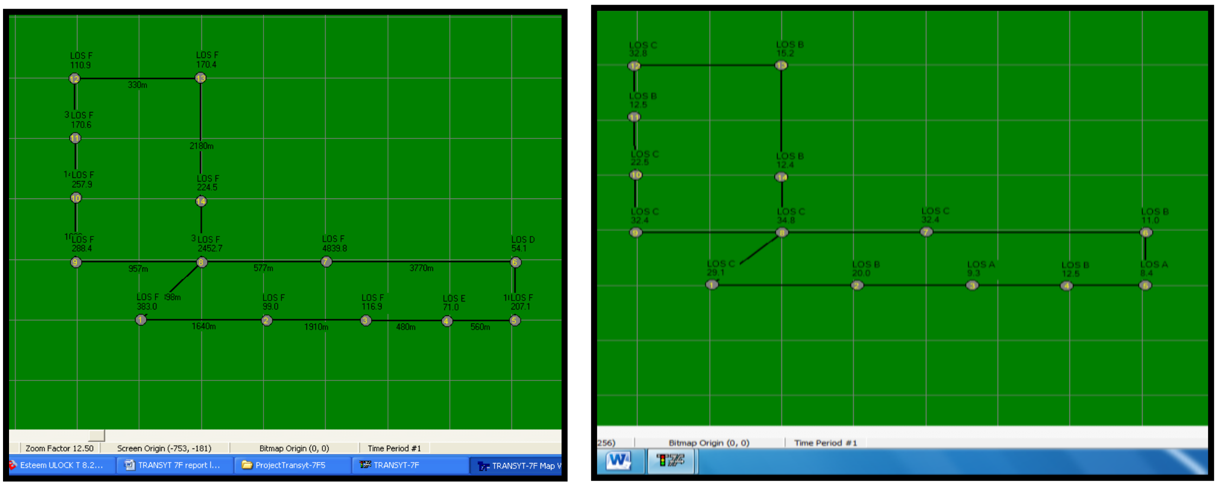
Figure 3.4 : intersection 2- Before optimization intersection 2 - After optimization

4.0. RESULT AND DISCUSSION

4.1 The improvement have been implement through 14 intersection as per below:

i- Added special lanes (slip) for the vehicles to turn left.
ii-Additional lanes to the road to estimate the large volume of traffic flow at rush hours.
iii-Change cycle time of signal.

The application of TRANSYT-7F model for the selected network was able to enhance the level Of services (LOS) as per Figure 4.1



a) Before optimization b) after optimization

Figure 4.1 : Map view screen shows the level of service (LOS)

4.2 Summarize LOS between before and after optimization at every intersection

Table :4.1 Summarize LOS before and after optimization

No of intersection	Level Of service (LOS) Before	After
Intersection 1	F	C
Intersection 2	F	B
Intersection 3	F	A
Intersection 4	D	B
Intersection 5	F	A
Intersection 6	E	B
Intersection 7	F	C

No of intersection	Level Of service (LOS) Before	After
Intersection 8	F	C
Intersection 9	F	C
Intersection 10	F	C
Intersection 11	F	B
Intersection 12	F	C
Intersection 13	F	B
Intersection 14	F	B

The general network for the 14 intersections has been markedly improved. Table 4.1 shows the Level Of Services (LOS) and the figure 4.2 shows the performance measure for the network after optimization. All the intersection was improved with LOS A,B,C.

4.3 Summarize situation before and after optimization for all nodes

SYSTEM-WIDE PERFORMANCE: ALL NODES

Performance Measures	Units	System Totals
Total Travel	veh-km/hr	43363
Total Travel Time	veh-hr/hr	8883
Total Uniform Delay	veh-hr/hr	1548
Total Random Delay	veh-hr/hr	6527
Total Delay	veh-hr/hr	8074
Average Delay	sec/veh	750.4
Passenger Delay	pax-hr/hr	9689
Uniform Stops:	veh/hr	36957
	%	95
Random Stops:	veh/hr	20400
	%	53
Total Stops:	veh/hr	57356
	%	148
Degree of Sat > 1	# of links	44
Queue Spillback	# of links	21
Time Jammed	%	3
Period Length	sec	900
System Speed	km/hr	4.9
Fuel Consumption	lit/hr	27416
Operating Cost	$/hr	33456
Performance Index	DI	6356.

Performance Index (PI): Disutility Index (DI):
Disutility Index Excess Fuel Consumption

Performance Measures	Units	Totals
Total Travel	veh-km/hr	12700
Total Travel Time	veh-hr/hr	317
Total Uniform Delay	veh-hr/hr	72
Total Random Delay	veh-hr/hr	11
Total Delay	veh-hr/hr	83
Average Delay	sec/veh	22.8
Passenger Delay	pax-hr/hr	99
Uniform Stops:	veh/hr	7617
	%	58
Random Stops:	veh/hr	768
	%	6
Total Stops:	veh/hr	8385
	%	64
Degree of Sat > 1	# of links	0
Queue Spillback	# of links	0
Time Jammed	%	0
Period Length	sec	900
System Speed	km/hr	40.1
Fuel Consumption	lit/hr	1607
Operating Cost	$/hr	3083
Performance Index	DI	124.0

Performance Index (PI): Disutility Index (DI):
Disutility Index Excess Fuel Consumption

a) Before optimization b) After optimization

Figure 4.2 Optimization before and after for all nodes

Table 4.2 : Summarize Performance achievement before and after optimization

Performance achievement	Before Optimization	After Optimization	Reduction and Increase % after Optimization
Total Travel Time (Vec/hr)	8883	317	96 % Reduction
Average Delay (Sec/v)	750.4	22.8	97 % Reduction
Fuel consumption (L/hr)	27414	1607	94 % Reduction
Operating Cost ($/hr)	33456	3083	91% Reduction
Performance Index	6356	124	98% Increase
Passenger Delay(Pax/hr)	9689	99	99% Reduction

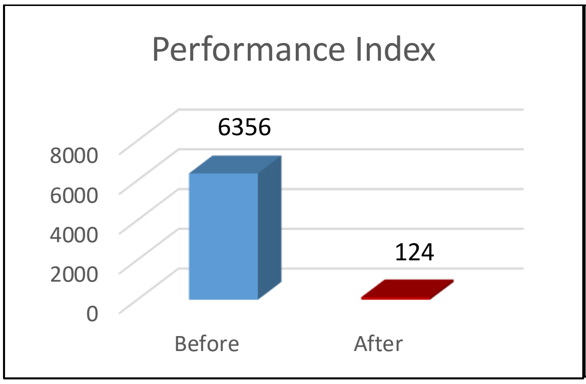


Figure 4.3 Relationship between Performance Index before and after optimization

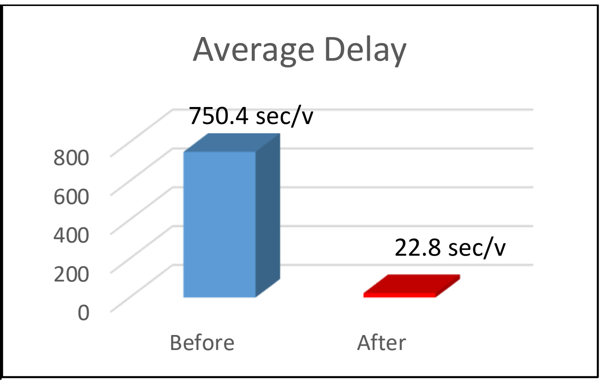


Figure 4.4 Relationship between Average Delay before and after optimization

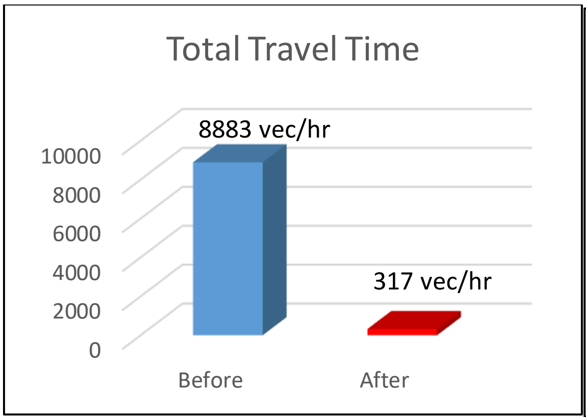


Figure 4.5 Relationship between Total Travel Time before and after optimization

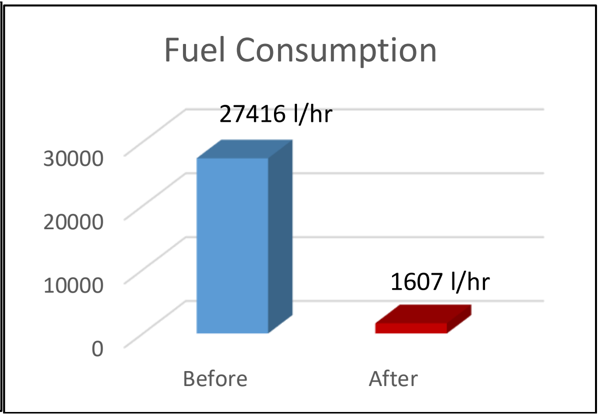


Figure 4.6 Relationship between Fuel consumption before and after optimization

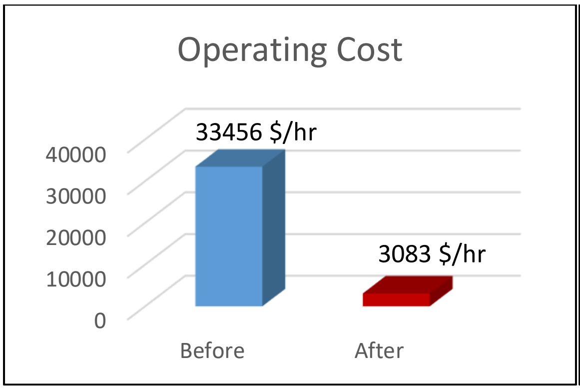


Figure 4.7 Relationship between Operating Cost before and after optimization

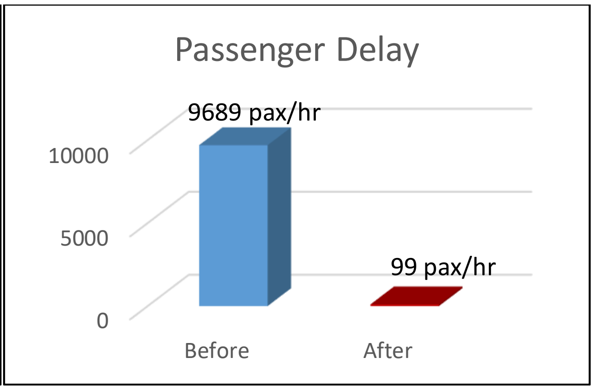


Figure 4.8 Relationship between Passenger Delay before and after optimization

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 Bandar Baru Bangi considerations that the intersection in this town are faced with traffic flow problems due to the high numbers of vehicles. After applying the TRANSYT -7F software, an improvement was seen and the average delay had reduced down to 22.8 Sec. The percentage of reduction was about 97%. It is known that the speed on the roads is in direct correlation with traffic congestion. However Total Travel Time also improve 96% and performance index increase 98%.

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 above shows that drivers waste fuel during multiple stops and delay at intersections, but TRANSYT -7F software optimization succeeded to minimize the fuel consumption from 27414 Lit/hr to 1607 Lit/hr . Thus, the percentage of reduction is up to 94.1% .

5.0 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. This study found that the intersections are very close to each other sometimes causes disorder in the traffic flow.

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 Bandar Baru Bangi, tend to suffer from traffic congestion. The congestion is a result of ineffective traffic signal control. This study for 14 nodes at Bandar Baru Bangi 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 level of service (LOS) of road junction networks as during peak hours in the field of study in Bandar Baru Bangi from **F to A, B and C.**

The results that obtained from the software gives a clear indication that TRANSYT-7F is able improve the system of networks of traffic at intersections studied in Bandar Baru Bangi, with the reduction in the performance index (PI) from **6356** to **124** and reducing fuel consumption from **27416 l/hr** to **1607 l/hr.** Hence, TRANSYT -7F software proved that can solve traffic congestion problem in this study.

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