The Effect of Countdown Timer on Red Light Violation at Signalized Intersection

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The Effect of Countdown Timer on Red Light Violation at Signalized Intersection

By

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Dissertation submitted in partial fulfillment of

the requirements for the

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Universiti Teknologi PETRONAS

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CERTIFICATION OF APPROVAL

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A dissertation submitted to the

Civil Engineering Programme

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Approved by,

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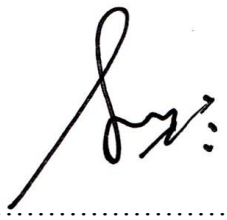
CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.



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JASON CHUNG CHIN CHERN

ABSTRACT

Red light violation happens when a driver do not stop and go across intersection junction after the traffic signal turns red. This endangers the road safety at the intersection and cause more accidents and even fatality. Objectives of the survey is to study the effectiveness of countdown timer to reduce red light violation, investigate whether geographical locations (urban and sub-urban) affect the efficiency of the countdown timer, find out whether the countdown timer affect the effectiveness of Level of Service (LOS) at the signalized intersections and justify the driving behavior of drivers from different states in Malaysia and from different country in affecting the efficiency of countdown timer to reduce red light violation. Four locations had been chosen for the surveys which are Batu Gajah Highway Intersection in Batu Gajah, Perak, Ipoh-Lumut Highway Intersection in Seri Iskandar, Perak, Jalan Bakau Condong Intersection in Batu Pahat, Johor and Jalan Peserai Intersection in Batu Pahat, Johor. For each intersection, video camera used to capture the movement of vehicles and traffics flow into intersection for 2 hours. Data summary of the survey converted into percentage and Chi-Square analysis from the purely numbers to passenger car unit (pcu). The level of service (LOS) of all intersections involved in the traffic survey can be obtained through SIDRA software. The results shown the countdown timer is effective enough to reduce red light violation. The LOS were random at all intersections and did not see much significant different when the occurrence of countdown or without countdown timer. The comparison of results between geographical location whether urban or sub-urban is done with comparing results of Batu Pahat, Johor (urban) and Seri Iskandar, Perak (sub-urban) and result had shown the urban intersections have higher potential for red light violation due to emotion and stress level on drivers. Besides, the driving behavior in different cities in Malaysia and other countries can be done by comparing with previous survey in Ipoh, Georgetown, Bangkok (Thailand) and Changsha (China). The results had shown that the countdown timer is effective in any places in Malaysia but due to different driving culture with Malaysia, drivers in Changsha (China) more tend to go across the intersection when red light with the occurrence of the countdown timer.

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I also wish to send my gratitude to Universiti Teknologi PETRONAS (UTP) for providing this golden opportunity to me to pursue these 6 credit hours Final Year Project as per requirement to complete my Bachelor of Engineering (Hons) in Civil Engineering. This had made me more familiar real world problem solving and survey and get ready for my career in near future.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Traffic light has different naming in different region or area. Commonly, it names as traffic signals, traffic lamps and signal lights. However in South Africa, it can be known as robots [1] while in England, United Kingdom, it known as semaphores [2] It is a signalized device which consists of green light, amber light and red light. According the global traffic law including Malaysia, green light indicates the drivers allow passing through the intersection; amber light indicates the drivers no more crossing intersection and they should prepare themselves to stop at the stop line; red light indicates the driver must stop at the stop line and not allow crossing the intersection. Traffic light plays the important role in control the traffic at the junction or pedestrian zebra crossing. Besides, it also provides the safety condition for vehicles as well as pedestrians to cross across the intersection.

A traffic signal countdown timer is a built-in device together with traffic light and countdown timer. It functions to countdown the remaining time in term of seconds for the traffic light to change from green to yellow to red or from red to green. This system is currently widely implement in the world signalize traffic system such as in Malaysia, Indonesia, Thailand, China, India, Taiwan and some of the European countries. However in Singapore and United States, the traffic signal countdown timer is only use for pedestrian. In Netherland, there is the traffic signal countdown timer which for the cyclist. There are now a variety of different types of countdown timer used on cycle path traffic lights in the Netherlands. [3] The device implement at the green light phase, this able to tell

drivers about the remainder time left to change into amble and red light. When the device implement at red light phase, this manage to tell drivers the time ready for green light and reduce the start-up lost time. [4]

Red light violation is one of the main reasons to cause road accident. Red light violation happens when a driver do not stop at the stop line and go across intersection junction after the traffic signal turns red. However, a motorist who is already in an intersection when the signal turns red is not considering as red light violation. [5] Due to road accidents, each year there are more than 6000 people died and estimated more than 40000 people are injured and there are quite number of total accidents are caused by red light violation and speeding. Below is the statistic of "Ops Sikap Year 2007-2011" from Polis Diraja Malaysia (PDRM) [6]:

Perayaan Tahun Baru Cina	Ops Sikap XIV 2007	Ops Sikap XVI 2008	Ops Sikap XVI 2009	Ops Sikap XXI 2010	Ops Sikap XXII 2011
Jumlah Kenderaan Berdaftar Jpj	16.813.943	17.733.084	18.933.237	20.006.953	21.311.630*
Jumlah Kemalangan	14.930	14.991	14.618	14.183	17.288
Jumlah Kemalangan Maut	192	178	198	179	183
Jumlah Kematian	207	190	212	201	199
Jumlah Cedera Parah	277	299	252	273	278
Jumlah Cedera Ringan	461	471	374	395	398
Jumlah Kenderaan Terlibat	23.776	24.559	23.813	26.079	29.637
Nisbah Kematian Mengikut 10.000 Kenderaan	0.12	0.11	0.11	0.10	0.09

Table 1.1: Statistic of "Ops Sikap" from year 2007 until 2011

From the statistic of "Ops Sikap Year 2007-2011", we can see that the number of accidents in Malaysia is maintaining at high number and this scenario is worried and deep concern by public! There are seven factors had been identified to contribute to road and road's environment that often cause accidents. Among all of the factors, traffic light signal is one of the factors too. [5] For instant at the intersection junction with the signalize traffic, amber light may create the blur or dilemma towards drivers for passing the intersection if the timing of amber light set is insufficient and this have the risk to cause the road accident.

There are five studies had done in Australia, Singapore and the United State all found that use of red-light cameras cut the number of accidents for nearly 30%. [7] Hence, in order to solve the red light violation, related authority had taken various methods to resolve it. In Malaysia, Automatic Enforcement System (AES) has installed at the intersection junction to capture and summon those red light violation's drivers. Currently, AES which installed at the intersection junction are [8]:

- KM26, Jalan Ipoh, Kuala Kangsar
- Jalan Pasir Putih, Ipoh
- Old Klang Road, Kuala Lumpur
- Jalan Ipoh, Kuala Lumpur

Numerous studies had shown that the number of red light violation reduced after red light cameras were installed. [5] There is 32% decrease in right-angle collisions at signalized intersections were recorded after red light cameras were installed in Victoria, Australia. [9] After one year of installation of red light cameras in Fairfax, Virginia, the red light violation reduced by 40%.

Besides that, based on some researches and studies had been done, the results shown the Traffic Signal Countdown Timer is one of the way to minimize the red light violation. The research which had been done in Ipoh, Georgetown,

Kuala Lumpur, Changsha (China) and Bangkok (Thailand) at the urban intersection, the results had shown the potential of Traffic Signal Countdown Timer in improving capacity, reducing red-light angle crashes, easing driver anxiety and reducing the number of red light violation. An experiment with an intersection in Singapore by Lum and Halim in year 2006, they found that the installation of the device managed to reduce the red light violation by 65% at one and half months after the installation. [10] Melaka city is the first installed Traffic Signal Countdown Timer in Malaysia and now this device is widely implement national wide including urban and suburban area. The aim of installing the device is to help drivers decide to stop or to cross the intersection. [5] Therefore, the red light violation can be reduced and hence can enhance safety condition for crossing the intersection.

However, the effect of countdown timer on red light violation at suburban signalized intersection in Malaysia has never been studied. Most of the research is do for the urban or city signalized intersection only. In the nut shell, this project will specifically discuss and study on effect of countdown timer on red light violation at suburban signalized intersection in Batu Gajah (Perak), Seri Iskandar (Perak) and Batu Pahat (Johor).

1.2 Problem Statement

Normally, traffic lights will install at the busy, dangerous and complicated intersection to control the traffic flow and also can save the life of drivers or pedestrians. However due to red light violation occurs at the intersection, this behavior brings to the tragedies to be happened. Road accidents have endangered the safety of road users. Thus, Traffic Signal Countdown Timer is now widely installed by related authorities in some cities and towns in Malaysia. Countdown timer has the potential to provide visual information about the time remainder to pass the intersection safe and sound. Because of the installation, this helps to

minimize the number of red light violation and this will help to reducing the road accident rate as well.

From the previous studies have done in Ipoh, Georgetown, Kuala Lumpur, Bangkok (Thailand) and Changsha (China) on the effect of countdown timer on red light violation, all of them concluded that the countdown timer plays important roles in reducing percent of red light violation. However, the previous researches had only done in the urban area, meaning that the focus of previous researches is in the cities' or towns' center. Urban and sub-urban drivers may have different behavior and culture in driving. Hence, more study and research have done on sub-urban locations to support firmly with the previous researches.

1.3 Objectives

The objectives of the project will achieve as following:

1. To study the effectiveness of countdown timer to reduce red light violation.

2. To investigate whether geographical locations (urban and sub-urban) affect the efficiency of the countdown timer.

3. To find out whether the countdown timer affect the effectiveness of Level of Service (LOS) at the signalized intersections.

4. To justify the driving behavior of drivers from different states in Malaysia and from different country in affecting the efficiency of countdown timer to reduce red light violation.

1.4 Scope of Study

As schedule for Final Year Project 1 and Final Year Project 2 courses, there are approximately 7 to 8 months to do research, survey, study and finally complete our final year project. Within these 7 to 8 months duration, I had done the research on previous studies or the projects that had been done regarding the effect of countdown timer on red light violation at signalized intersection. Based on the previous studies that been done in urban intersections, I collected and gathered all the data on same issues in sub-urban intersections. Four random locations in sub-urban intersections have been identified to carry out my survey on red light violation. Below are the potential intersections had been chosen for survey purpose:

1. Batu Gajah, Perak
    - ❖ Batu Gajah Highway: Batu Gajah-Tanjung Tualang 4 ways intersection (1 ways with countdown timer and 3 ways without countdown timer)
2. Seri Iskandar, Perak
    - ❖ Ipoh-Lumut Highway: Taman Maju-Bandar Universiti 4 ways intersection (2 ways with countdown timer and 2 ways without countdown timer)
3. Batu Pahat, Johor
    - ❖ Jalan Bakau Condong: Taman Nira-Jalan Rugayah 4 ways intersection (4 ways with countdown timer)
4. Batu Pahat, Johor
    - ❖ Jalan Peserai: Kampung Muhibbah 3 ways intersection (3 ways without countdown timer)

For each junction, video camera used to capture the movement of vehicles and traffics flow into intersection for 2 hours. Thus, as total I had been used 8 hours to complete my site survey at potential intersections. The video are the useful tool for calculating the number of vehicles cross the intersection during green light, amber light and red light. Data summary of the survey is then converted into percentage and Chi-Square analysis from the purely numbers. Analysis of with or without installing the countdown timer had been determined to show the effectiveness of countdown timer to reduce red light violation. The comparison of results between geographical location and the driving behavior between urban and sub-urban can be done with previous survey in Ipoh, Georgetown, Bangkok (Thailand) and Changsha (China).

1.5 Relevancy of the Project

The related courses which are useful in completing my project are as following:

- Transportation Planning and Engineering
- Possibility and Statistics

In the Transportation Planning and Engineering course, I need to equired myself with the knowledge of Passenger Car Unit (PCU), Level of Service (LOS) and SIDRA software to complete my project. In addition, the Possibility and Statistics course, I need to understand Chi-Square statistics and Hypothesis Statement to calculate the effectiveness of countdown timer at signalized intersection and do the comparison with previous studies. Both of the related courses had given me a relatively strong foundation about transportation planning and statistics. Hence, I can easily understand what I do in my final year project.

1.6 Feasibility of the project within the Scope & Time Frame

As schedule for Final Year Project 1&2 courses, there are approximately 7 to 8 months for us to do research, survey, study and finally complete our final year project. In order to make use of the time more efficiently, time frame for each of the scope of survey and study is very important. I propose to do the survey in Final Year Project 1 and so, I have more time to do some review and improvement works for my project in Final Year Project 2. Besides, I have the responsibility to complete, pass up and attend as per required for this 6 credit hours course such as Extended Proposal, Proposal Defence, Interim Report, Seminar, Progress Report, Project Exhibition (SEDEX), Final Draft, VIVA and Hard Bound Copy of Dissertation.

CHAPTER 2

LITERATURE REVIEW

2.1 Understanding Red Light Violation

Red light violation occurs when a road user enters an intersection after the traffic light signal has turned red. Based on the figure below, there is the minimum distance (X_c) from the interception and the distance (X_o) from the stop line (which is not the same as X_c).

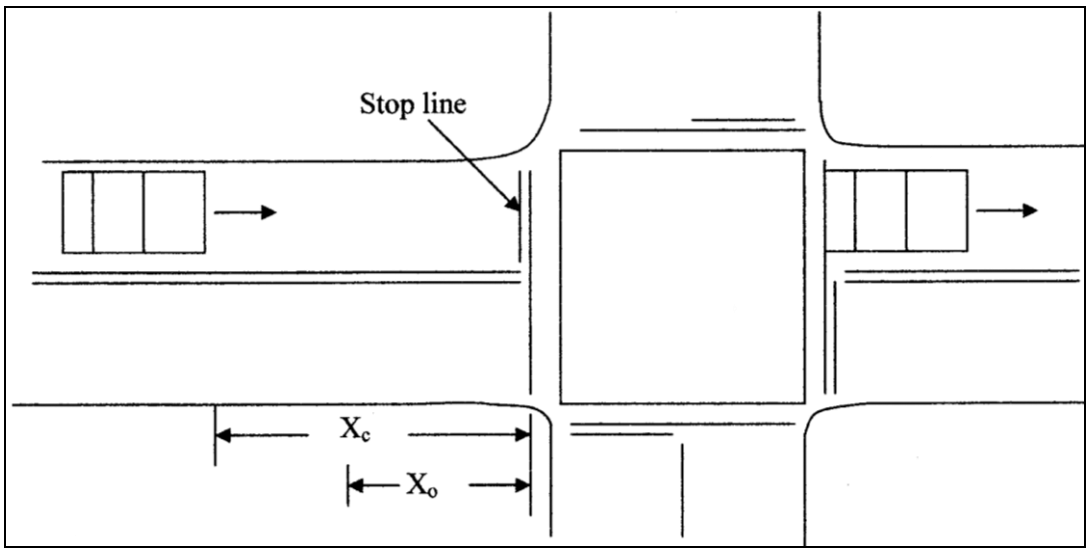

Figure 2.1: Vehicle approaching signalized intersection at the onset of yellow

Minimum distance (X_c) is the minimum distance for a driver who decide to stop the vehicle safe before the stop line. It depends on a number of factors including approaching speed, duration of the yellow interval and the perception-reaction-time. [5] Distance (X_o) is the distance when the driver decides not to stop at minimum distance X_c and the vehicle continued to move until within the region of distance (X_o) from the stop line. It provides the driver who located within the

distance X_o from the stop line and allows the driver to pass through the intersection safely. [5] However in some cases, a driver who decide not to stop and cannot stop his vehicles within the time when the traffic light turns red, end up entering the intersection and continue pass the intersection. Therefore, this driver can classify as red light violation driver.

2.2 Effect of Red Light Violation

As the definition in previous topic, we can understand now what red light violation is and there is negative effect due to red light violation which can lead to dangerous accidents and hence may cause fatality.

In year 2011, United States have 714 deaths and approximately about 118,000 people were injured in the accidents that involved red light violation. There are 50% of the deaths of red light violation accidents are pedestrians, bicyclists, other vehicles and other innocent people who are hit by red light violators. [11] There are the study shows that the red light violation very dangerous to other road users especially pedestrians, bicyclists and motorcyclists. Some studies had been done after states first adopted right-turn-on-red laws found that allowing right turns on red increased pedestrian and bicyclist collisions at intersections by 43% to 123%. [11]

Besides, an analysis of intersection accidents in four states in United States had found that right-turn-on-red accident frequently involved pedestrians and bicyclists, and 93% of these accident resulted in injuries to the pedestrians and bicyclists. Based on the research done by Accident Analysis & Prevention, it has been determined that red light running is normally happens during day time [12] and causes more fatal accident cases than other unsafe driving behaviors. [13]

In Malaysia, there are average 6000 deaths due to road accidents. There are one research shows that about 6% of motorcycle accidents occurred at signalized

intersections. [14] Due to red light violation, Malaysia is paying a heavy price due to road accidents. Based on the statistics in year 2010, Malaysia economy was lost about RM9.3billion just only because of accidents. (Datuk Suret Singh, 2010). [15]

Population	Population	Deaths	Rate per 100000
Phoenix, AZ	1,125,599	122	10.8
Memphis, TN	614,067	49	8
Mesa, AZ	333,756	26	7.8
Tucson, AZ	445,840	34	7.6
St. Petersburg, FL	237,480	18	7.6
Birmingham, AL	256,386	18	7
Dallas, TX	1,047,816	73	7
Albuquerque, NM	412,625	28	6.8
Louisville, KY	260,572	17	6.5
Detroit, MI	998,523	65	6.5

Table 2.1: Cities in United States with highest death rates in red light running crashes per 100,000 people, 1992-98

Population	Population	Deaths	Rate per 100000
Arizona	4,280,998	305	7.1
Nevada	1,529,841	59	3.9
Michigan	9,655,540	355	3.7
Texas	18,677,046	663	3.5
Alabama	4,255,686	143	3.4
New Mexico	1,670,580	56	3.4
Florida	14,197,723	434	3.1
California	31,645,023	956	3
Delaware	717,499	21	2.9

Table 2.2: States in United States with highest death rates in red light running crashes per 100,000 people, 1992-98

2.3 Previous Studies

There are number of samples for different studies that have been performed related to this research and the data collection equipment or techniques may get some ideas on them and apply in my study, if applicable.

2.3.1 Traffic Flow Analysis of Digital Countdown Signalized Urban Intersection, Kuala Lumpur

In a study done by Farhan Ahmad KIDWAI, Mohd Rasdan IBRAHIM and Mohamed Rehan KARIM in year 2005 [16], they chosen one intersection in a non-CBD area in Kuala Lumpur city for analyze and study the effect of countdown timer on driver behavior and intersection approach capacity. The data is collected at the same intersection before and after the installation of countdown signal in order to exclusively study the effect of timer, keeping other factors the same. The intersection approach capacity of countdown signal is compared with normal signal and other standards. In order to analyze to make the analysis of seven signalized intersections more accurate, four with countdown timer and three without timer are analyzed for red light violation by drivers. The results of red light running are compared for two types of signalized intersections. The method they used to collect the data is by video recording method and intersection's dimension measurement. The cassette was run in the video camera through television to obtain the data. The consideration for the chosen intersection have similar geometric features, traffic and control conditions. Their survey is done on weekdays during clear weather. Throughout their survey, they concluded that:

- The throughput in independent of effective green time.
- The difference in average throughput for timer and no-timer case is not significant at 95%confidance level using t-statistic.

- There is large variation in throughput values for different cycles for both timer and no timer case.
- The average throughput values for both timer and no-timer case are very close to US Highway capacity values.
- The incidences of red light running are about two times at no-timer case than the timer one.

2.3.2 The Effect of Countdown Timer on Red-Light-Running, Ipoh

Based on a study done by M. Napiah, M.I.Koh and L.Che Long in year 2006 [5], they chosen 3 study stations in Ipoh city centre to study the effect of countdown timer on red-light-running. The main focus of their survey is in the urban area, where is in city centre. The data collecting method for their survey was by using video camera recording the traffic movements at the intersections. The levels of service (LOS) of all the intersections involving in the study were analyzed by using SIDRA software. Two video cameras were left for 2 hours, from 9am until 11am simultaneously at both intersections with and without countdown timer in all 3 stations. Throughout their survey, they concluded that red light running is one of the leading problems at urban intersections with traffic signals. The percentage of red light running is lower at the intersection with countdown timer compare with the intersection without countdown timer. Besides, they also conclude that countdown timer will not affect the level of service (LOS) of the intersection and red light running violations.

2.3.3 Effect of Geographical Location on the Effectiveness of Countdown Timer at Signalized Intersections, Pulau Pinang

In a study done by Ahmad Ashraf bin Abu Bakar in year 2008 [17], he chosen 8 stations in Georgetown, Perai, Tanjung Tokong, Jelutong,

Bayan Lepas and Gelugor for the study of the effectiveness of countdown timer at signalized intersection. There are four intersections with countdown timer and another four intersections without countdown timer. Time outside peak hour was chosen to conduct the survey. The method he used to collect the data is by video recording method. Data gathering was then obtained from the videos which had recorded in video camera by laptop and television. Throughout his survey, he concluded that geographical locations do not affect the effectiveness of countdown timers at signalized intersections. However, it affects the behavior of drivers at intersections without countdown timer. His study also justified that countdown timers are effective in reducing red light running.

2.3.4 Exploring Impacts of Countdown Timers on Traffic Operations and Driver Behavior at a Signalized Intersection in Bangkok

Based on the study done by Thirayoot Limanond, Pramuk Prabjabok and Kraisi Tippayawong in year 2010 [10], their survey is to explore the impact of the countdown timer at various stages of the signal cycle, using two approaches: a traffic analysis and a public opinion survey conducted in Bangkok. The traffic analysis made a comparison of traffic characteristics during an off-peak day time at a selected intersection when the countdown timer was in operation against when it was switched off. Throughout their survey, they concluded that at the beginning of the red phase, the countdown timers would reduce the number of red-light running occurrences, since it provides timing information about the end of the green phase beforehand so that drivers have more time to make a proper decision. This helps in the reduction in red-light running incidents because based on the research which had been done, the number of red-light violations with timer condition was a half of the number found without timer condition. In the research also stated that the

countdown timers potentially help in relieving drivers' frustration from stopping for long and uncertain amounts of time during the red phase.

2.3.5 Effects of Countdown Timers on Driver Behavior After the Yellow Onset at Chinese Intersections, Changsha

In a study done by Ke Jun Long, Lee D. Han and Qiang Yang in year 2011 [4], their study had been done to find out the effect of countdown timers on driver behavior during the yellow interval at 4 urban intersections in Changsha city. For collecting and gathering the result, signal phasing and traffic operations were videotaped at 4 comparable signalized intersections under normal conditions. Microscopic details were extracted manually at 25 Hz to yield 24 h of data on onset time of the yellow, onset time of the red, driver location and actions after the onset of the yellow, red light–running violations, etc. For comparable intersections with and without countdown timers, driver behavior measured by driver decision (stop or go) and vehicle entry time (when the vehicle crosses the stop line) were analyzed using binary logistical regression (BLR) and a nonparametric test, respectively. Throughout their survey, they concluded that based on the driving attitude in China, when countdown timers are present, drivers are more likely to cross the intersection after the onset of yellow and hence contribute the red light running cases and endanger the other road users. From the outcome of the survey in Changsha as compare with others, that is relatively different for the effectiveness of countdown timer in reducing the red light violation. This may due to the different driving culture between China and Malaysia and in my study will focus to investigate the reason.

2.4 Factors Lead to Red Light Violation

2.4.1 Intersection Factors

2.4.1.1 Flow Rate or Volume of Intersection

There are the potential of red-light running when every vehicle approaching the intersection at the onset of the yellow. To stop or proceed through the intersection, this needs a good judgment of drivers. Survey had shown as the number of approaching vehicles increases, the number of red-light runners will also likely increase. [18]

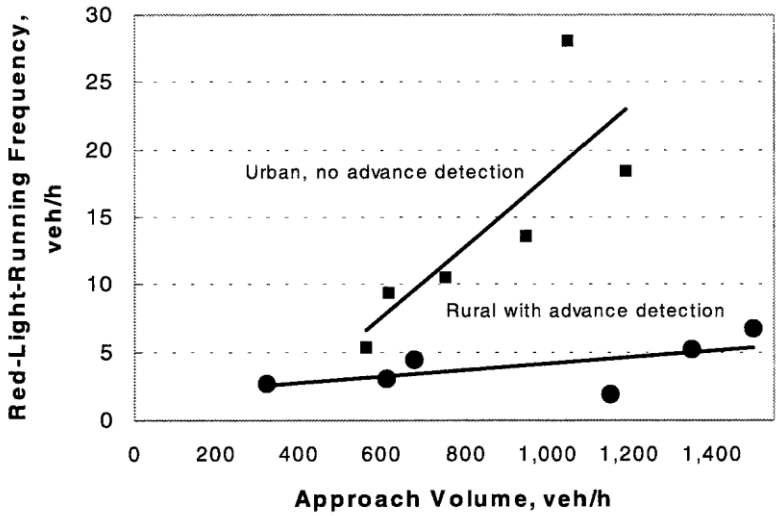

Figure 2.2: Graph on the effect of flow rate on red light running

2.4.1.2 Number of Signal Cycles

Researchers should report the violation rates normalized by the number of signal cycles because the more times the yellow phase is displayed, the more potential for red-light running. [18]

2.4.1.3 Phase Termination by Max-out

As long as the approach is occupied, the actuated signal systems can operate by using green extension time. However, the green may reach its maximum limit and "max-out" forcing the green phase to end regardless of whether the approach is occupied. Conversely, the signal may "gap-out" because the approach has been unoccupied for a set period of time. Hence as the frequency of max-out increases, the number of red-light running increasing too. [18]

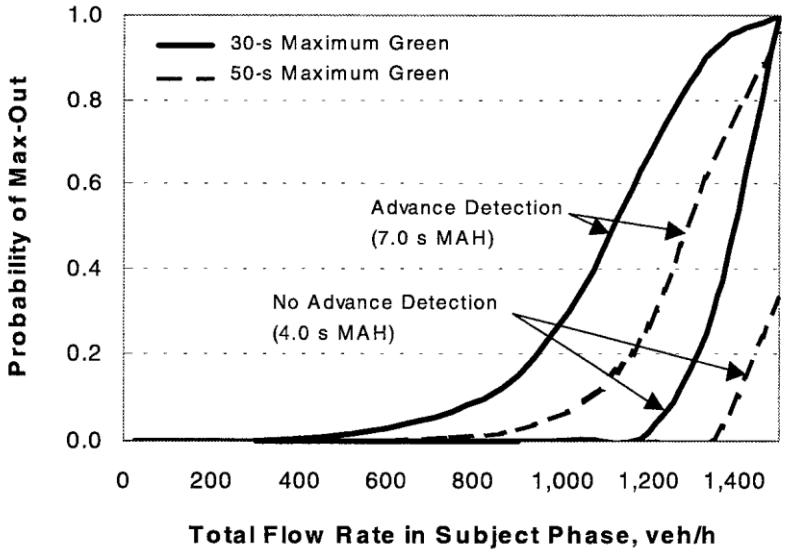

Figure 2.3: Graph on the effect of flow rate and detect design on Max-Out probability

2.4.1.4 Vehicle Speed

The decision of driver to stop at the intersection is reliable on the speed when approaching an intersection. Let say the same travel time to the intersection, high-speed drivers tend to be less likely to stop than low speed. Differences between high-speed drivers tend to be less likely to stop

than low speed. Differences between high-speed drivers and low-speed drivers tend to decrease, but, as the travel time to the stop line (assuming a constant approaching speed) decreases. [19]

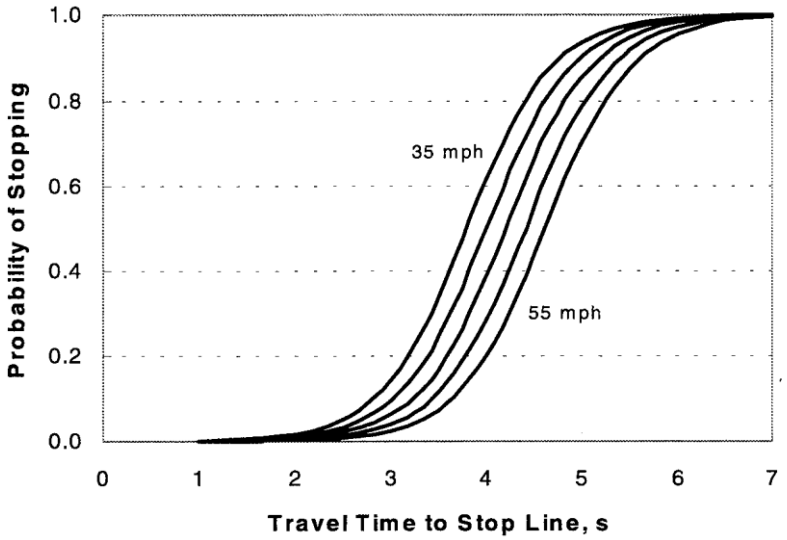

Figure 2.4: Graph on the probability on stop as a function of travelling time and speed

2.4.1.5 Type of Signal Control

For red light running, the type of signal control is the important key in the exposure of drivers to situations. Highway corridors with vehicle-actuated traffic control tend to produce more compact vehicle platoon configurations than pretimed traffic control. The result is an increase in the number of drivers who may be exposed to the yellow and/or red indications during "max out" phase terminations in the operation of the system and a reduction in the probability of stopping before the stop line after the light changes to yellow. [19]

2.4.1.6 Travel Time to Stop Line

Probability of a driver's assessment towards the stopping action requires accurate estimates of speed and distance to the stop line. Through these estimates, a driver assesses his or her ability to stop and the degrees of comfort associated with the stop. The relationships reported by these researchers are shown in the Figure 2.5. [18]

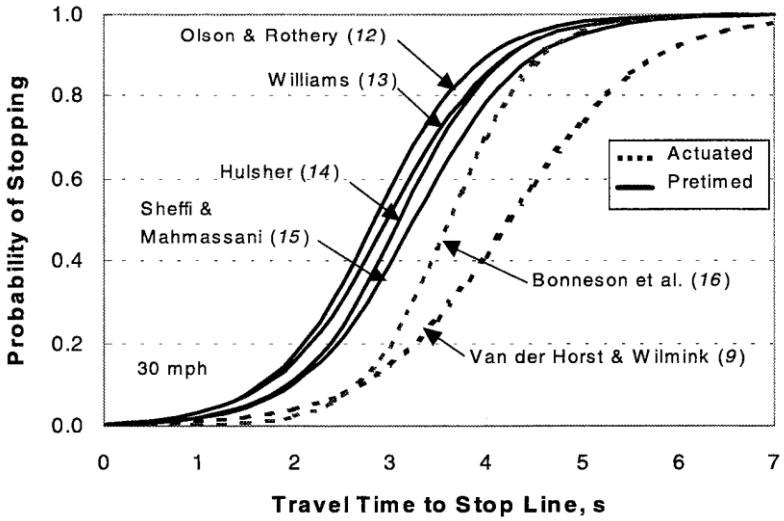

Figure 2.5: Graph on the probability on stop as a function of travelling time and control type

2.4.1.7 Duration of the Yellow Interval

There is a correlation between the duration of the yellow interval and red light running events. There was the survey by Van der Horst (1998) observed a substantial reduction in the number of red light running events after increasing the duration of the yellow interval from 3 to 4 seconds (in urban areas) and from 4 to 5 seconds (in rural areas). Van der Horst observed a small adjustment in the drivers' stopping behavior, which he attributed to the

relatively low increase in the duration of the yellow interval. He noted although that long yellow interval durations tend to result in greater variability in the decision making, it still could result in an increase in the number of rear-end collisions. [19]

2.4.1.8 Approach Grade

The approach grade has an effect on the probability that drivers will stop. Drivers on downward approaches are less likely to stop (at a given travel time to the stop line) than drivers on level approaches or upward approaches. The effect is particularly noticeable in the 2 to 6 second travel time range. [19]

2.4.1.9 Signal Visibility

Factor contributing to red light running, signal visibility has been long recognized as the critical factor. Examples of sight restrictions that can limit the driver's view of the signal include tree foliage, parked vehicles in the immediate vicinity of the intersection, inadequate intersection geometric layouts, and inadequate signal head physical characteristics (such as insufficient number of signal heads, small lens sizes, insufficient lens brightness, and insufficient background contrast). [19]

2.4.2 Human Factors

2.4.2.1 Vision

Mostly in the case of older drivers, visual impairments have an obvious effect on driving performance. Unclear vision may cause the red light violation to happen because they cannot see the traffic light signal clearly. In short, less clear is the relationship between visual impairments and safety. According the research done by Dewar, Olson, and Alexander (2002), there are three visual factors that affect the processing of dynamic information play a critical role on crash rates: dynamic visual acuity, angular movement, and movement in depth. Dynamic visual acuity refers to the task of seeing objects that are moving with respect to the eye, whereas angular movement and movement in depth refer to the task of judging the speed of objects crossing or approaching the path of travel. At the meanwhile, Sims, Owsley, Allman, Ball, and Smoot (1998) compared older drivers who had at least one at-fault crash in the previous 6 years with a control group of older drivers who were crash-free during the same period. They found a strong correlation between the incidence of crashes and useful field of view (UFOV) test results. These results are similar to those obtained previously by Owsley, Ball, Sloane, Roenker, and Bruni (1991). Many drivers who fail the UFOV test have good visual function, suggesting that the UFOV measure is a more effective crash predictor. A number of factors affect the UFOV, including driver age, vehicle speed, and heavy traffic. [19]

2.4.2.2 Driver Attention

Based on several estimates, 25% to 50% of human causal factors in crashes relate to perception or attention. This includes factors such as distraction, inattentiveness, improper lookout, and sleepiness. Stutts, Reinfurt, and Rodgman (2001) evaluated 5 years (1995–1999) of national Crashworthiness Data System (CDS) data to determine the role of driver inattention, in particular driver distraction, in crashes. They observed driver distraction was a factor in over half of the crashes attributed to driver inattention: 8% to 13% of drivers involved in crashes were distracted, 5% to 8% of drivers "looked but didn't see," and 2% to 3% of drivers were sleepy or fell asleep. The most commonly reported source of distraction was persons, objects, or events outside the vehicle 29%, followed by adjusting the radio, cassette or CD 11%, and other occupants in the vehicle 11%. Using a cell phone was associated with 1.5% of all crashes. Interestingly, cell phone use has been associated with a significant increase in the risk of motor vehicle crashes. Using crash and cell phone use data from 699 drivers, Redelmeier and Tibshirani (1997) observed that the risk of a crash when using a cellular phone was four times higher than the risk when the cellular phone was not in use. Driver attention is critical at intersections because of the additional cognitive demands required of drivers at those locations. Hancock, Lesch, Simmons, and Mouloua (2001) observed a 15% increase in the number of non-responses to red light activations at signalized intersections while the drivers were using in-vehicle phones. Where drivers reacted to

the red light activation, their reactions were slower and drivers braked more intensely. The study also showed differences by gender (female drivers had a longer stopping distance) and by age (drivers age 55 to 65 suffered a greater proportionate disadvantage in virtually every measure of vehicle control). [19]

2.4.2.3 Perception-Response Time

Critical component in the calculation of yellow interval durations is perception-response time. Current guidelines suggest using a perception-response time value of 1 second. However, several studies recommend using longer values. Wortman and Matthias (1983) investigated the perception-response time of drivers approaching six signalized intersections at the onset of yellow. At the 85th percentile, perception-response times varied from 1.5 to 2.1 seconds, with all but one intersection clustering in the 1.8 to 2.1 second range. Hooper and McGee (1983) found median perception-response times of 1.1 seconds and 85th percentile values of 1.8 seconds. Chang, Messer, and Santiago (1985) obtained similar results. In a summary of perception-response time literature, Olson (2002) reported suggestions for using values in the 0.75 to 1.5 second range for situations in which the hazard is readily detected and identified, and there are no complications in the decision and response stages. Staplin, Lococo, Byington, and Harkey (2001) recommended using 1.5 seconds to take into account the longer reaction-response times associated with older drivers. [19]

2.4.2.4 Effect of Other Drivers

Drivers approaching an intersection tend to be affected by neighboring vehicles, including preceding vehicles and following vehicles. Allsop, Brown, Groeger, and Robertson (1991) observed that drivers were more likely to go, therefore increasing the risk of running the red light, if they were closely following other vehicles or if they were being followed closely by other vehicles. In short, as the vehicles approaching a signalized intersection are close together, the probabilities of stopping decreases. The effect was particularly noticeable for time headways of 2 seconds or less. There is a close correlation between time headway, distance headway, and flow rate in the context of car following situations. In general, both time headways and the scatter in the distribution of time headways decrease as the flow rate increases, resulting in higher interaction among vehicles and more uniform time headways (May, 1990). Taieb-Maimon and Shinar (2001) observed that drivers tend to adjust their distance headways with speed in an effort to maintain relatively uniform time headways. They also noticed that drivers substantially overestimate their actual time headways. [19]

2.4.2.5 Other Factors

Almost all of the drivers know that red light violation is not the safe way in driving. According the survey done by Boyle, Dienstfrey, and Sothoron (1998) observed that 83% of those interviewed considered running a red light

dangerous. In another survey, 80% of those interviewed indicated they were more likely to engage in aggressive driver behavior other than red light running. However, when faced with time constraints in an urban environment, 28% of respondents indicated they would "speed up to beat the light." Stated reasons included being in a rush 35%, to save time 34%, frustration with having to stop again 12%, and enjoying the thrill of beating the light 3%. The perception of lenient enforcement policies may influence the decision to run a red light or engage in dangerous driving behavior at signalized intersections. Retting and Williams (2000) observed that 46% of drivers interviewed (in cities without automated enforcement systems) believed someone who ran a red light was likely to receive a citation. By comparison, the percentage increased to 61% in cities with automated enforcement systems. The " permissive yellow rule" mentioned previously requires drivers who receive a green indication to yield the right of way to other vehicles that are still (legally) at the intersection. However, a significant percentage of drivers 60% according to a survey cited by Parsonson, Czech, and Bansley (1993) stated that they are unaware of that requirement. [19]

2.5 Intersection

Intersection is part of the common road system. It is the road junction where there are two or three or more roads meet at the same level. An intersection may be 3-way intersection (T junction or fork), 4-way intersection (crossroads), or 5-way intersection or more intersections. It may often be controlled by traffic lights, but not all of them. There are intersections without any traffic signal in the low traffic volume road and may be control by a roundabout. [20]

Below are the types of intersections:

- 3-way intersection: T junction (two arms form one road) or a Y junction.
- 4-way intersection: Involve a crossing over of two streets or roads.
- 5-way intersection: Less common intersection but still exist in the traffic system, especially in urban areas with non-rectangular blocks.
- 6-way intersection: Involve a crossing of three streets at one junction (Let take an example, a crossing of two perpendicular streets and a diagonal street is a rather common type of 6-way intersection)

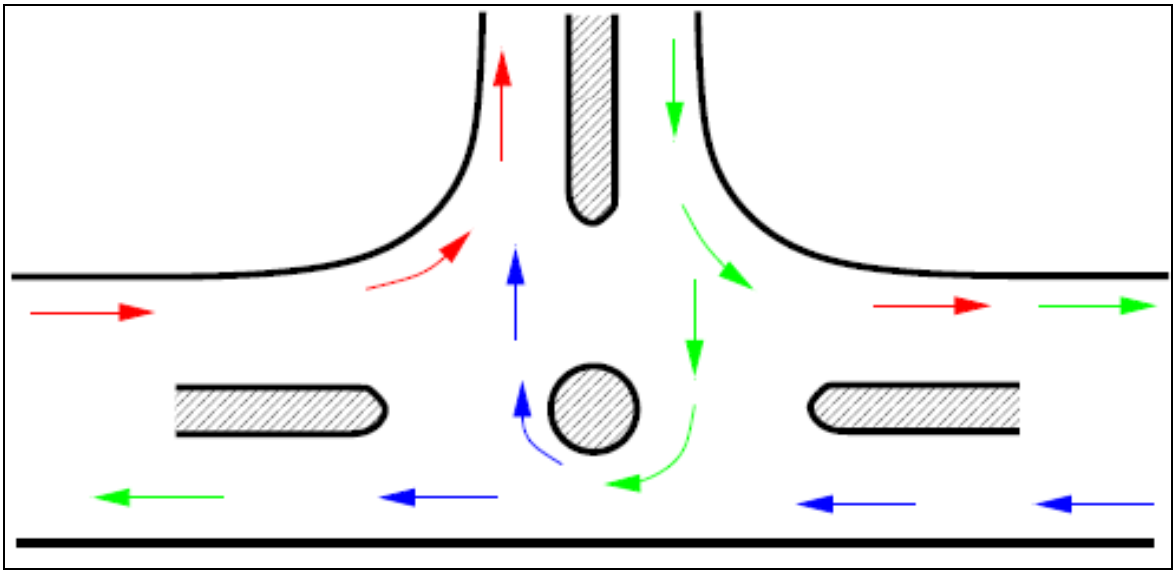

Figure 2.6: 3 legs intersection / T-junction

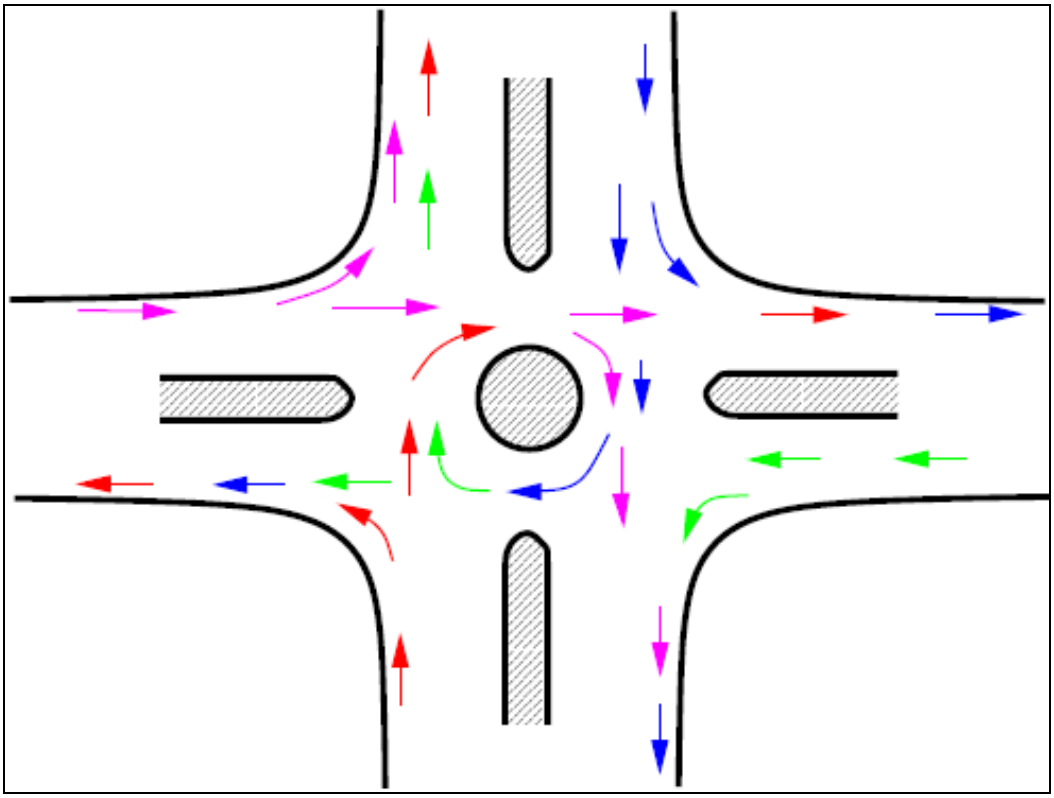

Figure 2.7: 4 legs intersection

2.6 Level of Service

Level of service (LOS) is a measurement commonly used by traffic engineers to determine the effectiveness of elements of transportation infrastructure. In most of the cases, LOS is used to analyze motorways or highways by categorizing traffic flow with corresponding safe driving conditions. [21] This can help for transportation planning in future to solve the traffic jam problem such as proposed inner ring or outer ring alternative routes, wider the available lanes (from 2 lane way to 3 lane way), and other solutions. Below is some description for the LOS in different category:

LOS A: Vehicles can travel in free-flow operations. Traffic flows at or above the posted speed limit and all motorists have complete mobility between lanes. Commonly occurs late at night in urban areas and normally in rural areas. [21]

LOS B: Vehicles can travel in reasonable free-flow operations. The lowest average vehicle spacing is about 330 ft(100m) or 16 car lengths. [21]

LOS C: Vehicles can travel at or near free-flow operations. Ability to maneuver through lanes is noticeably restricted and lane changes require more driver awareness. Minimum vehicle spacing is about 220 ft(67m) or 11 car lengths. Minor incidents may occur and will have noticeable effects and traffic delays will form behind the incident. Targeted of LOS C is for some urban and most rural highways. [21]

LOS D: Vehicles travel in decreasing free-flow levels. Speeds slightly decrease as the traffic volume slightly increases. Vehicles are spaced about 160 ft(50m) or 8 car lengths. LOS D is due to busy shopping weekend, events or a functional urban highway during commuting hours and others. It is the times for looking into propose the bypass roads and lane additions. [21]

LOS E: Flow becomes irregular and speed varies rapidly because there are virtually no usable gaps to maneuver in the traffic stream and speeds rarely reach the posted limit. Vehicle spacing is about 6 car lengths. LOS E is a common standard in larger urban areas, where some roadway congestion is inevitable. [21]

LOS F: It describes a breakdown in vehicular flow. Flow is forced and every vehicle moves in lockstep with the vehicle in front of it very slow speed. Technically, a road in a constant traffic jam would be at LOS F. Generally, this is due to the facilities operating at LOS F generally having more demand than capacity. [21]

LOS	Signalized Intersection	Unsignalized Intersection	General Description
A	≤10 sec	≤10 sec	Free Flow
B	10-20 sec	10-15 sec	Stable Flow (slight delays)
C	20-35 sec	15-25 sec	Stable Flow (acceptable delays)
D	35-55 sec	25-35 sec	Approaching Unstable Flow (tolerable delay)
E	55-80 sec	35-50 sec	Unstable Flow (intolerable delay)
F	≥80 sec	≥50 sec	Forced Flow (jammed)

Table 2.3: LOS criteria for Signalized and Unsignalized Intersections (Highway Capacity Manual)

2.7 Summary of Literature Review

Red light violation occurs when a road user enters an intersection after the traffic light signal has turned red. It potentially brings the negative effect and endangers the road users and hence accident may happen. Based on the statistics, United States and Malaysia are paying a heavy price due to road accidents in term of lives and money.

Throughout the research had been done, there are factors contribute to red light violation. Those factors are further divided into intersection factors and human factors. Among the intersection factors include flow rate or volume of intersection, number of signal cycles, phase termination by max-out, vehicle speed, travel time to stop line, type of signal control, duration of the yellow interval, approach grade and signal visibility; while human factors include vision, driver attention, perception-response time, effect of other drivers and some other factors which potentially cause the red light violation happen due to human factors.

Understanding the definition of intersection is very important in my survey. Intersection is part of the common road system. It is the road junction where there are two or three or more roads meet at the same level. An intersection may be 3-way intersection (T junction or fork), 4-way intersection (crossroads), or 5-way intersection or more intersections. It may often be controlled by traffic lights, but not all of them. There are intersections without any traffic signal in the low traffic volume road and may be control by a roundabout. The concern of the project is conducting the survey at the signalized intersection with and without countdown timer and shows whether the countdown timer helps in reducing the number of red light violation.

Besides, the quality of the intersection can be measured by Level of Service (LOS). LOS can help for transportation planning in future to solve the traffic jam problem such as proposed inner ring or outer ring alternative routes, wider the available lanes (from 2 lane way to 3 lane way), and other solutions. LOS is further divided into different level of flow from LOS A to LOS F. However, LOS is not taken into consideration since this study is mainly focus on red light violation and the previous research done by M. Napiah, M. I. Koh, L. Che Long (2006), they concluded that the countdown timer will not affect the level of service (LOS) of the intersection and red light running violations. [5]

CHAPTER 3

METHODOLOGY

Below is the flow of methodology for the traffic survey of this project:

3.1 Reconnaissance Survey

Reconnaissance survey was carried out in Batu Gajah (Perak), Seri Iskandar (Perak) and Batu Pahat (Johor) to find out the suitable sub-urban intersection for the study. From the preliminary studies had done, the peak hour at Batu Gajah (Perak), Seri Iskandar (Perak) and Batu Pahat (Johor) are at 6.30am to 8am (time depart to work and school) and 5pm to 6.30pm (time back from work and school) at most of the intersection in these 3 towns. However, the suitable time for the study should be off-peak hour. Free-flow is required to work on this survey. Thus, the best time for the traffic survey during off-peak hour should be at 9.30am until 11.30am. Below are the chosen characteristics of the intersections and the type of traffic signal:

Station No.	Road System Code	Name of Station	Town	State	Type of Intersection	Countdown Timer
1	FT 199	Batu Gajah Highway	Batu Gajah	Perak	4 legs junction	Yes (1 only)
2	FT 5	Ipoh-Lumut Highway	Seri Iskandar	Perak	4 legs junction	Yes (2 only)
3	FT 5	Jalan Bakau Condong	Batu Pahat	Johor	4 legs junction	Yes (have 4)
4	FT 5	Jalan Peserai	Batu Pahat	Johor	3 legs junction/T-junction	None

Table 3.1: Characteristics of Road and Traffic Signal

Below are the four study site locations from Google map:

Figure 3.1: Batu Gajah Highway intersection (Batu Gajah town-Tanjung Tualang junction)

Figure 3.2: Ipoh-Lumut Highway intersection (Taman Maju-Bandar Universiti junction)

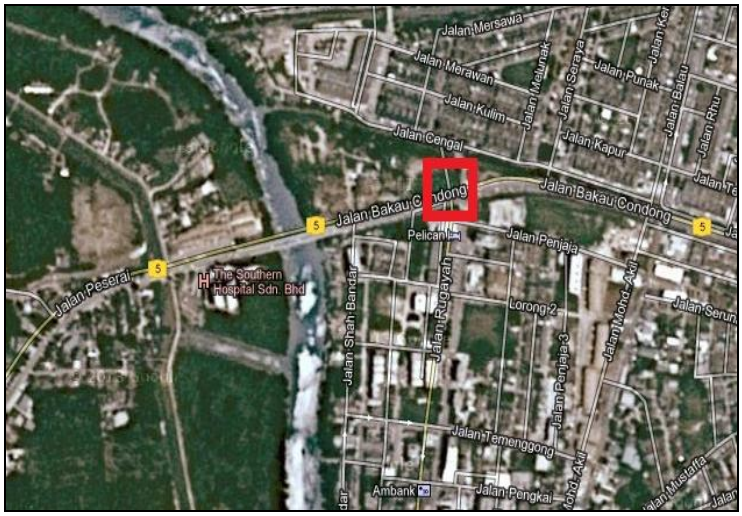

Figure 3.3: Jalan Bakau Condong intersection (Taman Nira-Jalan Rugayah junction)

Figure 3.4: Jalan Peserai intersection (Kampung Muhibbah junction)

Below are the photos for four study site locations (In-situ Photos):

Figure 3.5: Batu Gajah Highway

Figure 3.6: Ipoh-Lumut Highway

Figure 3.7: Jalan Bakau Condong

Figure 3.8: Jalan Peserai

3.2 Preliminary Traffic Survey

For sampling purpose, preliminary traffic surveys performed on the selected locations. This survey can ensure that the locations chosen for the observation is suitable for study. From this survey, traffic count data is tabulated and analyse them. Any problems and obstacles can identify during the early stage. Once the problems being identified, best solutions and alternatives are discussed and justified to solve those problems. After that, real traffic survey is started.

3.3 Traffic Survey

Video recording technique is used in this traffic survey. Video camera runs for 2 hours continuously at each intersection. The time for surveying is off-peak hour to make sure that the traffic is in free-flow state when the survey is carried out. The duration of recoding at each junction for this project is by 9.30am until 11.30am on weekdays or weekends. Four site surveys, where two sites in Perak and two sites in Johor are conducted the traffic surveys during the off-peak hour.

3.4 Traffic Count

Traffic count is done by observing recorded videos during traffic survey. The recorded videos is then replayed on a television or laptop for the ease to see the number of road users comply at red light. Amber and red light violation is counted manually. Data counted for the road users cross during amber and violates the red light is tabulated. The data is then summarize and convert into Passenger Car Unit (PCU).

3.5 Data Analysis

The levels of service (LOS) of all junctions involved in the traffic survey are obtained through Sidra software. The data summaries are then converted into percentage for countdown and without countdown traffic light intersections for the ease of result comparison and the analysis of the result. Chi-square analysis is performed from the percentage gained. The analysis determined the significant of with or without countdown timer at signalized intersections.

3.6 Tools

3.6.1 Software

Programmed software used in this project are:

- SIDRA software
- Microsoft Excel

3.6.2 Survey Instruments

Survey tools used in the project as shown in the figure below:

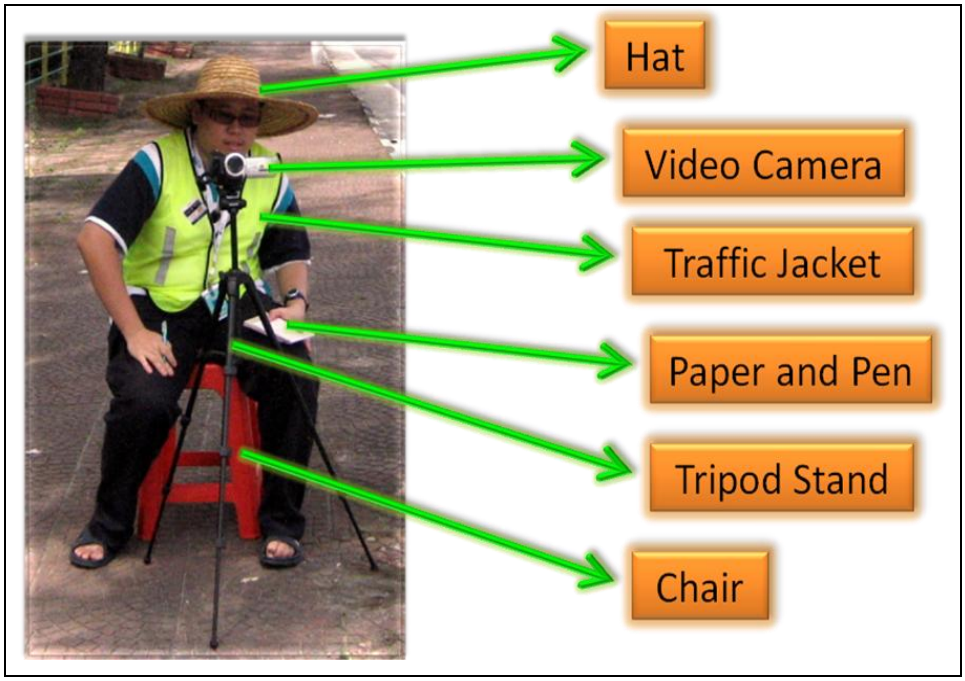

Figure 3.9: Example of survey tools used during traffic survey

3.7 Key Milestone

Task	Start Date	End Date
Project Initiation	14-Jan-13	01-Feb-13
Planning Phase (Literature Review)	01-Feb-13	22-Feb-13
Reconnaissance Survey	08-Feb-13	18-Feb-13
Preliminary Traffic Survey	18-Feb-13	27-Feb-13
Traffic Survey & Traffic Count	28-Feb-13	12-May-13
Data Analysis	12-May-13	02-Jun-13
Finding and Conclusion	02-Jun-13	16-Jun-13
Final Review	16-Jun-13	31-Jul-13
Release	01-Aug-13	30-Aug-13

Table 3.2: Project Milestone

3.8 Gantt Chart

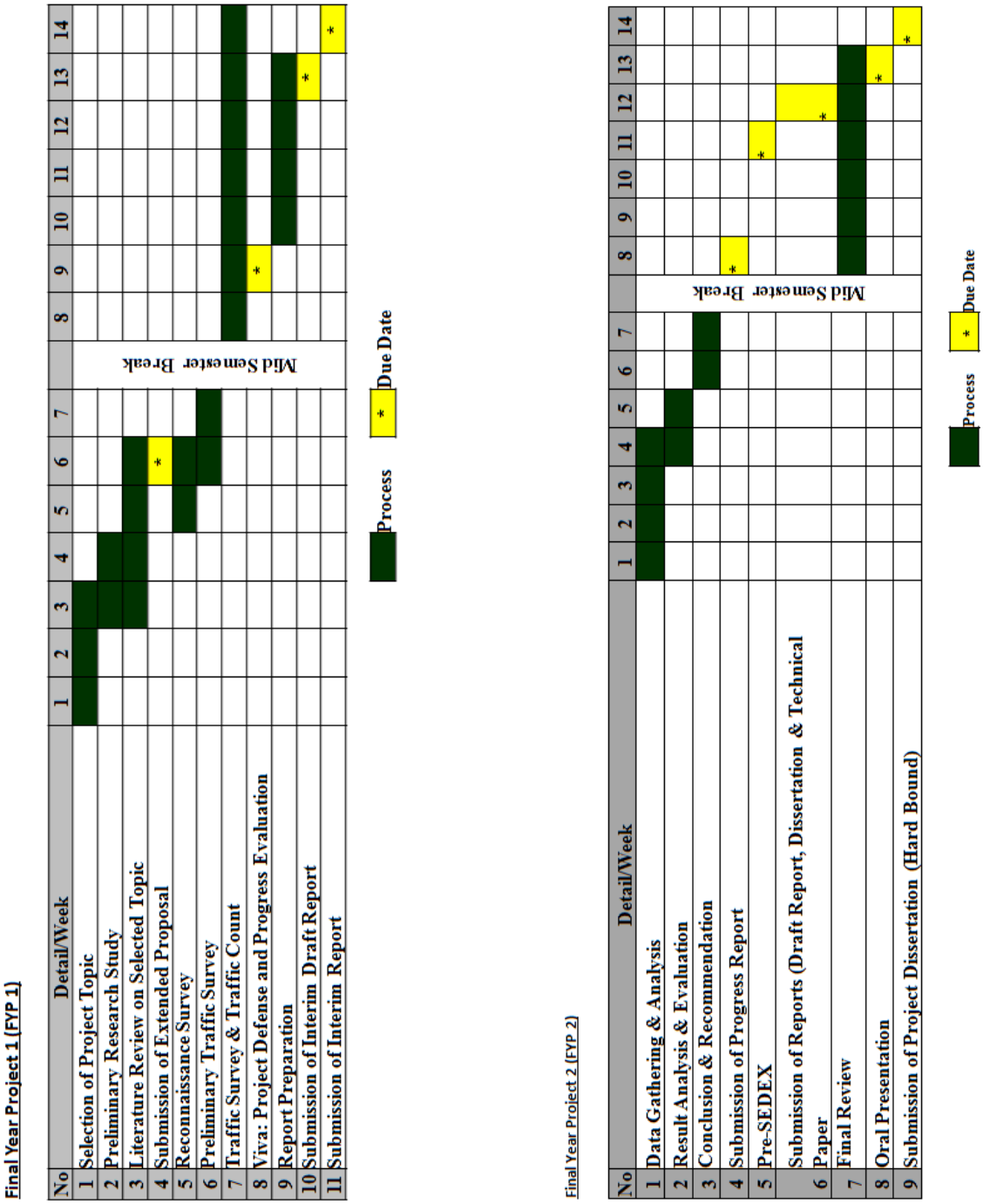

Table 3.3: Gantt Chart

CHAPTER 4

RESULT AND DISCUSSION

4.1 Data Gathering

Tables below are the data summary for the traffic volume at 4 surveyed intersections which are Jalan Peserai 3 Legs Intersections (Batu Pahat, Johor), Jalan Bakau Condong 4 Legs Intersections (Batu Pahat, Johor), Ipoh-Lumut Highway 4 Legs Intersections (Seri Iskandar, Perak) and Batu Gajah Highway 4 Legs Intersections (Batu Gajah, Perak). The survey had been done for 2 hours from 9.30am to 11.30am.

Table 4.1 to Table 4.4 show the data summary for the number of vehicles in purely numbers; while Table 4.5 to Table 4.8 show the data summary for the number of vehicles in passenger car unit (pcu) for the Sindra analysis of Level of Service (LOS).

Table 4.1 as below:
No. of vehicles Jalan Peserai 3 Legs Intersections, Batu Pahat, Johor in purely numbers (Non-timer Intersections)

TOTAL No. for Non-Timer: (9.30am-10.30am)	**Number of Vehicles**
Comply at Red Light and Amble Light	1832
Amber Light Violation	60
Red Light Violation	88
TOTAL:	1980

TOTAL No. for Non-Timer: (10.30am-11.30am)	**Number of Vehicles**
Comply at Red Light and Amble Light	2119
Amber Light Violation	83
Red Light Violation	125
TOTAL:	2327

GRAND TOTAL No. for Non-Timer: (9.30am-11.30am)	Number of Vehicles
Comply at Red Light and Amble Light	**3951**
Amber Light Violation	**143**
Red Light Violation	**213**
TOTAL:	**4307**

Table 4.2 as below:
No. of vehicles Jalan Bakau Condong 4 Legs Intersections, Batu Pahat, Johor in purely numbers
(Timer Intersections)

TOTAL No. for Timer: (9.30am-10.30am)	Number of Vehicles
Comply at Red Light and Amble Light	2934
Amber Light Violation	106
Red Light Violation	46
TOTAL:	3086

TOTAL No. for Timer: (10.30am-11.30am)	Number of Vehicles
Comply at Red Light and Amble Light	3431
Amber Light Violation	110
Red Light Violation	59
TOTAL:	3600

GRAND TOTAL No. for Timer: (9.30am-11.30am)	Number of Vehicles
Comply at Red Light and Amble Light	**6365**
Amber Light Violation	**216**
Red Light Violation	**105**
TOTAL:	**6686**

Table 4.3 as below:
No. of vehicles Ipoh-Lumut Highway 4 Legs Intersections, Seri Iskandar, Perak in purely numbers
(Mix Timer and Non-Timer Intersections)

TOTAL No. for Non-Timer: (9.30am-10.30am)	Number of Vehicles
Comply at Red Light and Amble Light	397
Amber Light Violation	7
Red Light Violation	8
TOTAL:	412

TOTAL No. for Non-Timer: (10.30am-11.30am)	Number of Vehicles
Comply at Red Light and Amble Light	482
Amber Light Violation	9
Red Light Violation	18
TOTAL:	509

GRAND TOTAL No. for Non-Timer: (9.30am-11.30am)	Number of Vehicles
Comply at Red Light and Amble Light	**879**
Amber Light Violation	**16**
Red Light Violation	**26**
TOTAL:	**921**

TOTAL No. for Timer: (9.30am-10.30am)	Number of Vehicles
Comply at Red Light and Amble Light	1111
Amber Light Violation	22
Red Light Violation	7
TOTAL:	1140

TOTAL No. for Timer: (10.30am-11.30am)	Number of Vehicles
Comply at Red Light and Amble Light	1306
Amber Light Violation	45
Red Light Violation	19
TOTAL:	1370

GRAND TOTAL No. for Timer: (9.30am-11.30am)	Number of Vehicles
Comply at Red Light and Amble Light	**2417**
Amber Light Violation	**67**
Red Light Violation	**26**
TOTAL:	**2510**

Table 4.4 as below:

No. of vehicles Batu Gajah Highway 4 Legs Intersections, Batu Gajah, Perak in purely numbers

(Mix Timer and Non-Timer Intersections)

TOTAL No. for Non-Timer: (9.30am-10.30am)	**Number of Vehicles**
Comply at Red Light and Amble Light	1391
Amber Light Violation	37
Red Light Violation	38
TOTAL:	1466

TOTAL No. for Non-Timer: (10.30am-11.30am)	**Number of Vehicles**
Comply at Red Light and Amble Light	1854
Amber Light Violation	63
Red Light Violation	54
TOTAL:	1971

GRAND TOTAL No. for Non-Timer: (9.30am-11.30am)	**Number of Vehicles**
Comply at Red Light and Amble Light	**3245**
Amber Light Violation	**100**
Red Light Violation	**92**
TOTAL:	**3437**

TOTAL No. for Timer: (9.30am-10.30am)	**Number of Vehicles**
Comply at Red Light and Amble Light	443
Amber Light Violation	22
Red Light Violation	10
TOTAL:	475

TOTAL No. for Timer: (10.30am-11.30am)	**Number of Vehicles**
Comply at Red Light and Amble Light	680
Amber Light Violation	32
Red Light Violation	15
TOTAL:	727

GRAND TOTAL No. for Timer: (9.30am-11.30am)	**Number of Vehicles**
Comply at Red Light and Amble Light	**1123**
Amber Light Violation	**54**
Red Light Violation	**25**
TOTAL:	**1202**

Table 4.5 as below:
No. of vehicles Jalan Peserai 3 Legs Intersections, Batu Pahat, Johor in passenger car unit (pcu)
(Non-timer Intersections)

GRAND TOTAL PCU for Non-Timer: (9.30am-11.30am)	Numbers of Vehicles (pcu)
Comply at Red Light and Amble Light	4257
Amber Violation	149
Red Violation	219
TOTAL:	4625

Table 4.6 as below:
No. of vehicles Jalan Bakau Condong 4 Legs Intersections, Batu Pahat, Johor in passenger car unit (pcu)
(Timer Intersections)

GRAND TOTAL PCU for Timer: (9.30am-11.30am)	Numbers of Vehicles (pcu)
Comply at Red Light and Amble Light	6590
Amber Violation	227
Red Violation	109
TOTAL:	6926

Table 4.7 as below:
No. of vehicles Ipoh-Lumut Highway 4 Legs Intersections, Seri Iskandar, Perak in passenger car unit (pcu)
(Mix Timer and Non-Timer Intersections)

GRAND TOTAL PCU for Non-Timer: (9.30am-11.30am)	Numbers of Vehicles (pcu)
Comply at Red Light and Amble Light	900
Amber Violation	16
Red Violation	26
TOTAL:	942

GRAND TOTAL PCU for Timer: (9.30am-11.30am)	Numbers of Vehicles (pcu)
Comply at Red Light and Amble Light	2633
Amber Violation	70
Red Violation	26
TOTAL:	2729

Table 4.8 as below:
No. of vehicles Batu Gajah Highway 4 Legs Intersections, Batu Gajah, Perak in passenger car unit (pcu)
(Mix Timer and Non-Timer Intersections)

GRAND TOTAL PCU for Non-Timer: (9.30am-11.30am)	Numbers of Vehicles (pcu)
Comply at Red Light and Amble Light	3561
Amber Violation	101
Red Violation	94
TOTAL:	3756

GRAND TOTAL PCU for Timer: (9.30am-11.30am)	Numbers of Vehicles (pcu)
Comply at Red Light and Amble Light	1234
Amber Violation	54
Red Violation	25
TOTAL:	1313

4.2 Statistical Analysis of the Traffic Count Data and Discussion

4.2.1 Percentage of Red Light Violation

The analysis had been carried out on the data obtained from the 2 hours survey. Below are the pie-charts show the percentage of road users who comply with the red light, amber light violation and red light violation at surveyed intersections at Jalan Peserai 3 Legs Intersections (Batu Pahat, Johor), Jalan Bakau Condong 4 Legs Intersections (Batu Pahat, Johor), Ipoh-Lumut Highway 4 Legs Intersections (Seri Iskandar, Perak) and Batu Gajah Highway 4 Legs Intersections (Batu Gajah, Perak).

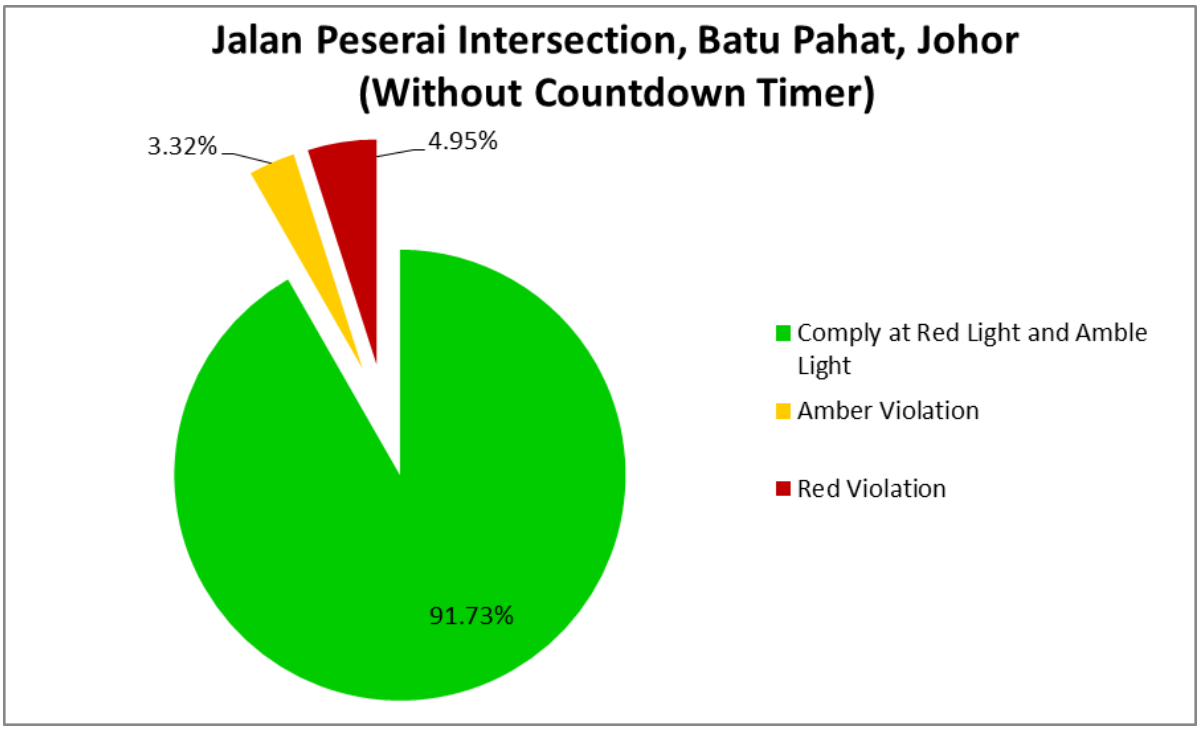

Figure 4.1: Pie-chart result for Jalan Peserai 3 Legs Intersection, Batu Pahat, Johor (Non-timer Intersections)

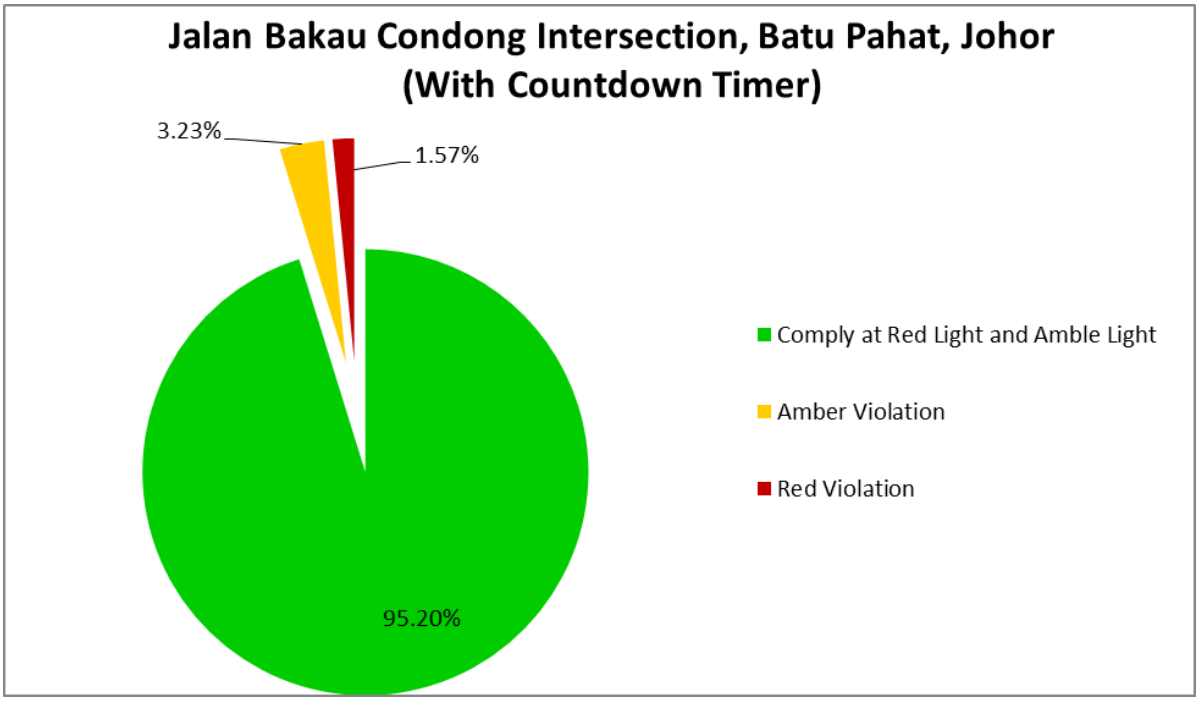

Figure 4.2: Pie-chart result for Jalan Bakau Condong 4 Legs Intersection, Batu Pahat, Johor
(Timer Intersections)

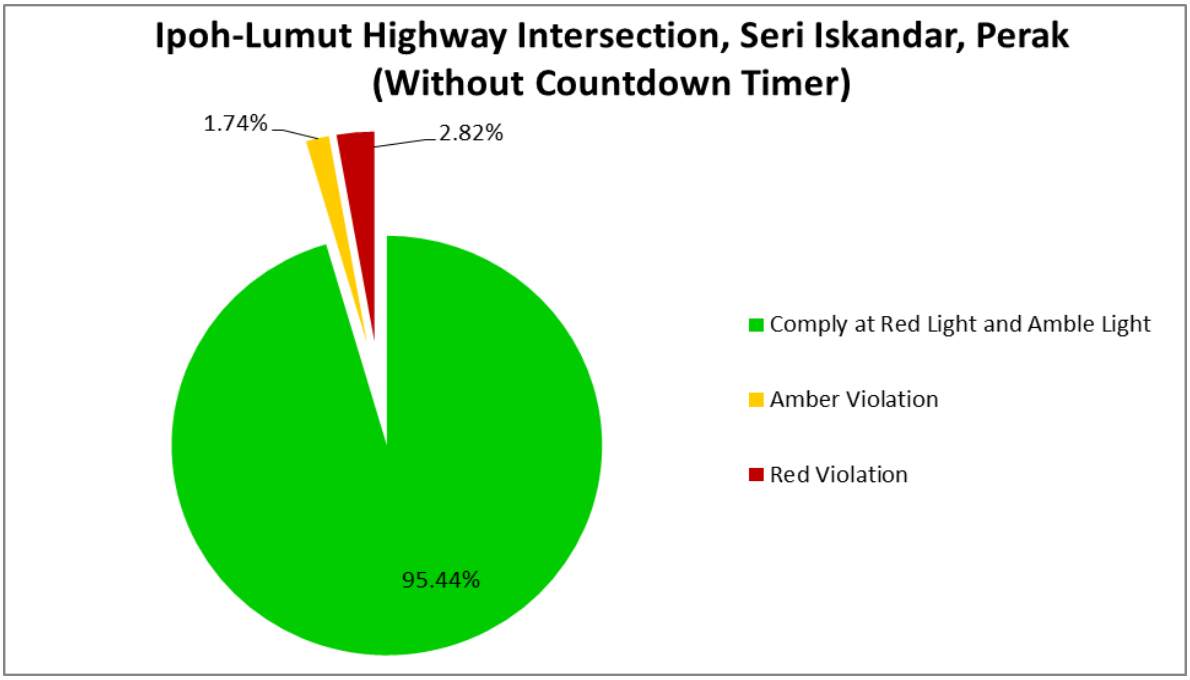

Figure 4.3: Pie-chart result for Ipoh-Lumut Highway 4 Legs Intersection, Seri Iskandar, Perak
(Non-Timer Intersections)

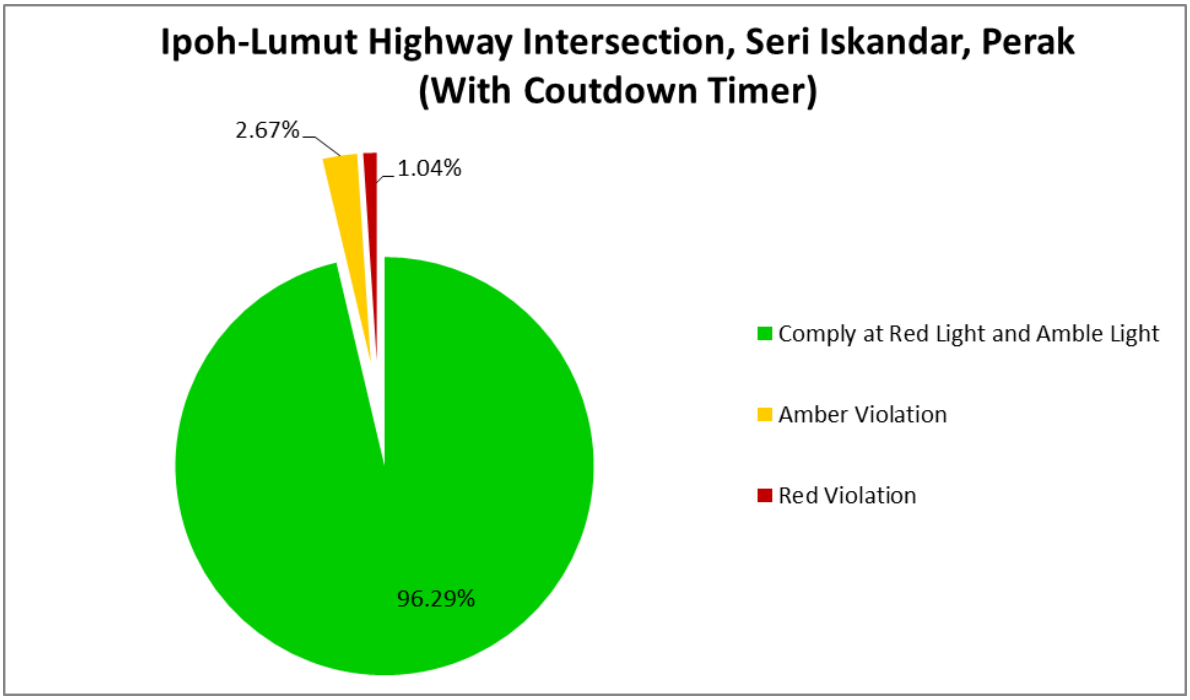

Figure 4.4: Pie-chart result for Ipoh-Lumut Highway 4 Legs Intersection, Seri Iskandar, Perak
(Timer Intersections)

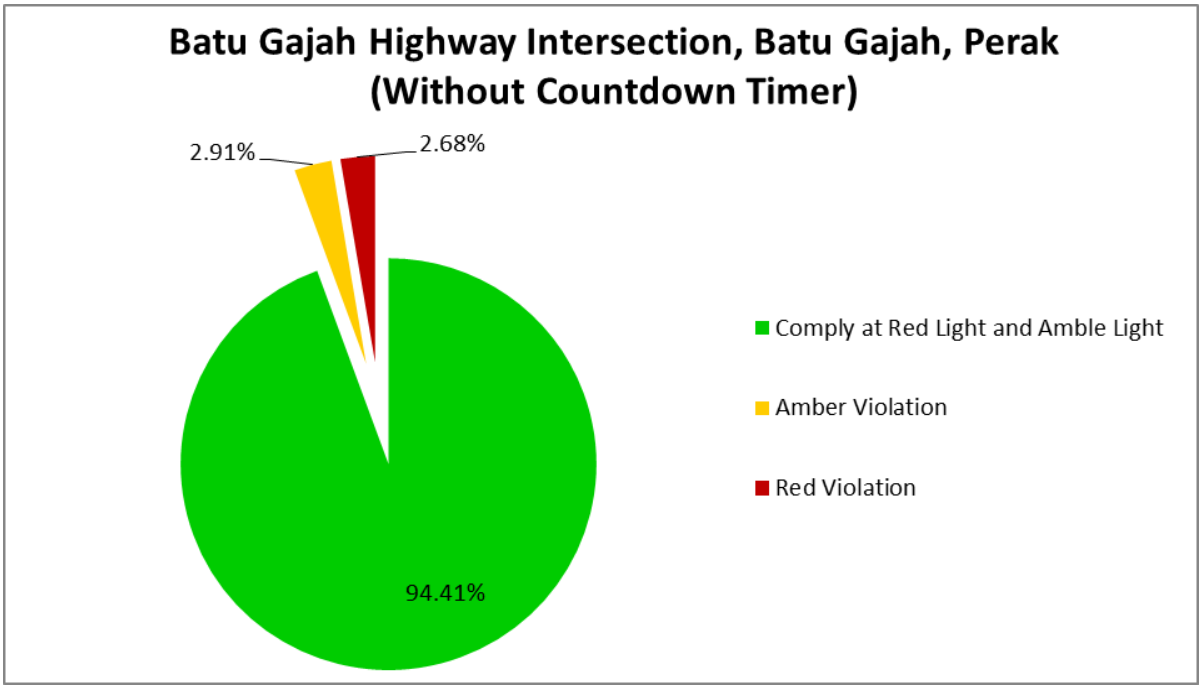

Figure 4.5: Pie-chart result for Batu Gajah Highway 4 Legs Intersection, Batu Gajah, Perak
(Non-Timer Intersections)

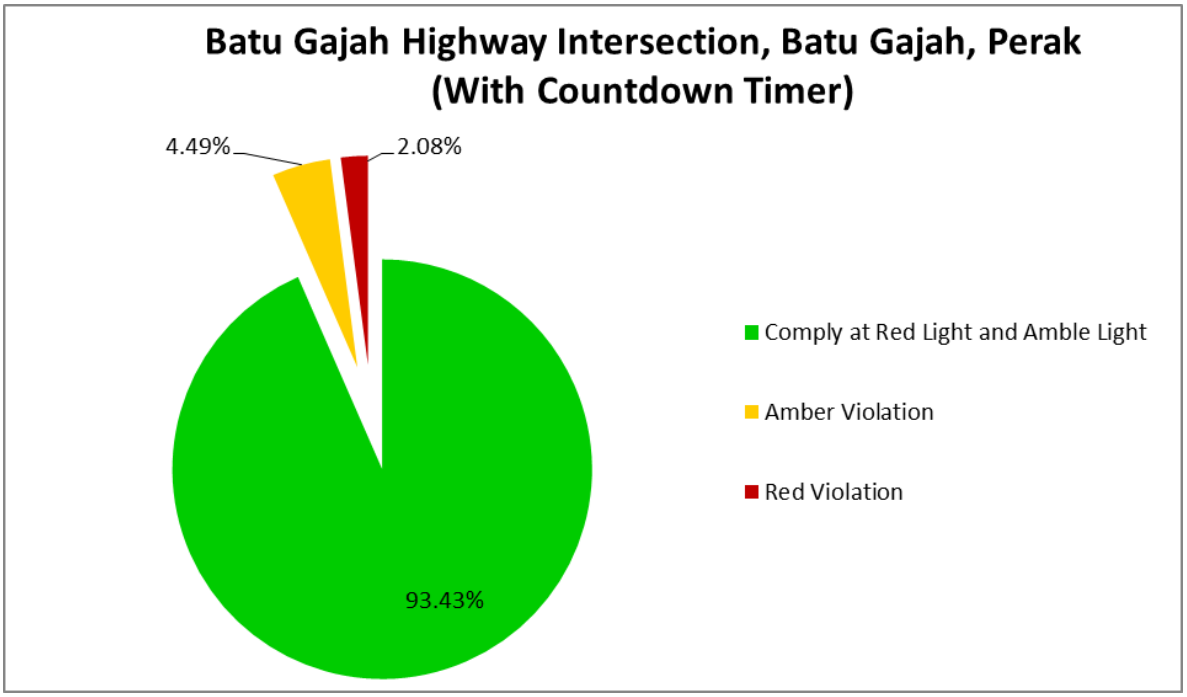

Figure 4.6: Pie-chart result for Batu Gajah Highway 4 Legs Intersection, Batu Gajah, Perak
(Timer Intersections)

Based on Figure 4.1 and Figure 4.2, both are two different intersections which 1 with timer and 1 without timer in Batu Pahat, Johor. The pie-charts of both have clearly shows that the red light violation is higher at non-timer signalized intersection than timer one. Jalan Peserai 3 Legs Intersection (non-timer intersection) contributes 4.95% of red light violation while Jalan Bakau Condong 4 Legs Intersection (timer intersection) only contributes 1.57% of red light violation. It is relatively 3.15 times higher percentage of red light violation at non-timer signalized intersection than timer one. Thus, from this survey clearly shows that timer signalized intersection can help effectively in reducing red light violation problem in Batu Pahat, Johor. Regarding the amber light violation, do not have much different at timer signalized intersection and non-timer one. Jalan Peserai 3 Legs Intersection (non-timer intersection) contributes 3.32% of amber light violation while Jalan Bakau Condong 4 Legs Intersection (timer intersection) contributes 3.23% of amber light violation.

Besides, from the observation of Figure 4.3 and Figure 4.4, the survey which had done at the Seri Iskandar, Perak, the pie-charts of both have clearly shows that the red light violation is higher at non-timer signalized intersection than timer one. Non-timer intersection contributes 2.82% of red light violation while the timer intersection only contributes 1.04% of red light violation. It is relatively 2.7 times higher percentage of red light violation at non-timer signalized intersection than timer one. Hence, from this survey clearly shows that timer signalized intersection can help effectively in reducing red light violation problem in Seri Iskandar, Perak. However as compare the amber and red light violation at timer intersection between Seri Iskandar, Perak and Batu Pahat, Johor, the amber light violation at Batu Pahat, Johor is 3.23%, about 1.85 times higher than the amber light violation at Seri Iskandar, Perak is only 1.57%; while the red light violation at Batu Pahat, Johor is 1.57%, about 1.51 times higher than the red light violation at Seri Iskandar, Perak is only 1.04%. This suspected that the Batu Pahat drivers is more aggressive and tend to rush while driving than Seri Iskandar drivers. This may also due to the different driving behavior between urban and sub-urban. As compare with Seri Iskandar, a small rural town in Perak Tengah district (sub-urban area), Batu Pahat is considering as the second largest town in Johor state (urban area) and people are busier and rushing each other to their one destination to another. Higher population in Batu Pahat (population: 417,458 people) [22] as compare with Seri Iskandar (population: 101,128 people) [22] can be the reason causing more congested road condition and hence Batu Pahat drivers drive under pressure, while Seri Iskandar drivers drive under less pressure on the road. For the amber light violation, it is higher at timer signalized intersection than non-timer one. Non-timer intersection contributes 1.74% of amber light violation while timer intersection contributes 2.67% of amber light violation. This may because of the drivers' behavior when they look at the countdown on timer, they tend to speed up and go across the intersection when the countdown time for green light is reducing and nearly change to amber light.

In addition for next survey site at Batu Gajah, Perak, the pie-charts as shown in Figure 4.5 and Figure 4.6 have clearly shows that the red light violation is higher at non-timer signalized intersection than timer one. Non-timer intersection contributes 2.68% of red light violation while the timer intersection only contributes 2.08% of red light violation. It is relatively 1.28 times higher percentage of red light violation at non-timer signalized intersection than timer one. Hence, from this survey clearly shows that timer signalized intersection can help effectively in reducing red light violation problem in Batu Gajah, Perak. For the amber light violation, same case as the survey site in Seri Iskandar, it is higher at timer signalized intersection than non-timer one. Non-timer intersection contributes 2.91 % of amber light violation while timer intersection contributes 4.49% of amber light violation. This may because of the drivers' behavior when they look at the countdown on timer, they tend to speed up and go across the intersection when the countdown time for green light is reducing and nearly change to amber light. As compare with the Seri Iskandar intersection with the Batu Gajah intersection, it shows higher percentage of amber and red light violation at timer intersection. At other survey sites, the timer intersection normally will have only less than 2% of red light violation, but at Batu Gajah intersection obtained 2.08% of red light violation. Same case goes to amber light violation which hits 4.49%, the highest among all survey sites I had done. From my observation, this is due to geographical condition, where there are a slope before the intersection which may cause by the gravitational and inertia force on vehicles, therefore they cannot stop exactly when amber light and red light.

4.2.2 Sindra Software Analysis for Level of Service (LOS)

In order to check and analyse Level of Service (LOS) at each survey sites, the traffic volume data are required to convert into passenger car unit (pcu). As in the data gathering, all the traffic volume in purely numbers in Table 4.1 to Table 4.4 are converting into passenger car unit (pcu) and

tabulated in Table 4.5 to Table 4.8. All data and condition of the intersections are inputting to the software for further analysis and come out the LOS results.

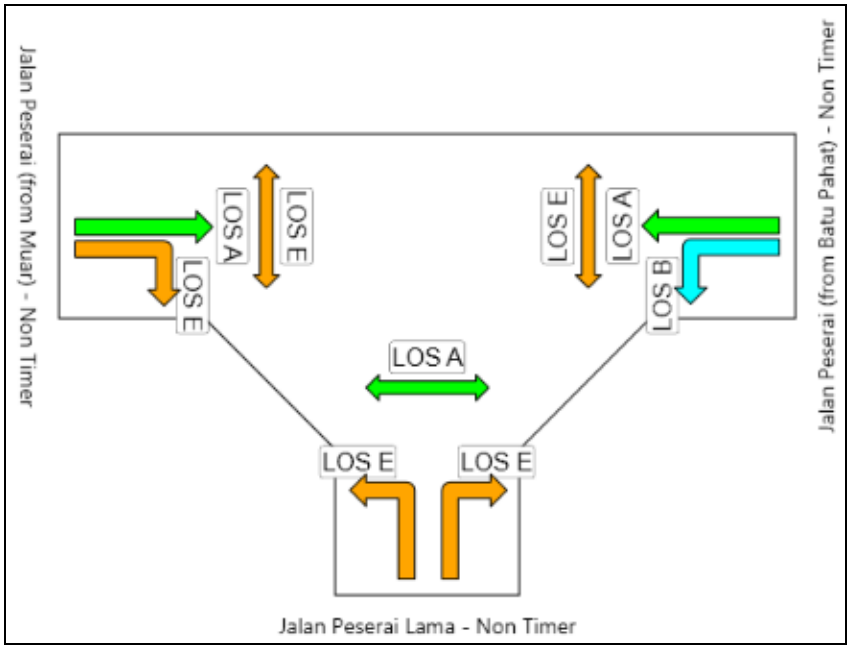

Figure 4.7: LOS at Jalan Peserai 3 Legs Intersection, Batu Pahat, Johor

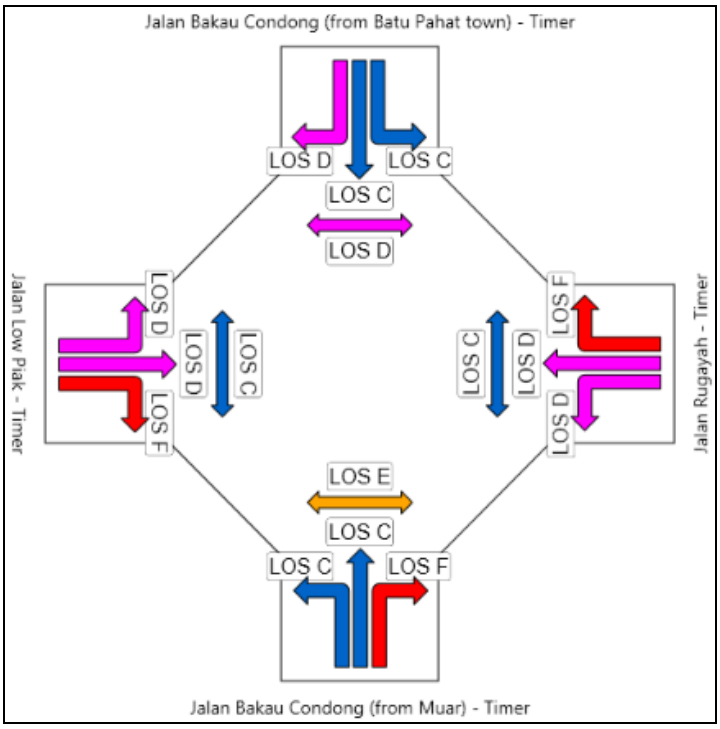

Figure 4.8: LOS at Jalan Bakau Condong 4 Legs Intersection, Batu Pahat, Johor

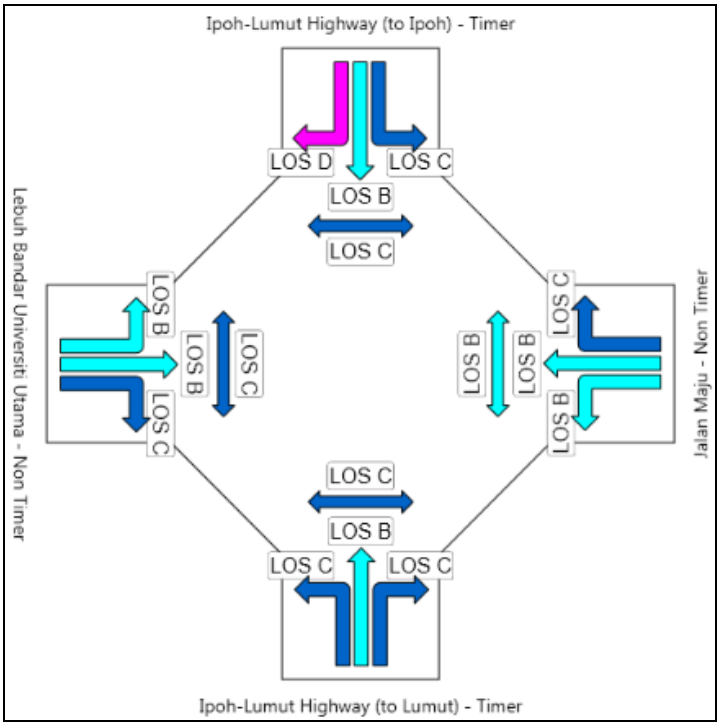

Figure 4.9: LOS at Ipoh-Lumut Highway 4 Legs Intersection, Seri Iskandar, Perak

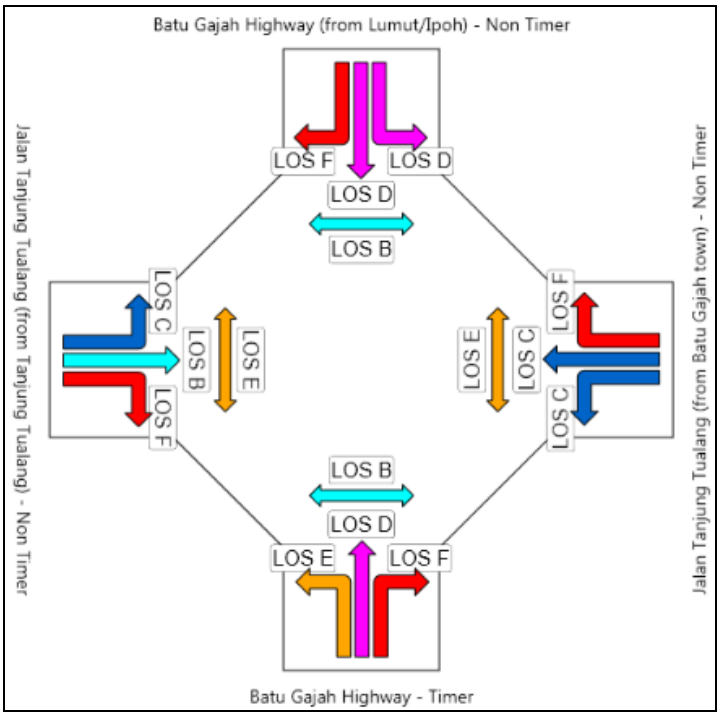

Figure 4.10: LOS at Batu Gajah Highway 4 Legs Intersection, Batu Gajah, Perak

As shown as the result analysis of LOS above for at all survey sites, it shows that the countdown timer at signalize intersections are not uniform which the outcome of the analysis do not tell significantly how well the LOS at the signalize intersections with and without countdown timer. That meaning that the outcomes tell there are no affect for the effectiveness of LOS with or without countdown timer. Hence, results tell that countdown timer is not play the role to ease the traffic and the intersections and thus increase the LOS of the road as well.

4.2.3 Chi-Square Statistical Analysis

Chi-square statistical analysis is done for the efficiency of signalized traffic with the comparison of with and without countdown timer for all 4 survey sites as such there are 2 survey sites in Batu Pahat, Johor and 2 survey sites in Seri Iskandar & Batu Gajah, Perak. Tabulate analysis results as below:

Table 4.9 as below:
Chi-Square statistical analysis for the comparison with and without countdown timer

	BATU PAHAT, JOHOR	SERI ISKANDAR, PERAK	BATU GAJAH, PERAK
Chi-Square Statistic	0.025	0.1812	0.6909
Chi-Square critical at 95% confident interval	45.857	29.484	33.695

Besides, the analysis is also performed for the purpose of comparison between Johor, Perak and Pulau Pinang. Comparison data for Johor (Batu Pahat-Jalan Peserai & Jalan Bakau Condong Intersections) is based on the survey had done in this research report. However, the comparison data for Perak (Ipoh-Silibin Intersection) is based on previous research paper by M. Napiah, M. I. Koh, L. Che Long (2006); while for the

comparison data for Pulau Pinang (Georgetown-Jalan Tanjung Tokong & Jalan Masjid Negeri Intersections) is based on previous research paper by Ahmad Ashraf bin Abu Bakar (2008). Tabulate analysis results as below:

Table 4.10 as below:
Chi-Square statistical analysis for the comparison with and without countdown timer in Johor (Batu Pahat), Perak (Ipoh) and Pulau Pinang (Georgetown)

COMPARISON BETWEEN JOHOR (BATU PAHAT), PERAK (IPOH) AND PULAU PINANG (GEORGETOWN)	
Chi-Square Statistic	0.0723
Chi-Square critical at 95% confident interval	25.645

4.2.3.1 Hypothesis Result for the Effectiveness of Countdown Timer

The aim is to study the effectiveness of countdown timer to reduce red light violation.

1. Batu Pahat, Johor

- Comparison among Jalan Peserai 3 Legs Intersection (Non-timer) and Jalan Bakau Condong 4 Legs Intersection (Timer)
- Since 0.0250 < 45.857, the hypothesis was accepted.
- Thus, the different was significant and this shows that the timer intersection is effective to reduce the red light violation as compare with the non-timer intersection.

2. Seri Iskandar, Perak

- ❖ Comparison of non-timer and timer junctions at Ipoh-Lumut Highway 4 Legs Intersection
- ❖ Since 0.1812 < 29.484, the hypothesis was accepted.
- ❖ Thus, the different was significant and this shows that the timer intersection is effective to reduce the red light violation as compare with the non-timer intersection.

3. Batu Gajah, Perak

- ❖ Comparison of non-timer and timer junctions at Batu Gajah Highway 4 Legs Intersection
- ❖ Since 0.6909 < 33.695, the hypothesis was accepted.
- ❖ Thus, the different was significant and this shows that the timer intersection is effective to reduce the red light violation as compare with the non-timer intersection.

4.2.3.2 Hypothesis Result for the Effectiveness of Countdown Timer and Previous Researches

The aim is to justify the driving behavior of drivers from different states in Malaysia (Johor, Perak and Pulau

Pinang) towards the effectiveness of countdown timer to reduce red light violation. The comparison data for Johor will be the survey done in this project, while the comparison data for Perak and Pulau Pinang are taken from the previous researches.

- Intersections chosen for comparison:
  - Johor
    - Batu Pahat (Jalan Peserai & Jalan Bakau Condong Intersections)
  - Perak
    - Ipoh (Silibin Intersection)
  - Pulau Pinang
    - Georgetown (Jalan Tanjung Tokong & Jalan Masjid Negeri Intersections)
- Since 0.0723 < 25.645, the hypothesis was accepted.
- Thus, the different was significant and this shows that the timer intersection is effective to reduce the red light violation as compare with the non-timer intersection in Johor, Perak and Pulau Pinang. This shows that the driving behavior in any places in Malaysia are more or less the same and less red light violation occur when countdown timer are installed at the intersection.

4.3 Other Comparison and Discussion

Among all the 4 objectives in the projects, all the 3 objectives which are to study the effectiveness of countdown timer to reduce red light violation, to investigate whether geographical locations (urban and sub-urban) affect the efficiency of the countdown timer and to find out whether the countdown timer affect the effectiveness of Level of Service (LOS) at the signalized intersections had been discussed in above pie-charts analysis on the percentage of amber and red light violation, Sindra software analysis for Level of Service (LOS) and Chi-Square statistical analysis. However, the forth objective which is to justify the driving behavior of drivers from different states in Malaysia and from different country in affecting the efficiency of countdown timer to reduce red light violation, the driving behavior of drivers from different states in Malaysia (Johor, Perak and Pulau Pinang) in affecting the effectiveness of countdown timer to reduce red light violation had been justified under Chi-Square statistical analysis, but driving behavior of drivers from different country in affecting the effectiveness of countdown timer to reduce red light violation not yet discuss in any analysis but can compare the findings with the previous researches.

From the previous researches had done in Bangkok, Thailand [10] and Changsha, China [4], the countdown timer is effective to reduce the number of red light violation in Bangkok, Thailand but it it no longer effective in Changsha, China. This means that the effectiveness of countdown timer to reduce the number of the red light violation in Bangkok, Thailand is similar to any cities in Malaysia which really helps in reducing the red light violation and hence reduces the number of accidents happen at the signalized intersection too. However, as compare with the driving behavior in Changsha, China and Malaysia, China drivers highly possible to go across intersection while amber light and red light when the present of countdown timer at the intersection, but it is opposite in Malaysia. This shows the different in driving behavior among Malaysia drivers and China drivers which may due to different cultures and traditions in driving.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

I had finished my research and the progress is following as close as the key milestone and gantt chart. The outcome is now shown positive and fulfill with the objectives to investigate in the project which are study the effectiveness of countdown timer to reduce red light violation, investigate whether geographical locations (urban and sub-urban) affect the efficiency of the countdown timer, find out whether the countdown timer affect the effectiveness of Level of Service (LOS) at the signalized intersections and justify the driving behavior of drivers from different states in Malaysia and from different country in affecting the efficiency of countdown timer to reduce red light violation. So next, I shall proceed for final review for my Final Year Project before I go for Science & Engineering Exhibition (SEDEX), produce my final hard bound dissertation, technical paper and VIVA oral presentation.

There are four suitable study sites had been chosen throughout Reconnaissance Survey and Preliminary Traffic Survey. Besides, the traffic survey had been done in Jalan Bakau Condong intersection and Jalan Peserai intersection in Batu Pahat (Johor), Batu Gajah Highway intersection in Batu Gajah (Perak) and Ipoh-Lumut Highway intersection in Seri Iskandar (Perak). Video recording method was used in the traffic survey. Traffic count on the comply at red light counted though the video that recorded by video camera and replaying in laptop. However, the traffic count on the amber and red light violation has to count manually during the traffic survey period.

As the survey results analysis had been done, I had fulfilled the four objectives of this project with positive outcome. For the first aim is to study the effectiveness of countdown timer to reduce red light violation and this had been proven and discussed under pie-charts analysis on the percentage of amber and red light violation and also Chi-Square Statistical Analysis. The final results for all survey sites in Batu Pahat (Johor), Seri Iskandar (Perak) and Batu Gajah (Perak) had shown that the countdown timer is effective to reduce red light violation significantly.

Besides, for the second aim is to investigate whether geographical locations (urban and sub-urban) affect the efficiency of the countdown timer and this had been proven and discussed under pie-charts analysis on the percentage of amber and red light violation. The final outcome had shown that the geographical location in urban area (Batu Pahat, Johor) and sub-urban area (Seri Iskandar, Perak) can affect the effectiveness of the countdown timer. Urban area will achieve higher amber light and red light violation as compare at the sub-urban area. This may because of the stress level of driver is higher in urban area than sub-urban area. The congested intersections and roads in urban may easy cause the tense of the driver while driving and lead to red light violation easily.

Moreover, for the third aim is to find out whether the countdown timer affect the effectiveness of Level of Service (LOS) at the signalized intersections and this had been proven and discussed under Sindra software analysis for LOS. The final outcome had shown that the LOS at Jalan Bakau Condong intersection and Jalan Peserai intersection in Batu Pahat (Johor), Batu Gajah Highway intersection in Batu Gajah (Perak) and Ipoh-Lumut Highway intersection in Seri Iskandar (Perak) have not uniform LOS and as such we can conclude there are no effects for the countdown timer to play the role to ease the traffic and the intersections and thus increase the LOS of the road as well.

Finally for the fourth aim which is justify the driving behavior of drivers from different states in Malaysia and from different country in affecting the efficiency

of countdown timer to reduce red light violation. The driving behavior of drivers from different states in Malaysia (Johor, Perak and Pulau Pinang) in affecting the effectiveness of countdown timer to reduce red light violation had been justified under Chi-Square statistical analysis and the final outcome together with the comparison had shown effective to reduce the red light violation as compare with the non-timer intersection in Johor, Perak and Pulau Pinang. This shows that the driving behavior in any places in Malaysia are more or less the same and less red light violation occur when countdown timer are installed at the intersection. For the drivers from Bangkok, Thailand, the effectiveness of countdown timer to reduce red light violation was valid and almost the similar outcome obtains in Malaysia. However as compare with the driving behavior in Changsha, China, the countdown timer is no longer effective to reduce red light violation but in the other hands increase the red light violation. This shows the different in driving behavior among Malaysia drivers and China drivers which may due to different cultures and traditions in driving.

5.2 Recommendations

There are some others effective ways to reduce the red light violation. Automatic Enforcement System (AES) which had just been started in Malaysia believe can reduce the red light violation cases and hence reduce the accidents due to red light violation. Besides, education is one of the important criteria to educate and create awareness to the public about the risk of red light violation and the important road safety.

Besides that, I found the limitations and problems I faced when conducting the traffic study. Therefore, I come across some recommendations for this project as shown as below to further improve the result obtains to be more accurate:

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No.	Limitations/Problems	Recommendations
1	2 hours survey results may not be most accurate data to survey on the effectiveness of the countdown timer due to shortage of time.	The timeline for conducting the survey should be longer, the best if can conduct 24 hours basis to study the effectiveness at peak and non-peak hours as well. However, This is impossible to get done for a Final Year Project which we have only 8 months in 2 semester.
2	All survey sites' intersections are differs in term of its geometry, capacity and location	Ideal survey should be conducting the survey base on before-and-after approach which manages to take away the intersection factors. However, this approach study requires the involvement of the local authority and Public Works Department (JKR) to install the countdown timer and taking the coordination. This is not possible to get done within 2 semester time because this approach need time to get approval and other official matters.
3	The present of me at the survey intersections may get attention of the drivers, so the results obtain is not based on their natural driving behavior.	In order to obtain the natural driving behavior when the drivers go across the intersection, there will be more ideal if I can hide nearby the intersection and so that the drivers will not notice me. However, not every intersection has the hiding shade for me to do the survey.
4	4 survey sites may not produce the accurate survey results on the effectiveness of the countdown timer.	If the timeline for Final Year Project is longer, more study can be done and I will able compare widely the effectiveness of the countdown timer in different places in Malaysia. Sarawak and Sabah would be an attracting survey location since the geography is different from Peninsular Malaysia.
5	Manual vehicles counting may not be so accurate.	If there are higher budget for Final Year Project and get the cooperation with local authority and Public Works Department (JKR), a counting sensor can be fixed at the survey intersections to obtain most accurate survey results on comply at amble and red light, amber light violation and red light violation.

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APPENDIX (I)

Photos of Signalize Intersection with Countdown Timer in Different Towns, Cities and Countries

Traffic signal with countdown timer in Indonesia

Traffic signal with countdown timer in India

Traffic signal with countdown timer in Thailand

Traffic signal with countdown timer in China

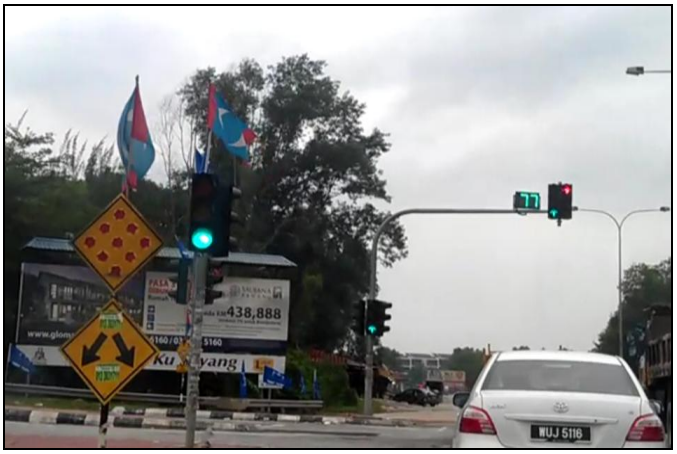
Traffic signal with countdown timer in Taiwan

Traffic signal with countdown timer in Bandaraya Melaka, Malaysia

Traffic signal with countdown timer in Jalan Bukit Pasir, Batu Pahat, Johor, Malaysia

Traffic signal with countdown timer in Jalan Rahmat, Batu Pahat, Johor, Malaysia

Traffic signal with countdown timer in Bakri, Muar, Johor, Malaysia



Traffic signal with countdown timer in Rawang, Selangor, Malaysia

Traffic signal with countdown timer for pedestrian in Singapore

Traffic signal with countdown timer for bicycle in Amsterdam, Netherlands

APPENDIX (II)

Details Calculation and Tabulate Data for Traffic Count and Analysis

Jalan Peserai Intersection, Batu Pahat, Johor

Traffic Survey

Car and Motorcycle

Date : 02 Mar 2013
Site: Jalan Peserai Intersection (without countdown timer)
Time: 9.30am-10.30am

Junctions from …	Comply at Red Light and Amble Light		Amber Violation		Red Violation		Availabilty of Timer
	No.	PCU (x1)	No.	PCU (x1)	No.	PCU (x1)	
Jalan Peserai (to Batu Pahat)	1633	1633	25	25	35	35	No
Jalan Peserai (to Muar)			29	29	49	49	No
Jalan Peserai Lama (to Kampung Muhibbah)			3	3	1	1	No
TOTAL			**57**	**57**	**85**	**85**	

Traffic Survey

Lorries and Buses

Date : 02 Mar 2013
Site: Jalan Peserai Intersection (without countdown timer)
Time: 9.30am-10.30am

Junctions from …	Comply at Red Light and Amble Light		Amber Violation		Red Violation		Availabilty of Timer
	No.	PCU (x1.75)	No.	PCU (x1.75)	No.	PCU (x1.75)	
Jalan Peserai (to Batu Pahat)	199	348.25	1	1.75	0	0	No
Jalan Peserai (to Muar)			2	3.5	3	5.25	No
Jalan Peserai Lama (to Kampung Muhibbah)			0	0	0	0	No
TOTAL			**3**	**5.25**	**3**	**5.25**	

Traffic Survey

Car and Motorcycle

Date : 02 Mar 2013
Site: Jalan Peserai Intersection (without countdown timer)
Time: 10.30am-11.30am

Junctions from …	Comply at Red Light and Amble Light		Amber Violation		Red Violation		Availabilty of Timer
	No.	PCU (x1)	No.	PCU (x1)	No.	PCU (x1)	
Jalan Peserai (to Batu Pahat)	1911	1911	31	31	39	39	No
Jalan Peserai (to Muar)			42	42	81	81	No
Jalan Peserai Lama (to Kampung Muhibbah)			6	6	1	1	No
TOTAL			**79**	**79**	**121**	**121**	

Traffic Survey

Lorries and Buses

Date : 02 Mar 2013
Site: Jalan Peserai Intersection (without countdown timer)
Time: 10.30am-11.30am

Junctions from …	Comply at Red Light and Amble Light		Amber Violation		Red Violation		Availabilty of Timer
	No.	PCU (x1.75)	No.	PCU (x1.75)	No.	PCU (x1.75)	
Jalan Peserai (to Batu Pahat)	208	364	3	5.25	1	1.75	No
Jalan Peserai (to Muar)			1	1.75	3	5.25	No
Jalan Peserai Lama (to Kampung Muhibbah)			0	0	0	0	No
TOTAL			**4**	**7**	**4**	**7**	

Jalan Bakau Condong Intersection, Batu Pahat, Johor

Traffic Survey

Car and Motorcycle
Date : 03 Mar 2013
Site: Jalan Bakau Condong Intersection (with countdown timer)
Time: 9.30am-10.30am

Junctions from …	Comply at Red Light and Amble Light		Amber Violation		Red Violation		Availabilty of Timer
	No.	PCU (x1)	No.	PCU (x1)	No.	PCU (x1)	
Jalan Rugayah	2808	2808	38	38	22	22	Yes
Jalan Bakau Condong (to Muar)			22	22	12	12	Yes
Jalan Bakau Condong (to Batu Pahat)			32	32	10	10	Yes
Jalan Low Piak			8	8	1	1	Yes
TOTAL			**100**	**100**	**45**	**45**	

Traffic Survey

Lorries and Buses
Date : 03 Mar 2013
Site: Jalan Bakau Condong Intersection (with countdown timer)
Time: 9.30am-10.30am

Junctions from …	Comply at Red Light and Amble Light		Amber Violation		Red Violation		Availabilty of Timer
	No.	PCU (x1.75)	No.	PCU (x1.75)	No.	PCU (x1.75)	
Jalan Rugayah	126	220.5	2	3.5	0	0	Yes
Jalan Bakau Condong (to Muar)			1	1.75	0	0	Yes
Jalan Bakau Condong (to Batu Pahat)			3	5.25	1	1.75	Yes
Jalan Low Piak			0	0	0	0	Yes
TOTAL			**6**	**10.5**	**1**	**1.75**	

Traffic Survey

Car and Motorcycle
Date : 03 Mar 2013
Site: Jalan Bakau Condong Intersection (with countdown timer)
Time: 10.30am-11.30am

Junctions from …	Comply at Red Light and Amble Light		Amber Violation		Red Violation		Availabilty of Timer
	No.	PCU (x1)	No.	PCU (x1)	No.	PCU (x1)	
Jalan Rugayah	3258	3258	32	32	17	17	Yes
Jalan Bakau Condong (to Muar)			27	27	18	18	Yes
Jalan Bakau Condong (to Batu Pahat)			23	23	15	15	Yes
Jalan Low Piak			20	20	5	5	Yes
TOTAL			**102**	**102**	**55**	**55**	

Traffic Survey

Lorries and Buses
Date : 03 Mar 2013
Site: Jalan Bakau Condong Intersection (with countdown timer)
Time: 10.30am-11.30am

Junctions from …	Comply at Red Light and Amble Light		Amber Violation		Red Violation		Availabilty of Timer
	No.	PCU (x1.75)	No.	PCU (x1.75)	No.	PCU (x1.75)	
Jalan Rugayah	173	302.75	2	3.5	0	0	Yes
Jalan Bakau Condong (to Muar)			4	7	2	3.5	Yes
Jalan Bakau Condong (to Batu Pahat)			2	3.5	2	3.5	Yes
Jalan Low Piak			0	0	0	0	Yes
TOTAL			**8**	**14**	**4**	**7**	

Ipoh-Lumut Highway Intersection, Seri Iskandar, Perak

Traffic Survey

Car and Motorcycle
Date : 30 Mar 2013
Site: Ipoh-Lumut Highway Intersection (mix with&without timer)
Time: 9.30am-10.30am

Junctions from …	Comply at Red Light and Amble Light		Amber Violation		Red Violation		Availabilty of Timer
	No.	PCU (x1)	No.	PCU (x1)	No.	PCU (x1)	
Ipoh Lumut Highway (to Lumut)	999	999	11	11	4	4	Yes
Ipoh Lumut Highway (to Ipoh)			10	10	3	3	Yes
Taman Maju	386	386	3	3	3	3	No
Bandar Universiti			4	4	5	5	No
TOTAL			**28**	**28**	**15**	**15**	

Traffic Survey

Lorries and Buses
Date : 30 Mar 2013
Site: Ipoh-Lumut Highway Intersection (mix with&without timer)
Time: 9.30am-10.30am

Junctions from …	Comply at Red Light and Amble Light		Amber Violation		Red Violation		Availabilty of Timer
	No.	PCU (x1.75)	No.	PCU (x1.75)	No.	PCU (x1.75)	
Ipoh Lumut Highway (to Lumut)	112	196	0	0	0	0	Yes
Ipoh Lumut Highway (to Ipoh)			1	1.75	0	0	Yes
Taman Maju	11	19.25	0	0	0	0	No
Bandar Universiti			0	0	0	0	No
TOTAL			**1**	**1.75**	**0**	**0**	

Traffic Survey

Car and Motorcycle
Date : 30 Mar 2013
Site: Ipoh-Lumut Highway Intersection (mix with&without timer)
Time: 10.30am-11.30am

Junctions from …	Comply at Red Light and Amble Light		Amber Violation		Red Violation		Availabilty of Timer
	No.	PCU (x1)	No.	PCU (x1)	No.	PCU (x1)	
Ipoh Lumut Highway (to Lumut)	1130	1130	24	24	11	11	Yes
Ipoh Lumut Highway (to Ipoh)			19	19	8	8	Yes
Taman Maju	465	465	4	4	9	9	No
Bandar Universiti			5	5	9	9	No
TOTAL			**52**	**52**	**37**	**37**	

Traffic Survey

Lorries and Buses
Date : 30 Mar 2013
Site: Ipoh-Lumut Highway Intersection (mix with&without timer)
Time: 10.30am-11.30am

Junctions from …	Comply at Red Light and Amble Light		Amber Violation		Red Violation		Availabilty of Timer
	No.	PCU (x1.75)	No.	PCU (x1.75)	No.	PCU (x1.75)	
Ipoh Lumut Highway (to Lumut)	176	308	1	1.75	0	0	Yes
Ipoh Lumut Highway (to Ipoh)			1	1.75	0	0	Yes
Taman Maju	17	29.75	0	0	0	0	No
Bandar Universiti			0	0	0	0	No
TOTAL			**2**	**3.5**	**0**	**0**	

Batu Gajah Highway Intersection, Batu Gajah, Perak

Traffic Survey

Car and Motorcycle

Date : 9 Apr 2013
Site: Batu Gajah Highway Intersection (mix with&without timer)
Time: 9.30am-10.30am

Junctions from …	Comply at Red Light and Amble Light		Amber Violation		Red Violation		Availabilty of Timer
	No.	PCU (x1)	No.	PCU (x1)	No.	PCU (x1)	
Batu Gajah Highway (to Tronoh/Lahat/Ipoh)	395	395	22	22	10	10	Yes
Batu Gajah Highway (to Gopeng/Simpang Pulai/Ipoh)	1233	1233	8	8	8	8	No
Tanjung Tualang			20	20	19	19	No
Batu Gajah Town			9	9	10	10	No
TOTAL			**59**	**59**	**47**	**47**	

Traffic Survey

Lorries and Buses

Date : 9 Apr 2013
Site: Batu Gajah Highway Intersection (mix with&without timer)
Time: 9.30am-10.30am

Junctions from …	Comply at Red Light and Amble Light		Amber Violation		Red Violation		Availabilty of Timer
	No.	PCU (x1.75)	No.	PCU (x1.75)	No.	PCU (x1.75)	
Batu Gajah Highway (to Tronoh/Lahat/Ipoh)	48	84	0	0	0	0	Yes
Batu Gajah Highway (to Gopeng/Simpang Pulai/Ipoh)	158	276.5	0	0	0	0	No
Tanjung Tualang			0	0	0	0	No
Batu Gajah Town			0	0	1	1.75	No
TOTAL			**0**	**0**	**1**	**1.75**	

Traffic Survey

Car and Motorcycle

Date : 9 Apr 2013
Site: Batu Gajah Highway Intersection (mix with&without timer)
Time: 10.30am-11.30am

Junctions from …	Comply at Red Light and Amble Light		Amber Violation		Red Violation		Availabilty of Timer
	No.	PCU (x1)	No.	PCU (x1)	No.	PCU (x1)	
Batu Gajah Highway (to Tronoh/Lahat/Ipoh)	581	581	32	32	15	15	Yes
Batu Gajah Highway (to Gopeng/Simpang Pulai/Ipoh)	1591	1591	12	12	7	7	No
Tanjung Tualang			33	33	25	25	No
Batu Gajah Town			17	17	21	21	No
TOTAL			**94**	**94**	**68**	**68**	

Traffic Survey

Lorries and Buses

Date : 9 Apr 2013
Site: Batu Gajah Highway Intersection (mix with&without timer)
Time: 10.30am-11.30am

Junctions from …	Comply at Red Light and Amble Light		Amber Violation		Red Violation		Availabilty of Timer
	No.	PCU (x1.75)	No.	PCU (x1.75)	No.	PCU (x1.75)	
Batu Gajah Highway (to Tronoh/Lahat/Ipoh)	99	173.25	0	0	0	0	Yes
Batu Gajah Highway (to Gopeng/Simpang Pulai/Ipoh)	263	460.25	1	1.75	0	0	No
Tanjung Tualang			0	0	0	0	No
Batu Gajah Town			0	0	1	1.75	No
TOTAL			**1**	**1.75**	**1**	**1.75**	

APPENDIX (III)

Sidra Software Output Data and Information

Jalan Peserai Intersection, Batu Pahat, Johor

Unlicensed Trial Version

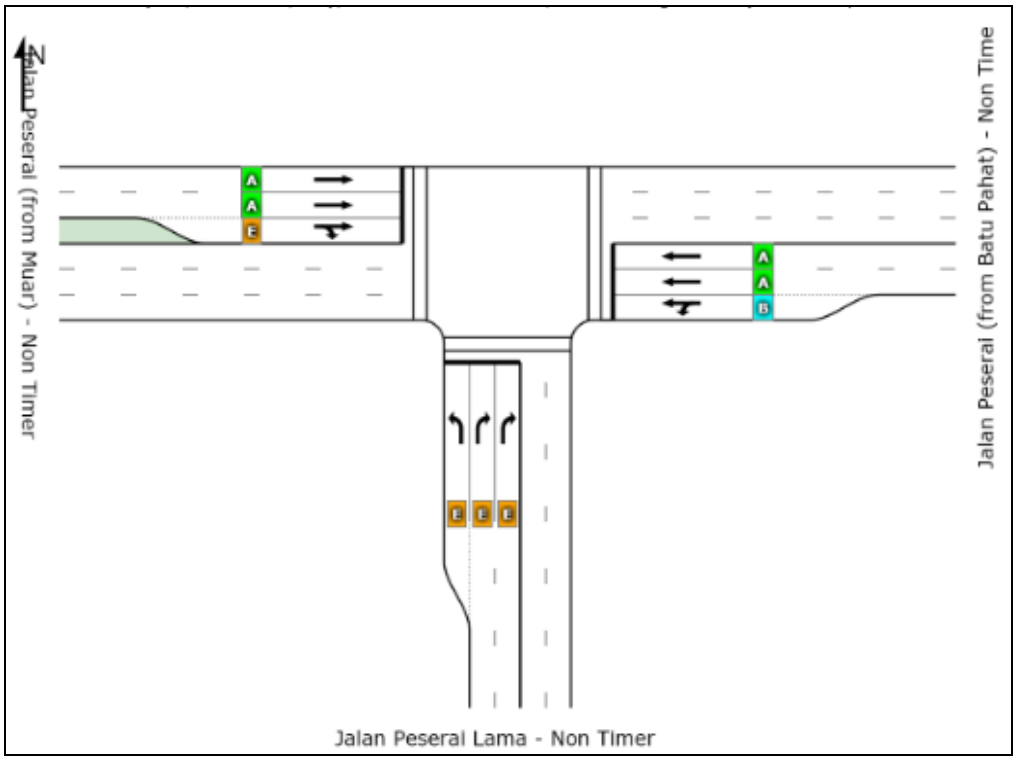
LANE SUMMARY

Site: Peserai Intersection

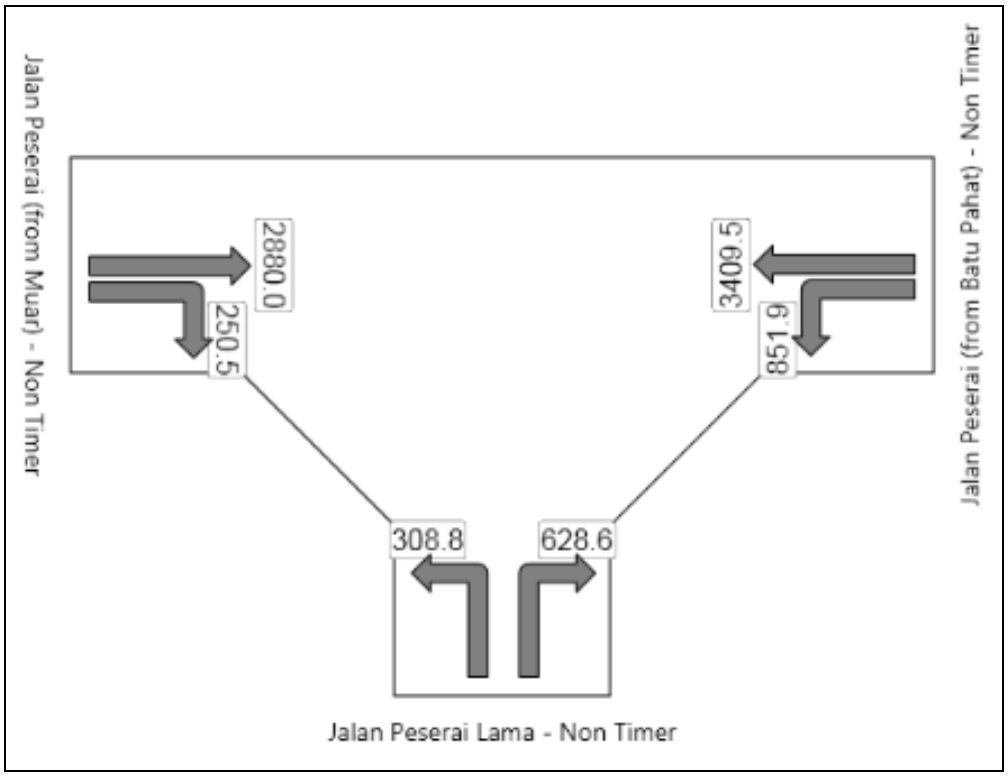
Peserai Intersection
Signals - Fixed Time   Cycle Time = 130 seconds (Practical Cycle Time)
Flow Scale Analysis (Practical Capacity): Results for Flow Scale (chosen as largest for any movement) = 108.0 %

Lane Use and Performance

	Demand Flows L veh/h	Demand Flows T veh/h	Demand Flows R veh/h	Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Lane Length m	SL Type	Cap. Adj. %	Prob. Block. %
South: Jalan Peserai Lama - Non Timer																
Lane 1	80	0	0	80	0.0	309	P	100	59.2	LOS E	4.5	31.2	500	Turn Bay	0.0	0.0
Lane 2	0	0	40	40	0.0	314	P	100	57.6	LOS E	2.2	15.2	500	–	0.0	0.0
Lane 3	0	0	40	40	0.0	314	P	100	57.6	LOS E	2.2	15.2	500	–	0.0	0.0
Approach	80	0	80	160	0.0		0.260		58.4	LOS E	4.5	31.2				
East: Jalan Peserai (from Batu Pahat) - Non Timer																
Lane 1	270	168	0	438	0.0	1381	P	100	11.1	LOS B	9.2	64.7	500	Turn Bay	0.0	0.0
Lane 2	0	456	0	456	0.0	1440	P	100	6.1	LOS A	9.6	67.4	500	–	0.0	0.0
Lane 3	0	456	0	456	0.0	1440	P	100	6.1	LOS A	9.6	67.4	500	–	0.0	0.0
Approach	270	1081	0	1351	0.0		0.317		7.7	LOS A	9.6	67.4				
West: Jalan Peserai (from Muar) - Non Timer																
Lane 1	0	447	0	447	0.0	1440	P	35[5]	6.0	LOS A	9.4	65.5	500	–	0.0	0.0
Lane 2	0	447	0	447	0.0	1440	P	35[5]	6.0	LOS A	9.4	65.5	500	–	0.0	0.0
Lane 3	0	0	223	223	0.0	250	P	100	77.1	LOS E	19.5	136.3	500	Turn Bay	0.0	0.0
Approach	0	894	223	1117	0.0		0.892		20.2	LOS C	19.5	136.3				
Intersection				2628	0.0		0.892		16.1	LOS B	19.5	136.3				



Level of Service (LOS) lane by lane



Traffic Volume

Jalan Bakau Condong Intersection, Batu Pahat, Johor

Unlicensed Trial Version

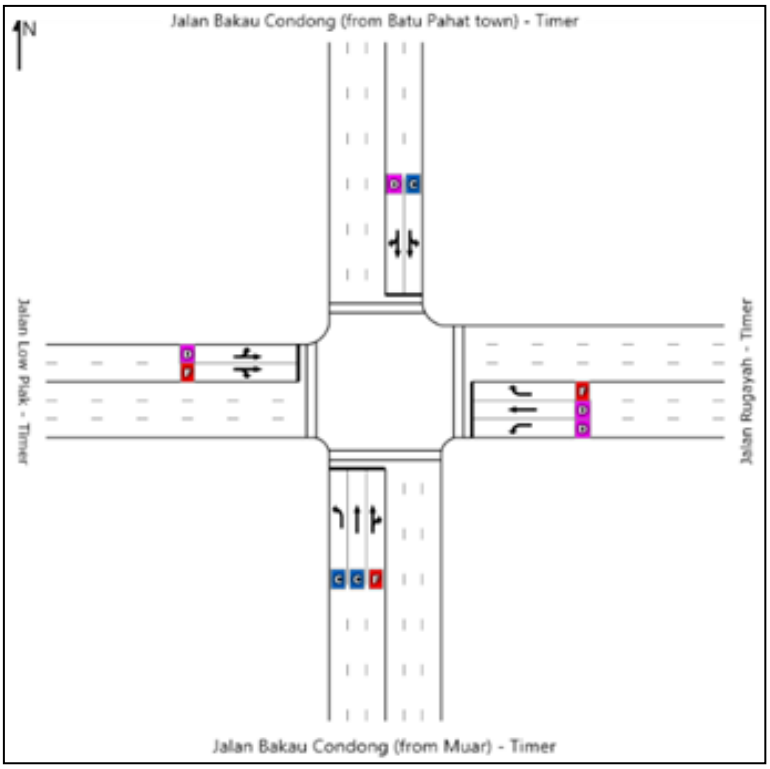
LANE SUMMARY

Site: Bakau Condong Intersection

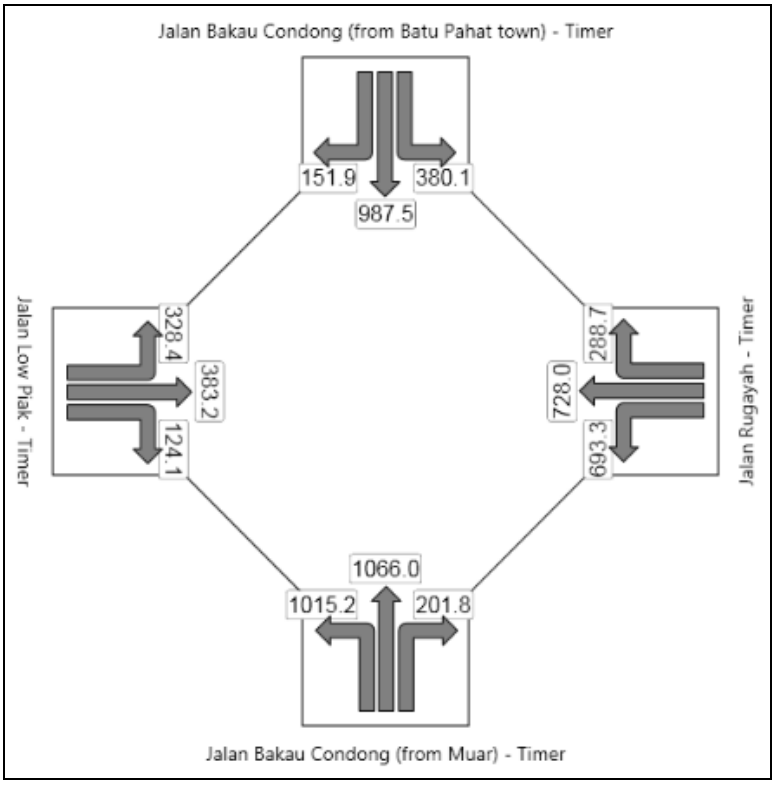
New Site
Signals - Fixed Time Cycle Time = 150 seconds (Practical Cycle Time)
Design Life Analysis (Practical Capacity): Results for 0 years

Lane Use and Performance

	Demand Flows L veh/h	Demand Flows T veh/h	Demand Flows R veh/h	Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Lane Length m	SL Type	Cap. Adj. %	Prob. Block. %
South: Jalan Bakau Condong (from Muar) - Timer																
Lane 1	102	0	0	102	0.0	1015	P	100	25.2	LOS C	3.5	24.4	500	–	0.0	0.0
Lane 2	0	612	0	612	0.0	1066	P	38[5]	23.7	LOS C	29.0	202.8	500	–	0.0	0.0
Lane 3	0	0	306	306	0.0	202	P	100	1035.1	LOS F	113.0	791.2	500	–	0.0	47.1
Approach	102	612	306	1021	0.0		1.518		327.4	LOS F	113.0	791.2				
East: Jalan Rugayah - Timer																
Lane 1	496	0	0	496	0.0	693	P	100	49.2	LOS D	30.7	214.9	500	–	0.0	0.0
Lane 2	0	310	0	310	0.0	728	P	100	37.1	LOS D	16.7	116.6	500	–	0.0	0.0
Lane 3	0	0	434	434	0.0	289	P	100	998.9	LOS F	155.9	1091.2	500	–	0.0	77.8
Approach	496	310	434	1239	0.0		1.502		378.5	LOS F	155.9	1091.2				
North: Jalan Bakau Condong (from Batu Pahat town) - Timer																
Lane 1	228	400	0	628	0.0	1047	P	100	27.1	LOS C	30.3	212.4	500	–	0.0	0.0
Lane 2	0	192	91	283	0.0	472	P	100	44.1	LOS D	16.8	117.9	500	–	0.0	0.0
Approach	228	592	91	911	0.0		0.600		32.4	LOS C	30.3	212.4				
West: Jalan Low Fiak - Timer																
Lane 1	142	166	0	308	0.0	712	P	32[5]	39.3	LOS D	16.6	116.2	500	–	0.0	0.0
Lane 2	0	0	166	166	0.0	124	P	100	706.1	LOS F	48.6	340.5	500	–	0.0	0.0
Approach	142	166	166	474	0.0		1.336		272.7	LOS F	48.6	340.5				
Intersection				3645	0.0		1.518		263.9	LOS F	155.9	1091.2				



Level of Service (LOS) lane by lane



Traffic Volume

Ipoh-Lumut Highway Intersection, Seri Iskandar, Perak

Unlicensed Trial Version

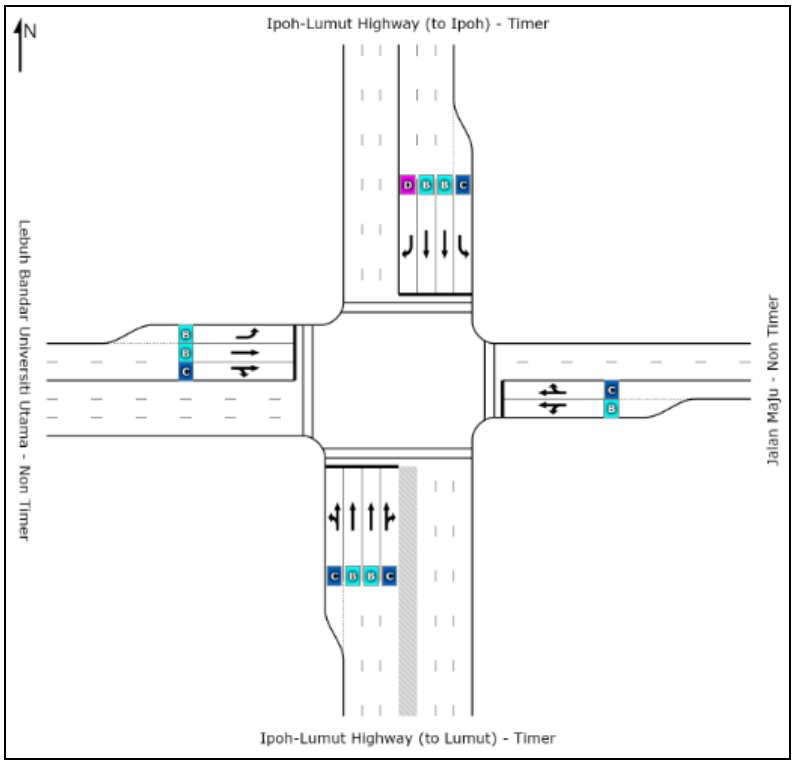
LANE SUMMARY

Site: Seri Iskandar Tesco Intersection

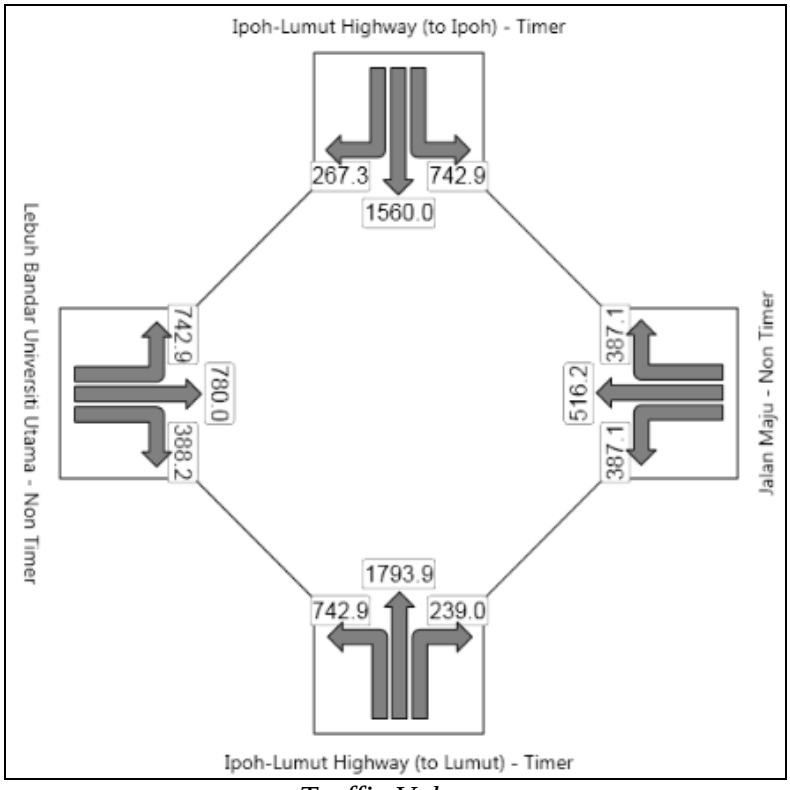
New Site
Signals - Fixed Time Cycle Time = 60 seconds (Practical Cycle Time)
Design Life Analysis (Practical Capacity): Results for 10 years

Lane Use and Performance

	Demand Flows L veh/h	Demand Flows T veh/h	Demand Flows R veh/h	Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Lane Length m	SL Type	Cap. Adj. %	Prob. Block. %
South: Ipoh-Lumut Highway (to Lumut) - Timer																
Lane 1	142	0	0	142	0.0	743	P	48[5]	24.0	LOS C	2.7	19.1	500	Turn Bay	0.0	0.0
Lane 2	0	309	0	309	0.0	780	P	100	14.0	LOS B	6.6	45.9	500	–	0.0	0.0
Lane 3	0	309	0	309	0.0	780	P	100	14.0	LOS B	6.6	45.9	500	–	0.0	0.0
Lane 4	0	93	95	187	0.0	473	P	100	21.8	LOS C	4.2	29.6	500	–	0.0	0.0
Approach	142	711	95	948	0.0		0.396		17.0	LOS B	6.6	45.9				
East: Jalan Maju - Non Timer																
Lane 1	136	132	0	268	0.0	761	P	100	16.0	LOS B	5.6	38.9	500	Turn Bay	0.0	0.0
Lane 2	0	50	136	187	0.0	530	P	100	20.5	LOS C	4.0	28.1	500	–	0.0	0.0
Approach	136	182	136	455	0.0		0.352		17.8	LOS B	5.6	38.9				
North: Ipoh-Lumut Highway (to Ipoh) - Timer																
Lane 1	76	0	0	76	0.0	743	P	100	23.4	LOS C	1.4	9.8	500	Turn Bay	0.0	0.0
Lane 2	0	228	0	228	0.0	780	P	100	13.3	LOS B	4.6	32.1	500	–	0.0	0.0
Lane 3	0	228	0	228	0.0	780	P	100	13.3	LOS B	4.6	32.1	500	–	0.0	0.0
Lane 4	0	0	227	227	0.0	267	P	100	46.6	LOS D	8.5	59.6	500	–	0.0	0.0
Approach	76	455	227	759	0.0		0.851		24.3	LOS C	8.5	59.6				
West: Lebuh Bandar Universiti Utama - Non Timer																
Lane 1	117	0	0	117	0.0	743	P	100	17.0	LOS B	2.2	15.5	500	Turn Bay	0.0	0.0
Lane 2	0	100	0	100	0.0	780	P	37[5]	12.3	LOS B	1.9	13.0	500	–	0.0	0.0
Lane 3	0	0	133	133	0.0	388	P	100	21.6	LOS C	3.1	21.9	500	–	0.0	0.0
Approach	117	100	133	350	0.0		0.343		17.4	LOS B	3.1	21.9				
Intersection				2511	0.0		0.851		19.4	LOS B	8.5	59.6				



Level of Service (LOS) lane by lane



Traffic Volume

Batu Gajah Highway Intersection, Batu Gajah, Perak

Unlicensed Trial Version

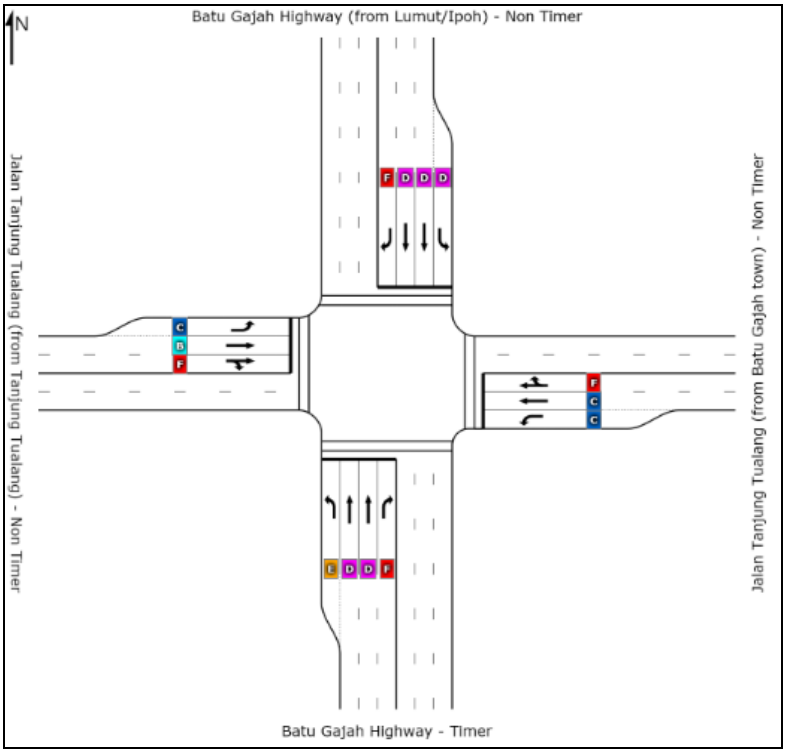
LANE SUMMARY

Site: Batu Gajah KTM Intersection

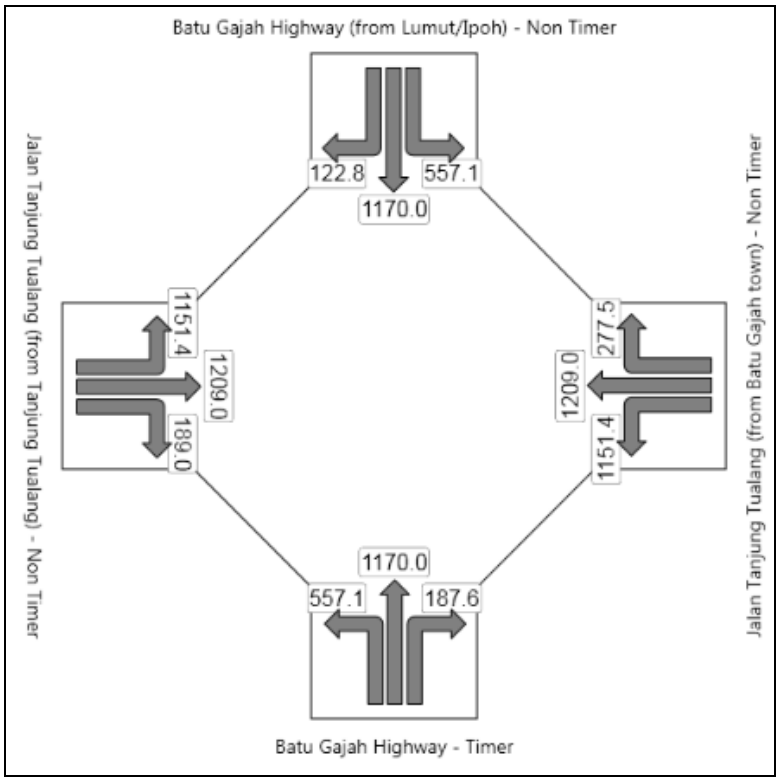
New Site
Signals - Fixed Time Cycle Time = 150 seconds (Practical Cycle Time)
Design Life Analysis (Practical Capacity): Results for 0 years

Lane Use and Performance

	Demand Flows L veh/h	Demand Flows T veh/h	Demand Flows R veh/h	Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Lane Length m	SL Type	Cap. Adj. %	Prob. Block. %
South: Batu Gajah Highway - Timer																
Lane 1	207	0	0	207	0.0	557	P	100	55.4	LOS E	11.9	83.0	500	Turn Bay	0.0	0.0
Lane 2	0	345	0	345	0.0	585	P	100	47.7	LOS D	21.3	149.3	500	–	0.0	0.0
Lane 3	0	345	0	345	0.0	585	P	100	47.7	LOS D	21.3	149.3	500	–	0.0	0.0
Lane 4	0	0	483	483	0.0	188	P	100	1528.7	LOS F	161.1	1128.0	500	–	0.0	81.0
Approach	207	691	483	1381	0.0		2.575		567.0	LOS F	161.1	1128.0				
East: Jalan Tanjung Tualang (from Batu Gajah town) - Non Timer																
Lane 1	534	0	0	534	0.0	1151	P	100	24.2	LOS C	20.3	142.4	500	Turn Bay	0.0	0.0
Lane 2	0	889	0	889	0.0	1209	P	69 [5]	21.0	LOS C	44.5	311.2	500	–	0.0	0.0
Lane 3	0	0	345	345	0.0	277	P	100	323.4	LOS F	62.5	437.5	500	–	0.0	0.0
Approach	534	889	345	1768	0.0		1.244		81.0	LOS F	62.5	437.5				
North: Batu Gajah Highway (from Lumut/Ipoh) - Non Timer																
Lane 1	158	0	0	158	0.0	557	P	100	54.0	LOS D	8.7	61.2	500	Turn Bay	0.0	0.0
Lane 2	0	237	0	237	0.0	585	P	100	48.8	LOS D	13.7	96.0	500	–	0.0	0.0
Lane 3	0	237	0	237	0.0	585	P	100	48.8	LOS D	13.7	96.0	500	–	0.0	0.0
Lane 4	0	0	158	158	0.0	123	P	100	367.1	LOS F	28.4	198.8	500	–	0.0	0.0
Approach	158	475	158	791	0.0		1.286		113.4	LOS F	28.4	198.8				
West: Jalan Tanjung Tualang (from Tanjung Tualang) - Non Timer																
Lane 1	346	0	0	346	0.0	1151	P	100	22.1	LOS C	11.5	80.8	500	Turn Bay	0.0	0.0
Lane 2	0	554	0	554	0.0	1209	P	18 [5]	15.9	LOS B	21.0	146.8	500	–	0.0	0.0
Lane 3	0	0	484	484	0.0	189	P	100	1519.2	LOS F	163.0	1140.7	500	–	0.0	82.1
Approach	346	554	484	1384	0.0		2.562		543.3	LOS F	163.0	1140.7				
Intersection				5324	0.0		2.575		332.1	LOS F	163.0	1140.7				



Level of Service (LOS) lane by lane



Traffic Volume