# EFFECT OF IMPLEMENTING ONE WAY TRAFFIC IN KUANTAN CITY

VUN HON YUAN

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## SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Civil Engineering.

Name of Supervisor: Assoc. Prof. Dr. Sulistyo Arintono

Position:

Date:

## STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award for other degree.

Name : VUN HON YUAN

ID Number : AA12203

Date :

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# ABSTRACT

One way traffic system has been implemented in Kuantan City to relieve traffic congestion problem. This study is done to evaluate the effect of implementing one way traffic system along Jalan Tun Ismail. The major objective is to study the traffic volume and pattern after conversion of the road into one way street, as well as to identify problems and issues related to traffic engineering that arose due to the conversion. A total of four surveys have been done on three weekdays and one weekend respectively, to determine traffic volume during peak hours. Traffic volume is recorded by means of manual counting, done by at least three researchers. Traffic volume is recorded according to vehicle classes. The outcome shows that traffic volume has increased significantly, while having smoother traffic flow. Light vehicles are having the highest composition in traffic volume. The major problems identified after implementing one way traffic system include frequent lane cutting of vehicles. One of the major adjustments proposed is to install adequate road signage to aid road users in driving on the road. In conclusion, implementing one way traffic has improved the traffic condition along Jalan Tun Ismail. Proposals have been made to rectify the problems identified on the stretch of road.

# ABSTRAK

Sistem trafik aliran searah telah dilaksanakan di Bandar Kuantan untuk mengurangkan masalah kesesakan lalulintas. Kajian ini dijalankan untuk menilai kesan daripada pelaksanaan sistem trafik aliran searah sepanjang Jalan Tun Ismail. Objektif utama adalah untuk mengkaji isipadu trafik serta corak perubahan trafik selepas pelaksanaan aliran satu arah. Selain itu, masalah dan isu yang berkaitan dengan kejuruteraan lalulintas yang timbul berikutan perubahan tersebut juga telah dikaji. Sebanyak empat bancian telah diadakan, tiga pada hari bekerja dan satu lagi pada hujung minggu, untuk mengenalpasti isipadu trafik sepanjang waktu kemuncak. Isipadu trafik direkod menggunakan kaedah manual, dijalankan oleh sekurang-kurangnya tiga orang. Isipadu trafik direkodkan mengikut kategori kelas kenderaan. Hasil kajian menunjukkan bahawa isipadu lalulintas telah meningkat, sedangkan aliran kenderaan bergerak secara lancar. Kenderaan ringan merupakan kelas kenderaan majoriti dalam komposisi isipadu lalulintas tersebut. Antara masalah utama yang mampu dikenalpasti adalah penukaran lorong secara kerap yang dilakukan oleh pemandu. Salah satu cadangan penambahbaikan adalah untuk memasang papan tanda yang mencukupi untuk membantu pengguna jalan. Secara tuntasnya, pelaksanaan sistem aliran lalulintas satu arah telah menambahbaiki keadaan lalulintas sepanjang Jalan Tun Ismail. Cadangan penambahbaikan juga telah dibentangkan.

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| | |
|---|---|
| $V_t$ | Quarter Hour Volume |
| $C_j$ | Cumulative Volume at the End of Quarter Hour |
| $C_i$ | Cumulative Volume at the Start of Quarter Hour |

# LIST OF ABBREVIATIONS

| | |
|---|---|
| ECER | East Coast Economic Region |
| MPK | *Majlis Perbandaran Kuantan* (Kuantan Municipal Council) |
| UMP | Universiti Malaysia Pahang |
| MLC | Mandatory Lane Change |
| DLC | Discretionary Lane Change |
| A.M. | Ante Meridiem |
| P.M. | Post Meridiem |
| HV | Hourly Volume |
| JKR | *Jabatan Kerja Raya* (Public Works Department) |

# CHAPTER 1

# INTRODUCTION

## 1.1 BACKGROUND OF STUDY

Urbanisation of cities in Malaysia is happening rapidly. This is a result of holistic development spearheaded by Malaysian government. This is happens in line with the Malaysians' vision to achieve the status of being an advanced country with high national income by year 2020, as first initiated by former Prime Minister Tun Dr. Mahathir Mohamad.

Urbanisation process has greatly improved the life quality of the citizens. In general perspective, urbanisation is the symbol of prosper and livability. However, urbanisation process is usually plagued with a serious issue, namely traffic congestion problems.

Traffic congestion is a problem which is common to most of the advancing third world countries. Traffic engineers around the world are implementing various kind of solutions to solve the problem.

For Kuantan City, as a result of lack of funding to upgrade major intersections into graded intersections, one way traffic system is implemented to ease traffic congestion problem.

### 1.1.1 Kuantan City

Located on the East Coast of Peninsular Malaysia, Kuantan (3° 49' 0" N, 102° 20' 0" E) is the capital city of Pahang state, the third largest of Malaysia, after Sarawak and Sabah. It is surrounded by Maran and Jerantut Districts on its west, Terengganu State in the north, and Pekan District in the south.

Blessed with abundant natural resources, Kuantan has been rapidly growing into a modernised and urbanised city for the past few decades. The growth has been accelerated by the government's planning to make Kuantan district the Special Economic Zone of East Coast Economic Region (ECER). Under this plan, integrated development approach including commercial, residential, education, industries, service, and knowledge components, which account for up to 80% of ECER's economic output and 45% of job opportunities generation by year 2020, are being introduced and implemented. This makes Kuantan City the power house of the region. Quality and efficient physical infrastructure is vital to transform ECER into a developed region.

### 1.1.2 One way traffic

One way traffic is traffic which moves in one direction. A one-way street is a street either facilitating only one-way traffic, or designed to direct vehicles to move in one direction.

One way traffic is implemented in many cities worldwide, most notably New York City Metropolitan (particularly Manhattan region). In United States, the system was implemented since 30s to 50s of 20$^{th}$ century. The conversion is done after automobile became the major transportation mode. One-way streets were an attempt to accommodate traffic in areas which were initially not built for the automobile.

One way traffic is also implemented for safety reason. Cities that converted to one-way street have shown a significant decline in accidents. The obvious advantage of one-way streets is that road users need only to concentrate on one-direction when watching for traffic.

Theoretically, one-way streets should result in higher average speeds because traffic signal could be synchronised to enable driver to proceed without stopping at a fixed rate of speed. As a comparison, traffic on two-way streets is often delayed by special right-turn signals.

In more general term, implementation of one-way traffic is expected to result in smoother traffic flow with shorter travel delay time.

### 1.1.3 One Way Traffic in Kuantan City

On 22nd July 2013, Kuantan Municipal Council (MPK) ran a trial for implementation of one-way traffic flow system. This system is then made permanent during 21$^{st}$ October 2013, after improvement by responding to feedback from the public.

As stated by Datuk Zulkifli Yaacob, the president of MPK, motorists are ‘comfortable’ and ‘well-versed’ with the new routes. He also further stated that traffic congestion problems have improved with the new system. The move has resulted in a smoother flow of traffic, especially along Jalan Gambut and Jalan Tun Ismail, which most of the financial institutions and shopping malls are located.

## 1.2 PROBLEM STATEMENT

The implementation of one way traffic system in Kuantan City is expected to ease traffic congestion problem. Thus, a study has to be carried out to determine the effectiveness of the implementation. There are two issues to be looked into in this study.

First of all, the traffic volume along the converted roads has to be surveyed. It is important to study the traffic volume change after the implementation of one way traffic system. The variation of traffic volume, according to different vehicle classes, has to be studied and interpreted. The composition of classes of vehicles in the traffic is also to be studied.

Besides, in order to evaluate the effectiveness of implementing one way traffic system in Kuantan City, traffic volume data for pre-implementation and post-implementation have to be compared. The comparison is important as traffic volume represents the capacity of the road to accommodate the traffic flow.

Apart from that, effect of implementing one way street system will also be examined by means of identifying problems that are related to change of traffic. This is important in order to ensure that not only traffic parameters have been evaluated, but also the serviceability and safety of the road users are assessed.

Lastly, a few changes that are corresponding to the problems identified will be proposed. These changes are proposed such that they rectify the problems into a better traffic solution.

## 1.3 RESEARCH OBJECTIVES

The objectives of this study are:

1. To study the effect of implementing one way traffic system in Kuantan city in terms of traffic volume, variation of traffic volume in quarter hour during peak hours, and vehicle class composition.

2. To compare the traffic volume for pre-implementation and post-implementation of one way traffic in Kuantan City.

3. To identify problems and issues related to traffic after implementing one way street system

4. To propose changes to rectify the problems and issues as discussed in objective (3)

## 1.4 SCOPE OF RESEARCH

### 1.4.1 Geographical Scope

In order to evaluate the effect of implementing one way traffic in Kuantan City, the outcome of the change has to be studied along the critical sections in the new traffic system.

One of the critical sections along the new one way loop is Jalan Tun Ismail. Jalan Tun Ismail is the main arterial road of Kuantan City. Jalan Tun Ismail is located at the heart of Kuantan City, providing access to several major commercial areas of Kuantan City.

The significance of Jalan Tun Ismail has grown even more since implementing one way street system. Jalan Tun Ismail facilitates the vehicles coming from Jalan Gambang-Kuantan which are heading into city centre via Jalan Gambut.

Thus, it is determined that in this study, survey location will be located at a middle section of Jalan Tun Ismail, in which a more precise location of study will be discussed in the next chapter.

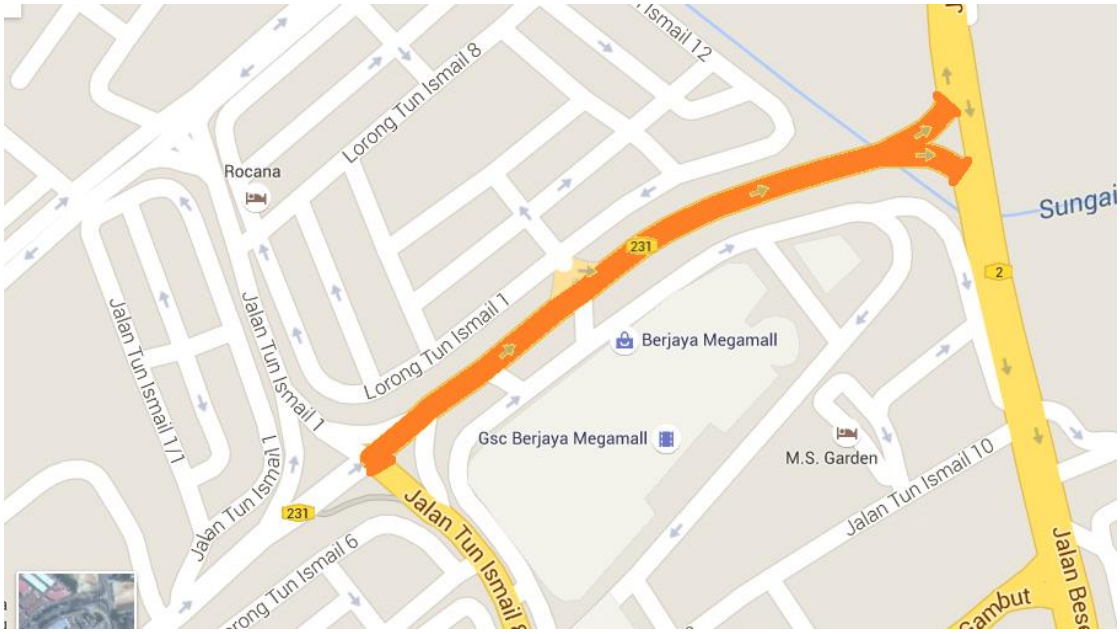


**Figure 1.1:** Geographical Scope of Study

Source: Google Map Screenshot

### 1.4.2 Research Parameters

The current traffic data, including traffic volume during peak hours and traffic condition are needed to be compared with pre-implementation data. This comparison will show the effectiveness of conversion into one-way traffic system onto Jalan Tun Ismail, and thus as the reference for other sections of road converted.

## 1.5 SIGNIFICANCE OF RESEARCH

The research analyses the traffic volume after implementing one way traffic. This is important for the traffic engineers to understand the effect of changing road system in one way flow. The traffic composition is also analysed, which enables the traffic engineer to understand the traffic composition for the purpose of road geometry design whenever needed. The traffic flow of pre-implementation and post-implementation of one way traffic system is also compared to demonstrate the effect of changing into one way system.

Besides, problems arising due to implementing one way traffic are discussed. Proposal is made to make good of the problems. This is important, in terms of road users' safety as well as the serviceability of Jalan Tun Ismail.

## 1.6 OVERVIEW OF RESEARCH

This research deals with the traffic volume along Jalan Tun Ismail. Surveys are conducted in four different days. Analysing of data involves traffic volume, traffic volume variation, and vehicle class composition. Comparison between current and previous data is done to compare the change in traffic volume. Problems on site are identified, with proposals to improve suggested.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 INTRODUCTION

As a part of urbanisation process, increase in vehicle volume due to improvement in living standard is deemed as one of the by-products. The increase in private vehicles has significant impact onto traffic congestion.

According to Abdullah et al (2007), the car is ranked second in most common mode of transportation in Malaysia, very much due to inefficient public transportation in Malaysia. The reliance on private cars has caused serious problems, namely traffic congestion, environmental impact, as well as inadequate parking spaces.

As stated by Aldukali et al (2011), increase in population, general increase in income, and rapid urbanisation process has created increase in travel demand. The service of transportation in most developing countries is claimed to be failures due to insufficient planning and design. In Malaysia, leaping progress in economy has enabled most citizens to be able to afford and own private vehicles. This has in turn caused the current scenario where traffic is badly congested with mostly private vehicles travelling at different speeds.

Numerous steps have been taken by local authorities in all over the world to coupe with such issue. As stated by Xu and Cheng (2008), the phenomena where traffic supply is being inadequate to sustain the increasing trip demands and in turn results in urban traffic congestion as well as environment deterioration and traffic accidents, is called ‘urban traffic diseases’. One of the most economical and realistic methods to cure the urban diseases is by improving the system of existing traffic resource through traffic management and control strategies. One of the said improvements is by implementing one-way traffic.

## 2.2 ONE WAY TRAFFIC IN KUANTAN CITY

### 2.2.1 One Way Traffic

In general, one way traffic is the traffic of vehicles which flows in only one direction. A one way street is the street which allows only one way traffic.

According to Xu and Cheng (2008), one way traffic allows vehicles to move in one direction, i.e. to move only from i->j but not j->i. The general advantage of such system is such that speed and capacity on urban street segments can be increased and simultaneously decrease the conflicts at intersections and thus the congestion that follows. However, the major disadvantage with one way streets is that travel length is lengthened and affected transit routing.

According to Springfield Police Department, one way streets are the streets which traffic are being directed in one direction only. This is done in order to move heavy traffic in efficient manner.

A couple of one-way streets which provide traffic flow in opposite directions in higher volumes than traditional two-way streets, which are separated by a city block, is known as a "one-way couplet". This concept is implemented widely in United States of America during 1930s as a response to traffic congestion as well as traffic accidents problem which got worsened. Efficiency was the goal of traffic planning back then.

### 2.2.2 Kuantan and Traffic Congestion

According to Kuantan Municipal Council, Kuantan has been existing for long since early 1850s. It started as a settlement in 19th century. The first implementation of Local Government System was initiated in 1913, with the establishment of Kuantan Sanitary Board. Kuantan Town Board is then formed in 1937, which was then replaced by Kuantan Town Council. In 1979, Kuantan Town Council is upgraded to Kuantan Municipal Council, until this day.

According to Nur Azzimah et al, rapid urbanisation has taken place in Kuantan. The city has been transformed and modernised. Many development projects have been implemented since 2005, such as Bukit Gambang Resort City, Putra Square, Mahkota Square, and Kuantan Port City. Kuantan has also introduced Malaysia's first Special Economic Zone (SEZ) to catalyse the growth of Kuantan city. Huge population increase has been happening in Kuantan, which in turn gives effect onto the sustainable development and thus causing traffic problems. They also stated that in 2010, Kuantan citizens suffered from paralysing congestion of more than 30 minutes. Thus, a sustainable urban traffic management is needed to solve this problem.

In Chapter 6 of the 2004 Baseline Survey on Millennium Development Goals in AACs, a report on Kuantan Development has highlighted the development of the city. The research was led by Assoc. Prof. Dr. Alias Abdullah. Inside the report, traffic congestion problem is highlighted as one of the major priority issues along with water supply shortage and housing slum problems. As cited inside the article, Kuantan's urbanisation rate is as high as 44% in 2005 according to Department of Statistics, Malaysia. Thus, the rapid growth of the city comes along with a drastic increase of vehicles. This has caused traffic congestion in major roads. Most of the major roads are

catering for very high traffic volumes, to the greater extent in which maximum capacity is exceeded. Such influx of traffic volume was due to completion and opening of the East-West (Kuala Lumpur-Kuantan) highway, which is known as East Coast Expressway.

### 2.2.3 One Way Traffic in Kuantan City

According to Nur Azzimah et al, one way traffic system is not a new traffic management method in Malaysia. There are many cities which implemented the system, such as Kuala Lumpur, Georgetown, and Ipoh. One way street is implemented to accommodate traffic movement at cheaper cost compared to other options such as upgrading the intersections to grade-separated ones. In 2007, Kuantan Municipal Council, in collaboration with Universiti Malaysia Pahang (UMP), has produced a master plan that changed the previously two way roads in Kuantan into one-way traffic system. Generally, under the new traffic system, traffic flow in Kuantan City is smoother with reduced delays.

## 2.3 PARAMETER OF RESEARCH: TRAFFIC VOLUME

According to Lawrence A. and Michael R. (1996), one of the parameters to characterise traffic flow is by means of quantity measures, which measure how much or at what rate is traffic moving. Traffic volume is generally expressed in terms of flow rate. It is a temporal quantity measure which is defined as the number of vehicles passing a point in a period of time, which is usually in one hour. Flow rate has many applications in traffic engineering, such as developing traffic trends, determining sites for traffic signals, and investigating operational improvements using capacity analysis. Traffic flow rate varies throughout the day and direction.

## 2.4 METHODOLOGY: VEHICLE CLASSIFICATION

According to Malaysian Road Transport Act 1987, unladen weight is the weight of a vehicle, which includes the body and all parts which are necessary to the vehicle when working on a road. Meanwhile, heavy motor cars are motor vehicles which are constructed to carry a load or passengers, with the unladen weight exceeding 3000 kilogrammes. Light motor cars, not inclusive for vehicles falling within definition of motorcycles, are constructed to carry a load or passengers with unladen weight not exceeding 3000 kilogrammes. Motorcycles are motor vehicles with less than four wheels, with unladen weight not exceeding 450 kilogrammes.

## 2.5 KNOWN PROBLEMS IN ONE WAY TRAFFIC SYSTEM

Despite being efficient in terms of traffic engineering, one-way traffic system has received many sticks for several issues that arose from its implementation.

According to Sun,F. et al. (2012), one-way traffic is said to be the culprit for commercial loss and traffic problems that happened in major business districts and central business districts of large cities towards the late twentieth century. To revitalise the downtown business which has declined for a long period, many cities started their effort to convert one-way streets into two-way streets. In China, one-way traffic is implemented in 1950s in major cities, including Beijing, Shanghai, Dalian, Qingdao, and Hangzhou, and successfully decreased traffic congestion in the commercial centre. However, as a tourism centre of China, tourists who travelled to and shopped in CBD of Hangzhou have experienced huge inconvenience due to the existing traffic system. To promote a safe, secure, and friendly environment for the pedestrians and tourists, Hangzhou local authority has reconverted Yan'an Road and Huansa Road, which are initially two parallel street in a north-south direction, into streets with two-way traffic system. Yan'an Road is expected to serve as a leisure street for shopping and walking. A study has been done to evaluate the reconversion of one-way street pairs to two-way.

### 2.5.1 Lane Change

According to Matthew T. (2014), Lane changing is a common scene on any road with more than one lane. It is the act of transferring a vehicle from one lane to the next adjacent lane(s). Lane change can be divided into two major classifications, namely Mandatory Lane Change (MLC) and Discretionary Lane Change (DLC). MLC is the scenario where the driver must change lane to follow a specified path. It is usually due to the exits he has to make at a certain exit which is located on either leftmost or rightmost lane of the carriageway. On the other hand, DLC happens when a driver changes lane to the one which he judged to be offering traffic condition. This could be done to achieve desired speed, avoid upcoming or merging traffic. In general term, this act is known as 'overtaking'.

According to Fitch, G. et al. (2009), accidents involving lane change is which the two primarily involved vehicles are travelling in the same direction on the same road without any planned turn, and one of the vehicle drivers intended to either change lane or to overtake.

## 2.5 Traffic Calming

According to Transportation Association of Canada, traffic calming involves alteration of motorists' behaviour on a street. It also includes traffic management, in which changing of traffic routes and flows are involved. Meanwhile, according to Institute of Transportation Engineers, traffic calming involves changes in street alignments, installation of barriers, and other measures to slow traffic down, for the purpose of traffic safety, livability, and other public interests.

Traffic calming can be implemented by means of textured pavement. According to TrafficCalming.org, textured and coloured pavement includes the use of stamped pavement or alternating paving materials in order to create an uneven surface for vehicles to move traverse on. The most fundamental traffic-calming goal is to reduce the speed of vehicular movement. They may be emphasised at either an entire intersection or a pedestrian crossing. It is good for main street areas where substantial pedestrian activity exists and noise is not a problem. The advantages of textured pavement includes reducing vehicle speed over an extended length, having aesthetic value if well designed, as well as to be able to calm two streets at once if placed at an intersection.

# CHAPTER 3

# METHODOLOGY

The prime objective of this study is to scientifically analyse the effect of implementation of one way street system in Kuantan, more precisely along Jalan Tun Ismail.

## 3.1 INTRODUCTION

In order to determine traffic condition, one of the main parameters that traffic engineers are keen to determine is traffic volume.

Before the study begins, collection of traffic data before implementation of one way traffic system has to be done. Traffic data before implementation can be obtained from the previous researchers. The traffic data obtained must be analysed and interpreted.

Besides, a careful and through planning must be conducted. This is done to ensure that the most suitable spots are selected to study traffic flow and movement.

## 3.2 FRAMEWORK PREPARATION

Before any study can be carried out, a pre-study analysis has to be carried out. During this stage, gathering of information is the main duty to be done. For some researchers, this stage might be neglected and deemed as unimportant. However, it is as important as any other stages as it sets out the general framework and layout for the whole study.

### 3.2.1 Collection of Pre-implementation Data

One of the vital information to gather before beginning this study is previous traffic data collected by researchers appointed by local authorities before the implementation of one way traffic. As traffic volume is the parameter to be studied in this study, traffic volume data before implementing one way traffic must be obtained. In order to compare the traffic condition before and after implementing one way traffic, traffic volume for both before and after will be compared and analysed.

The previous data obtained will give an overview of the method of survey to be carried out. From previous data also, the period of counting for this study is also determined. Besides, the location for study can also be referred from this pre-implementation data.

For this study, traffic data for pre-implementation of one way traffic is obtained from previous researcher's publication, as per discussed in chapter before. The previous researcher have set up a website portal sustiafwm.ump.edu.my to publish the traffic data such that traffic database is reachable by the other researchers.

Besides, a few interview sessions have been held with one of the previous researchers, Assoc. Prof. Ir Adnan Zulkiple. Besides gathering more information about the website portal sustiafwm.ump.edu.my, other important information is also obtained.

### 3.2.2 Determination of Study Scope

During the same stage, it is also important to obtain much needed resources from relevant organisations. For this study, the avaibility of traffic counting instruments very much determined the ability of researcher to carry out study on different parameters.

Several meetings have been held with the personnel of Highway and Traffic Laboratory of Universiti Malaysia Pahang to gather information on the instruments available in the laboratory. The avaibility of tally counters but no other electronic counting devices has limited the volume traffic count to be done by means of manual count.

Meanwhile, inavaibility of speed radar gun has also disabled the researchers from carrying out spot speed studies as another parameter of study. It was initially proposed that spot speed study is also carried out simultaneously with volume study.

## 3.3 PHYSICAL PREPARATION

The previous stage as discussed in section above is mostly abstract preparation for the studies. Since studying traffic volume is the only feasible option, traffic volume survey was planned to be carried out.

In this stage, physical preparation and planning is done. This stage is the stage where conceptual framework and idea is transformed into a real study. It is the intermediate stage between framework preparation and on site survey, which the latter will be discussed in the section 3.4

### 3.3.1 Determination of Location of Study

During this stage, one of the most important step is to determine the location of study. Since the study scope has already been determined in previous stage, the exact location to be studied is determined in this stage.

A few preliminary surveys have been made in Jalan Tun Ismail. These surveys are done to determine a suitable to carry out the survey. An ideal survey spot enables the researchers to carry out traffic counting effectively.

An ideal survey spot must be having high and wide view onto the stretch of road to be surveyed. There should not be any physical obstruction between researchers' eyesight and the road that might temporarily or permanently blocking the researchers' view onto the road.

Besides, the traffic volume data collected from the survey spot must be reflecting the traffic condition. Survey is carried out in a middle section of Jalan Tun Ismail. Thus, the survey spot must be located adjacent to the middle section of a road, in which vehicle entrance and exit from the section is minimal.

The survey spot is located at the bus stop in front of Berjaya Megamall, as shown in Figure 3.1.

**Figure 3.1:** Survey Spot, orange box indicates the location

Source: Google Map Screenshot

### 3.3.2 Designing Data Collection Method

For this study, a manual count is done to determine traffic volume. In contrast to previously proposed recording method by means of usage of a tally sheet, tally counters are used to record the volume of passing-by vehicles. Previous data have shown that the volume of traffic passing through the road is high and recording by means of tally might not produce accurate result.

A data recording sheet is designed to record the data obtained. This data recording sheet is designed such that the data could be analysed into quarter hour volume. The data are also categorised into three major vehicle classes, namely motorcycles, light vehicles, and heavy vehicles.

Traffic Volume Count AM / Noon / PM

Date: _____

| Time | Motorcycle | Light Vehicles | Heavy Vehicles |
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**Figure 3.2:** Screenshot for layout of Data Sheet designed

The data sheet, as shown is figure 3.1, is designed for recording of traffic volumes cumulatively, according to vehicle classes.

In order to understand the traffic condition better, the volume of vehicles passing through the section of Jalan Tun Ismail is broken down into three classes, namely Motorcycles (Less than four tyres, unladen weight less than 450kg), Light Vehicles (Unladen weight less than 3000kg), and Heavy Vehicles (Unladen weight more than 3000kg).

Classification of the vehicles is done according to their unladen weight. The surveyors must be briefed well enough of types of vehicles according to their classifications. This classification is done in order to understand the composition of vehicles passing through Jalan Tun Ismail.

Thus, a team of minimum 3 surveyors is needed in order to complete this survey. Having an extra surveyor as the recorder is recommended. Each of the surveyors is assigned to record the volume of one vehicle class.

In the presence of recorder, the surveyor who is recording volume of traffic with the lowest volume is responsible of recording the data each 15 minutes.

## 3.4 SITE SURVEY

This stage is done after careful and thorough planning has been carried out. This stage is the physical materialisation of all preparation work done is phases before. From this stage, traffic volume data is obtained. Besides, identification of problems related to traffic is done by means of observation during survey.

### 3.4.1 Traffic Volume Count

Traffic volume count is the main part in this survey. The preparation works have been discussed in detail in Subtopic 3.3

As discussed before, traffic volume survey is carried out during peak hours, which is consistent with the survey done by previous researchers. Peak hours occur in three phases in a normal weekday, namely AM Peak (7am-10am), Noon Peak (12pm-2pm), and PM Peak (4pm-7pm).

During the survey, the surveyors are located at the survey spots determined in stages before. Traffic volume is counted for a middle section of the road. Thus, an arbitrary line is formed collinear from the surveyors' eyesight line to the fixed permanent object, i.e. a tree.

**Figure 3.3:** Forming an arbitrary line by focusing onto a permanent object

As a standard of survey, only vehicles passed through the line will be counted into the traffic volume. For vehicles which stopped in the bus stop bay before the line, the vehicle will not be counted in until they started to move and pass through it.

For each vehicle passing through the line, the button on the tally counter will be pressed once. An increment of number in single digit (rightmost reading on the meter) should be seen, signifying movement of one vehicle is recorded. The advantage of using tally counter against by means of tally sheet is that record can be taken quickly and easy by pressing on the button. This enables the surveryors to record the movement of vehicle without missing out. In contrast, recording in a tally sheet consumes time as well as focus of the surveyor.

For each 15 minutes, data should be recorded into the data sheet as shown in Figure 3.2. The reading shown on each tally counter must be recorded into the sheet, according to vehicle class assigned to respective surveyors. It has to be noted that the reading recorded on data sheet is in cumulative traffic volume. Processing of data will be discussed in Subtopic 3.5.

### 3.4.2 Observing the Traffic

In this survey, the traffic condition is also assessed in terms of smoothness of flow. Problems related to traffic must also be observed and identified. Since observing is subjective, and may vary from one surveyor to another, traffic condition is assessed by only one of the consistent surveyor throughout the survey days.

To assess traffic condition, the smoothness of flow is always observed. However, the ‘smoothness’ of traffic could not be interpreted in terms of Level of Services, due to inability to carry out spot speed studies in this survey. In such, only when a queue is formed up to the visibility of surveyor will be recorded. Time and duration of the queue is recorded.

In terms of problem identifying, it could be subjective judgment. Thus, while stating any problems relating to traffic in the stretch of road surveyed, the researcher must justify his arguments in traffic engineering terms, supported by adequate sketch, figures, and other related materials.

## 3.5 INTERPRETATION OF DATA

This stage is done after the collection of data on site. It is the continuation to the stage of collecting the data, by means of converting the raw data into useful traffic parameter data, which in this case, traffic volumes of the middle section of Jalan Tun Ismail.

### 3.5.1 Converting Raw Data into Quarter Hourly Volume

The data recorded in the data sheet is in the form of cumulative traffic volume for the whole duration of that particular phase of peak. Quarter hourly volume can be obtained by using the formula below:

$$V_t = C_j - C_i$$

Traffic Volume Count AM / Noon / PM

Date: _____

| Time | Motorcycle | Light Vehicles | Heavy Vehicles |
|---|---|---|---|
| 7:00-7:15 | 100 | 500 | 50 |
| 7:15-7:30 | 189 | 902 | 98 |
| 7:30-7:45 | 235 | 1070 | 147 |
| | | | |

$C_i$

$C_j$

**Figure 3.4:** Example of Data Recorded

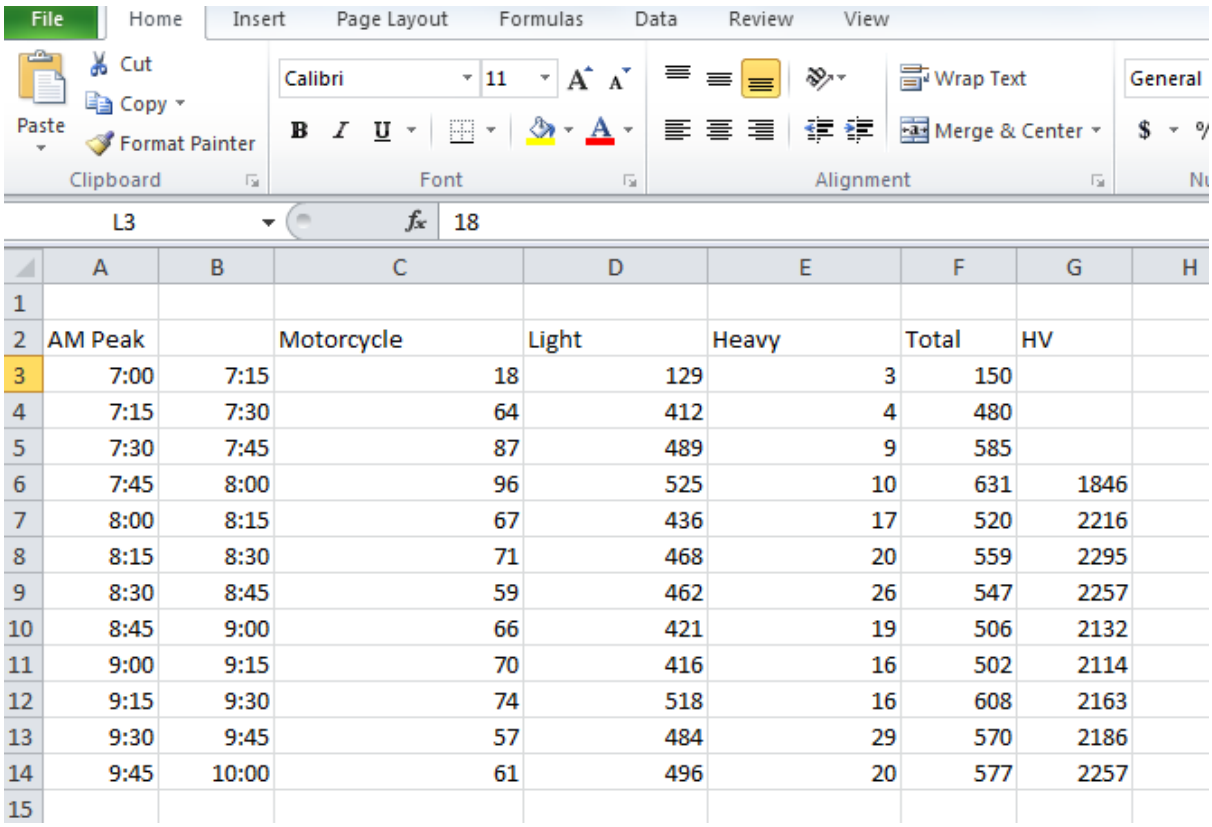
As shown in the example above, quarter hour volume for period 7:15-7:30 can be determined by simple calculation as shown below:

*For motorcycle, during 7:15-7:30*

$$V_{motorcycle} = 189 - 100$$

$$V_{motorcycle} = 89$$

For this survey, the researcher uses a Microsoft Excel 2010 spreadsheet to tabulate the data into quarter hour volume.




| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | |
| 2 | AM Peak | | Motorcycle | Light | Heavy | Total | HV | |
| 3 | 7:00 | 7:15 | 18 | 129 | 3 | 150 | | |
| 4 | 7:15 | 7:30 | 64 | 412 | 4 | 480 | | |
| 5 | 7:30 | 7:45 | 87 | 489 | 9 | 585 | | |
| 6 | 7:45 | 8:00 | 96 | 525 | 10 | 631 | 1846 | |
| 7 | 8:00 | 8:15 | 67 | 436 | 17 | 520 | 2216 | |
| 8 | 8:15 | 8:30 | 71 | 468 | 20 | 559 | 2295 | |
| 9 | 8:30 | 8:45 | 59 | 462 | 26 | 547 | 2257 | |
| 10 | 8:45 | 9:00 | 66 | 421 | 19 | 506 | 2132 | |
| 11 | 9:00 | 9:15 | 70 | 416 | 16 | 502 | 2114 | |
| 12 | 9:15 | 9:30 | 74 | 518 | 16 | 608 | 2163 | |
| 13 | 9:30 | 9:45 | 57 | 484 | 29 | 570 | 2186 | |
| 14 | 9:45 | 10:00 | 61 | 496 | 20 | 577 | 2257 | |
| 15 | | | | | | | | |

**Figure 3.5:** Tabulation of Data using Microsoft Excel 2010

The data are tabulated according to each vehicle classes, in chronological order by time period of 15 minutes. Under the *HV* column as shown in Figure 3.5, it is formulated to generate the hourly volume from the data input.

### 3.5.2 Plotting Graphs

After data are tabulated, graphs are plotted using Microsoft Excel 2010. The graphs to be plotted to visualise the data includes:

i) Bar chart for Variation of Total Traffic Volume versus Days
ii) Line chart for Variation of Volume for respective peaks versus Time
iii) Bar chart for Traffic Composition Breakdown for respective days
iv) Line chart for Variation of Total Traffic Volume before Implementing One-way Traffic
v) Bar chart for Comparison of Traffic Volume: Before and After Implementation

### 3.5.3 Discussing the Findings and Problems

Besides tabulating mathematical findings, the result from observations has to be discussed in detail.

For traffic condition, the finding has to be discussed in terms of time of the building up of traffic queue. Together with the time, the period of queue maintained must also be stated. Possible cause and interpretation must also be discussed.

Discussion for the problems identified during the survey for the traffic along the stretch of survey should also be discussed in depth. The problems should be clearly stated, and described, together with reasoning and justification. Supporting diagrams or other materials could also be used to discuss the problems.

The proposed improvement should be provided in terms of traffic engineering. Detailed justification should be support by reasoning. Suitable drawings, figures, or any other materials could be used to support the proposal.

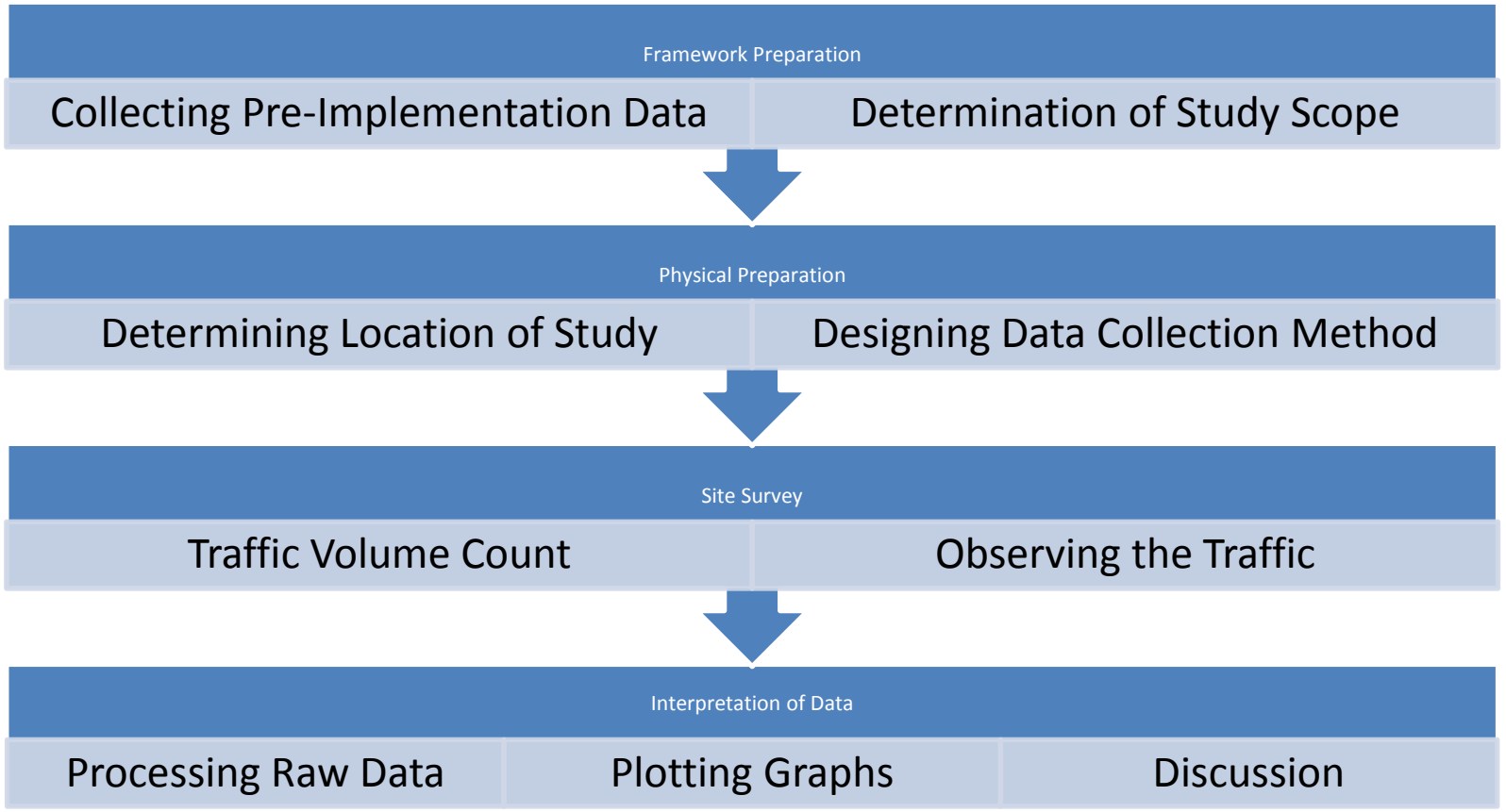



**Figure 3.6:** Summary of Flow for Methodology

# CHAPTER 4

# RESULTS AND DISCUSSION

## 4.1 INTRODUCTION

As discussed in Chapter 3, 4 surveys have been made in this study on implementation of one way traffic onto Kuantan City, in more specific, Jalan Tun Ismail.

The raw data obtained are in the form of number of vehicles, which is recorded in each 15 minutes interval. The data in this chapter is presented in chronological order. Tables and charts showing the total number of vehicle passing through the mid-section studied are presented for each session of peak, for each day of study. Peak hourly volumes are also determined for each day.

The result is then compared with the previous data provided by previous researchers. Graphs comparing before and after implementing one way street system are also plotted to demonstrate the effect of change in terms of traffic volume. Interpretation of data obtained is also made.

Problems observed on site are also presented and discussed thoroughly in terms of traffic engineering. A total of four problems have been determined. The proposal to solve such problems is also done, together with relevant diagrams and sketches.

## 4.2 VARIATION OF TOTAL TRAFFIC VOLUME FOR WEEKDAY SURVEYS

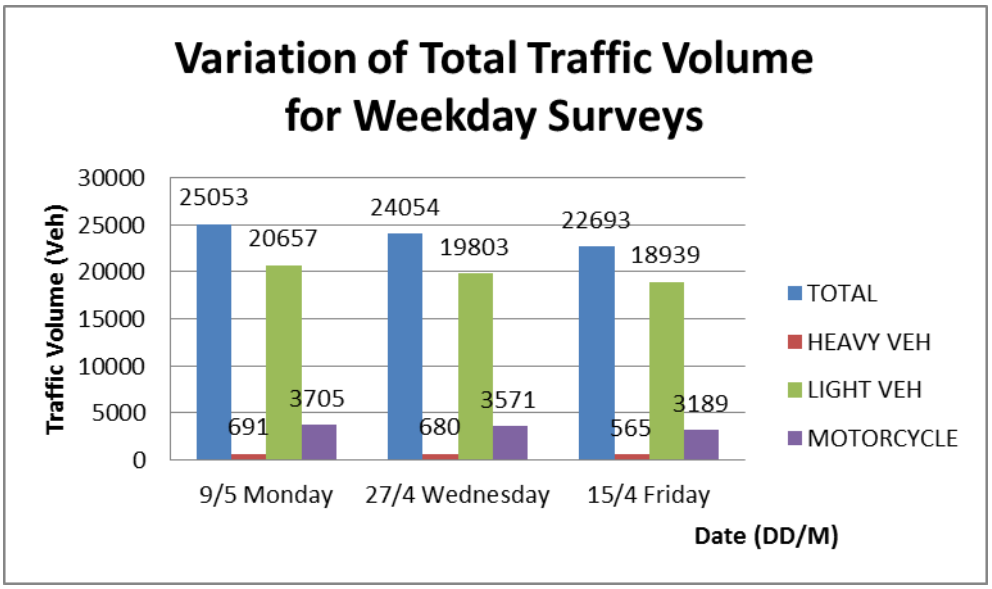



**Figure 4.1:** Variation of Total Traffic Volume for Weekday Surveys

Figure 4.1 shows the total traffic volume for weekday survey together with the breakdown of vehicle classes. In this subtopic, only variation of total traffic volume will be discussed. A detailed discussion on vehicle class composition will be presented in Subtopic 4.3

From the data obtained from this study, it can be seen that for typical weekdays, the total number of vehicles travelled past the section decreases from Monday to Friday. It is deduced that Monday has the highest traffic volume due to resume of banking operation on Mondays, and many businesses have to deposit their earnings on weekend into the bank. Meanwhile, Wednesday is deemed to be the typical weekday as the volume is at almost average of the other weekdays, giving the most accurate reflection to the traffic condition on road.

## 4.3 VARIATION OF TRAFFIC VOLUMES FOR DIFFERENT PEAKS: WEEKDAY SURVEYS

The study of implementing one way traffic is done based on the traffic volume that can be facilitated by the section of the road. The data are taken in 15 minutes interval. Three weekdays have been done, on 15th April, 27th April, and 9th May

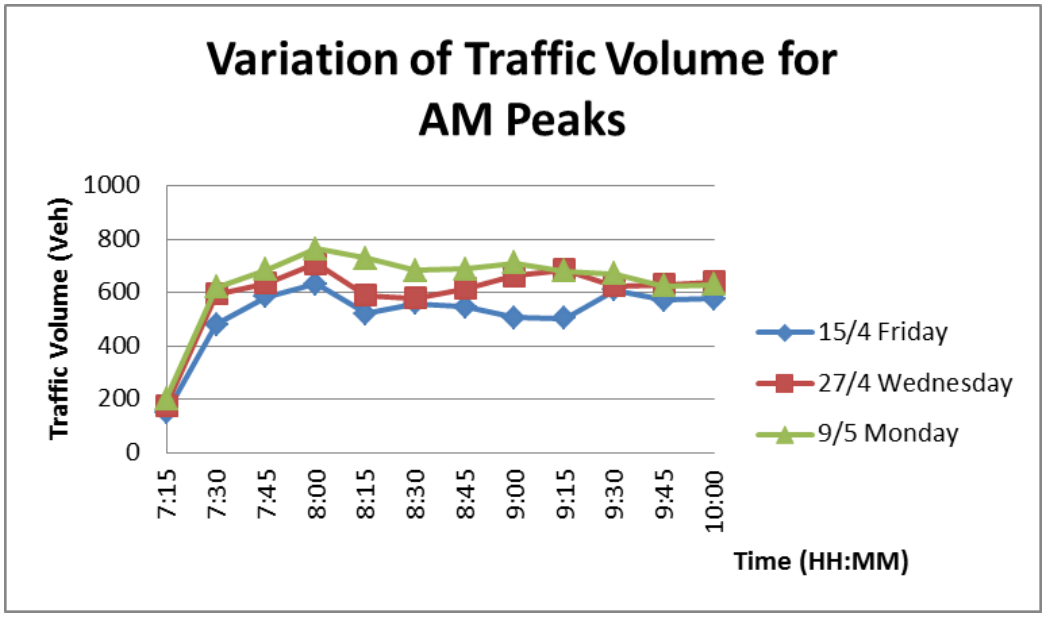



**Figure 4.2:** Variation of Traffic Volume for A.M. Peaks

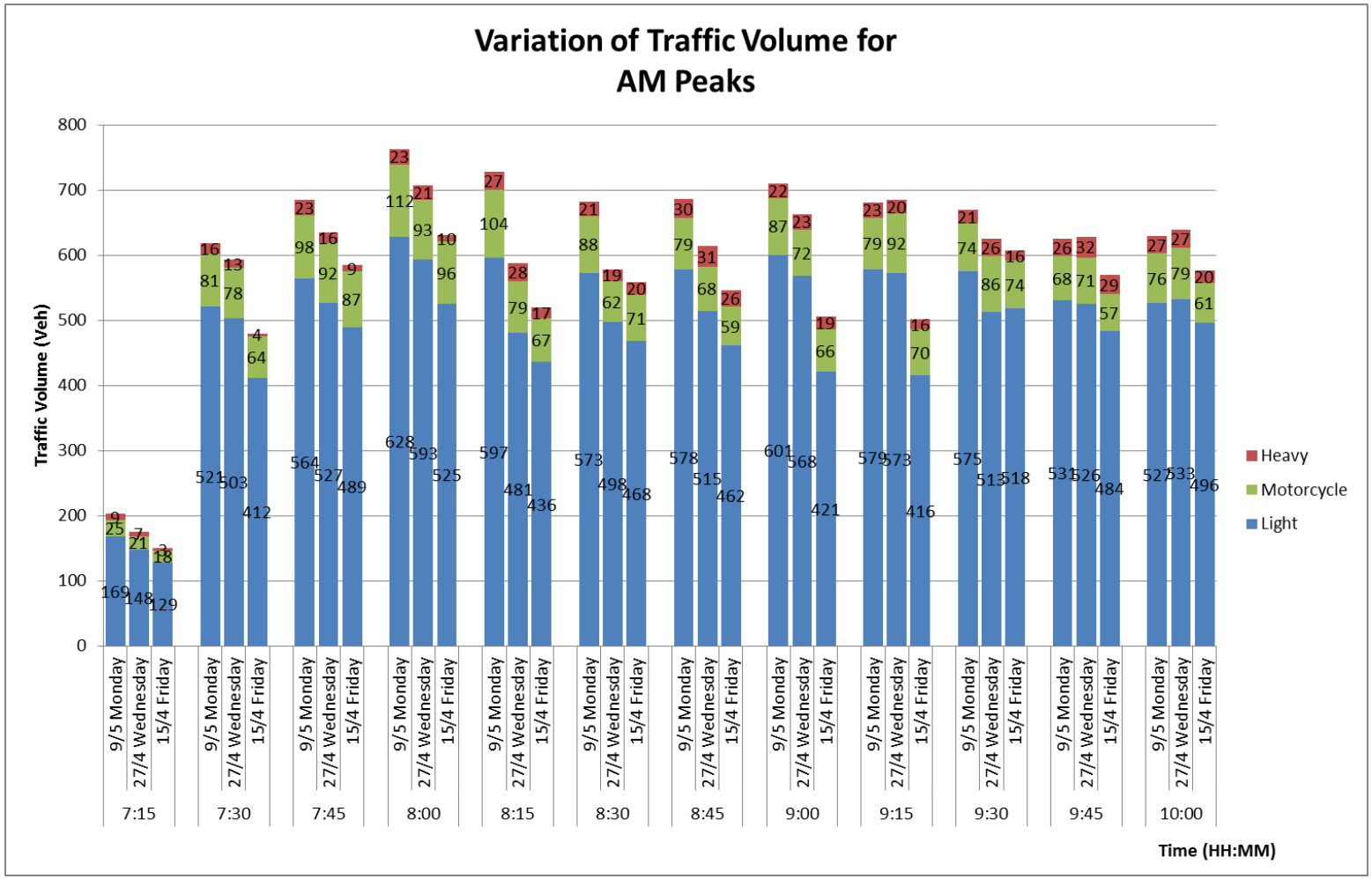



**Figure 4.3:** Variation of Traffic Volume for Weekday A.M. Peaks according to Vehicle Classes

Referring to the graph above, traffic volume is relatively low for all the specimen weekdays during the first quarter of 7am. There is no significant difference in volume for this period of time, for all three of the weekdays.

Traffic starts to build up during the second quarter of 7am (7:15am – 7:30am). During this period of time, the Monday study showed the highest quarter hour volume, which slightly exceeded 600 vehicles.

Traffic volume increased steadily from 7:30am to 8am. During 7:45am to 8am, the quarter hourly volume for AM peak for all three weekday studies reached their maximum value for respective days. This is deduced to be due to office hour and rush hour for the road users.

The traffic volume decreased during the first quarter of 8am. While Wednesday and Friday showed steep decline in traffic volume during 8:00am to 8:15am, the same result from Monday study showed a milder decline.

Another notable point within the result of AM peaks for weekday is such that there exists another mini-peak during 9:00am to 9:30am. However, Friday study had given a different pattern where its mini peak happened during 9:15 am to 9:30am.

It can be also observed that by not considering the first 15 minutes of AM peak study, traffic volume for each day for all quarter hours were consistent. The difference between highest and lowest volume does not exceed 200 vehicles.

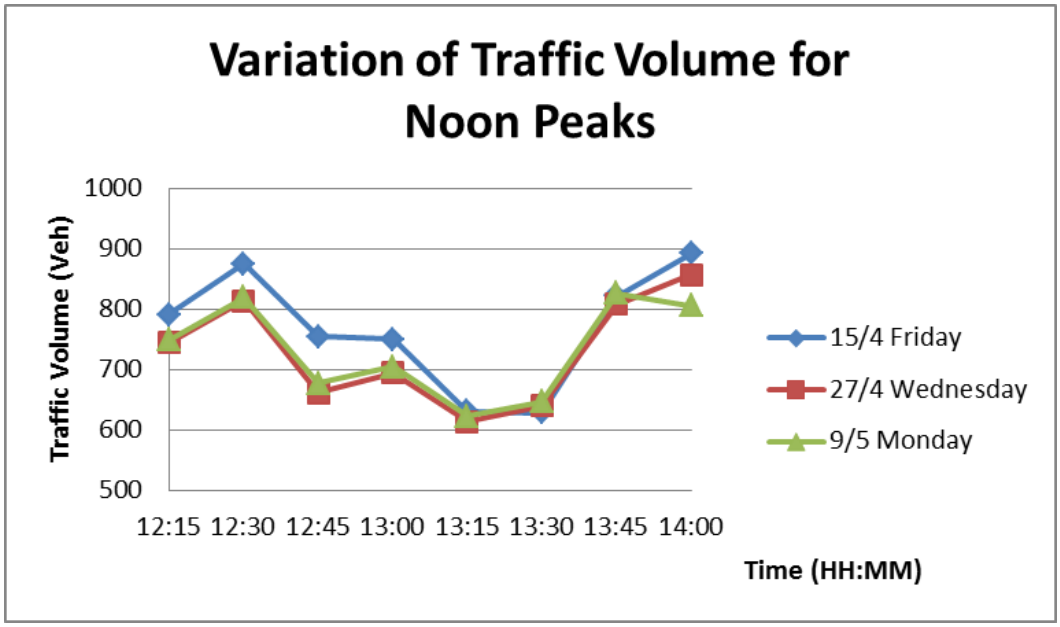



**Figure 4.4:** Variation of Traffic Volume for Weekday Noon Peaks

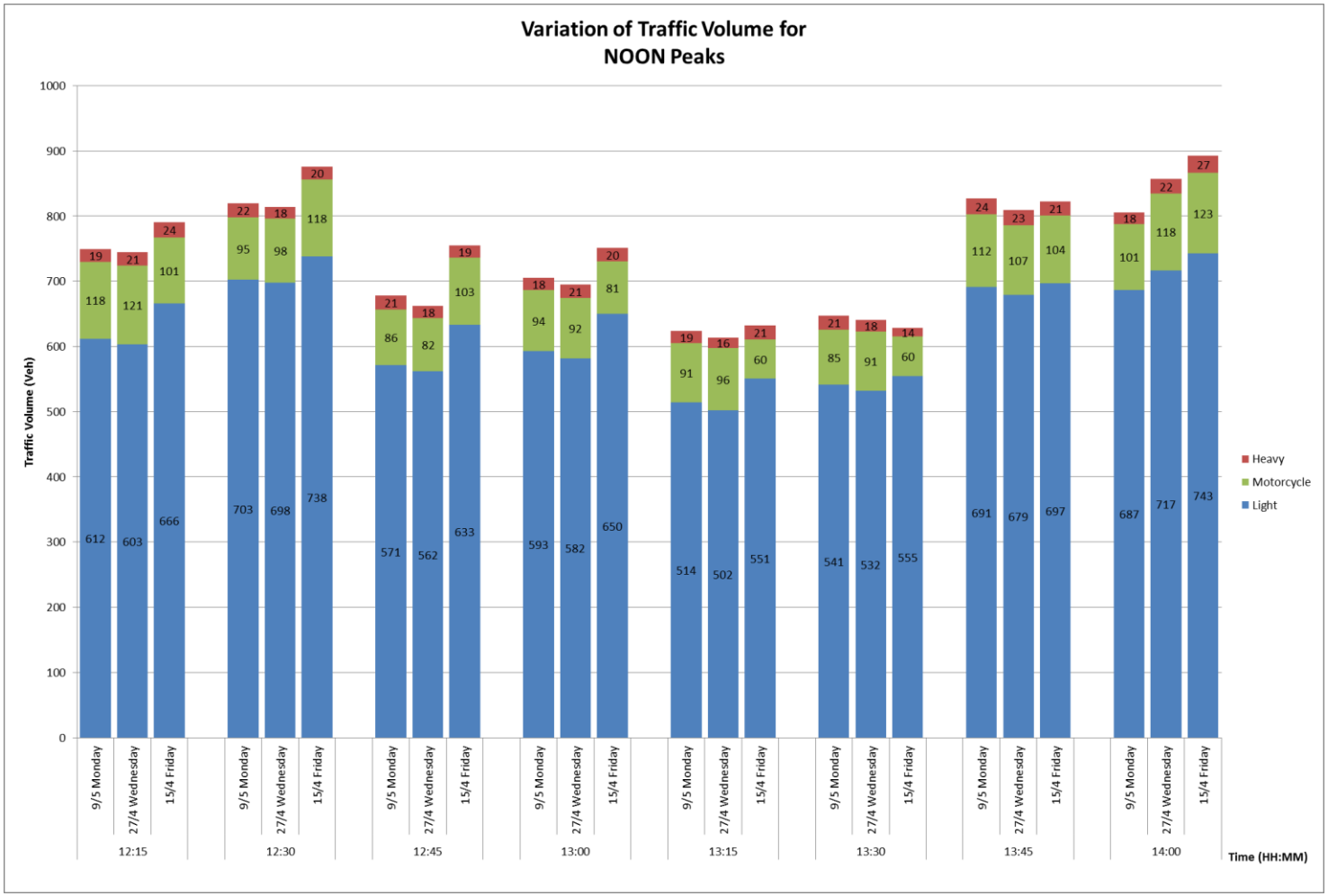



**Figure 4.5:** Variation of Traffic Volume for Weekday Noon Peaks according to Vehicle Classes

Traffic volume for noon peaks is surveyed to understand the variation of volume during lunch break hours.

Traffic volume of Noon Peaks is relatively high compared to morning peaks. This is due to the fact that not everyone starts working at the same time, but most of them are having same lunch break hours.

Similar to AM peak, there are generally two mini peaks happening during Noon Peak hours for all three of the weekday studies. One peak happened during 12:15 pm to 12:30 pm, while another peak happened during 1:45 pm to 2:00pm.

On Friday, the traffic volume for Noon Peak has shown significantly higher number of vehicles compared to other days. This has proven the hypothesis such that Friday Noon Peak will show higher volume than usual day, very much due to Friday prayer session.

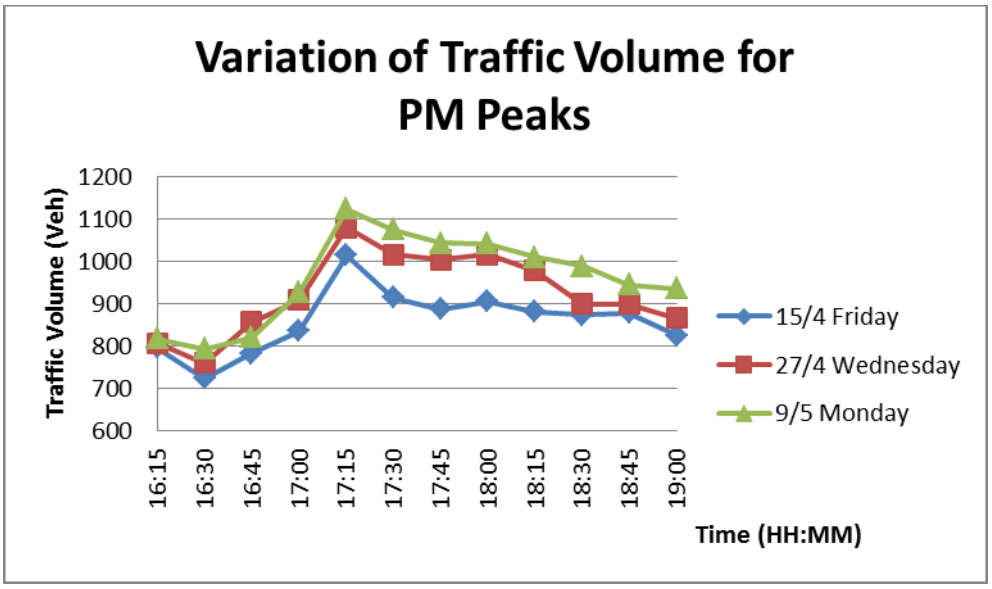



**Figure 4.6:** Variation of Traffic Volume for Weekday P.M. Peaks

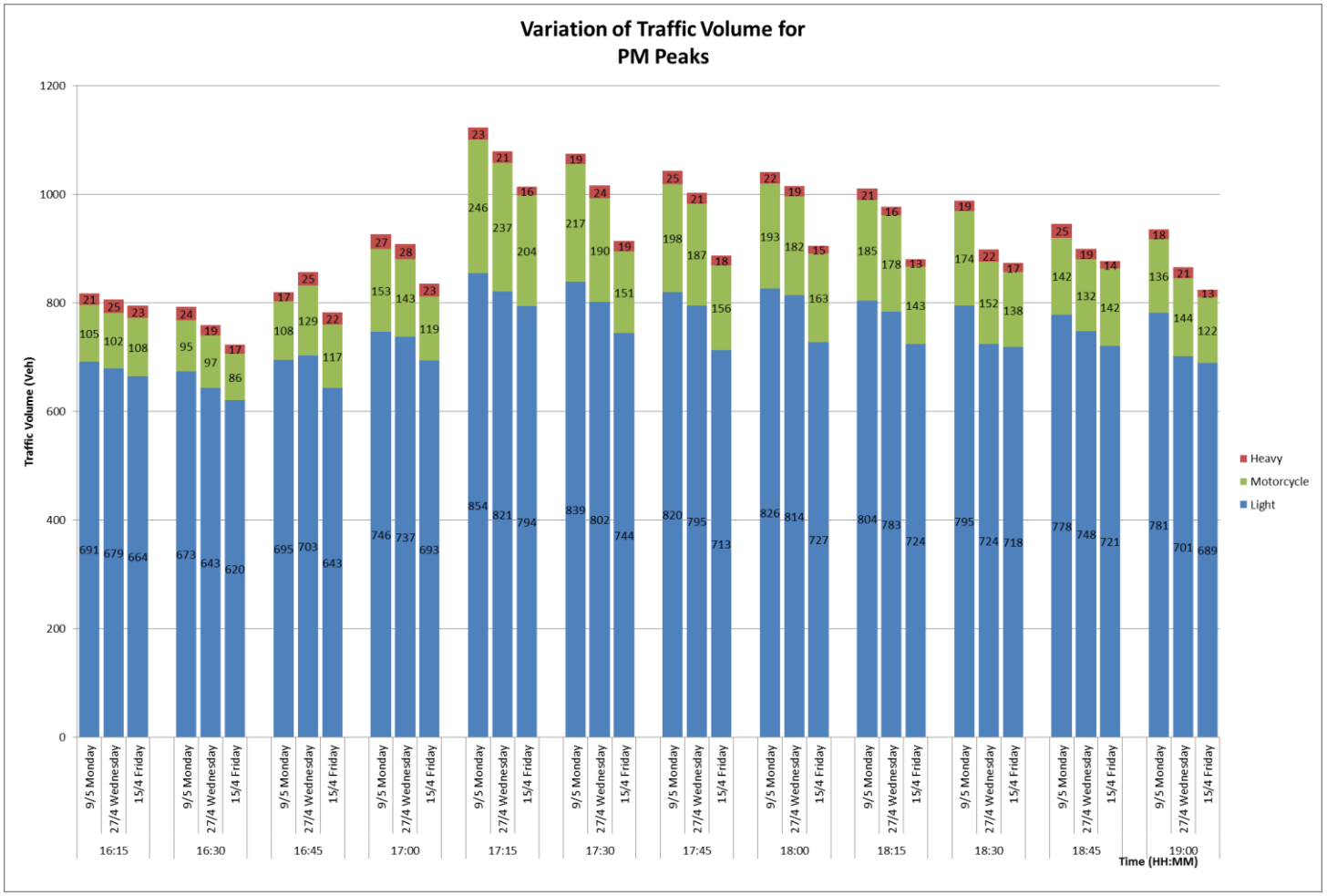



**Figure 4.7:** Variation of Traffic Volume for Weekday P.M. Peaks according to Vehicle Classes

For PM peaks, the pattern of graphs for all three weekday studies is fairly similar. In terms of volume per quarter hour, the reading of Monday study is generally the highest, with exception at one point (4:30pm to 4:45pm).

The peak quarter hour for PM peak for three surveys occurred during 5pm to 5:15pm. This result can be explained by the fact such that this period of time is the closing time for most offices, and many employees started to travel back to respective homes during this time.

## 4.4 VARIATION OF TRAFFIC VOLUMES FOR DIFFERENT PEAKS: WEEKEND SURVEY

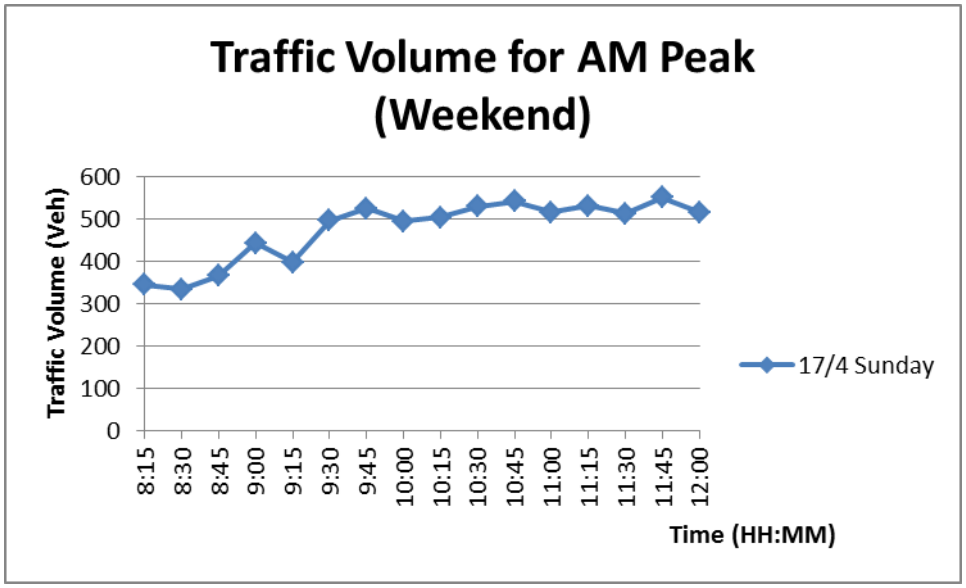



**Figure 4.8:** Variation of Traffic Volume for AM Peak (Weekend Survey)

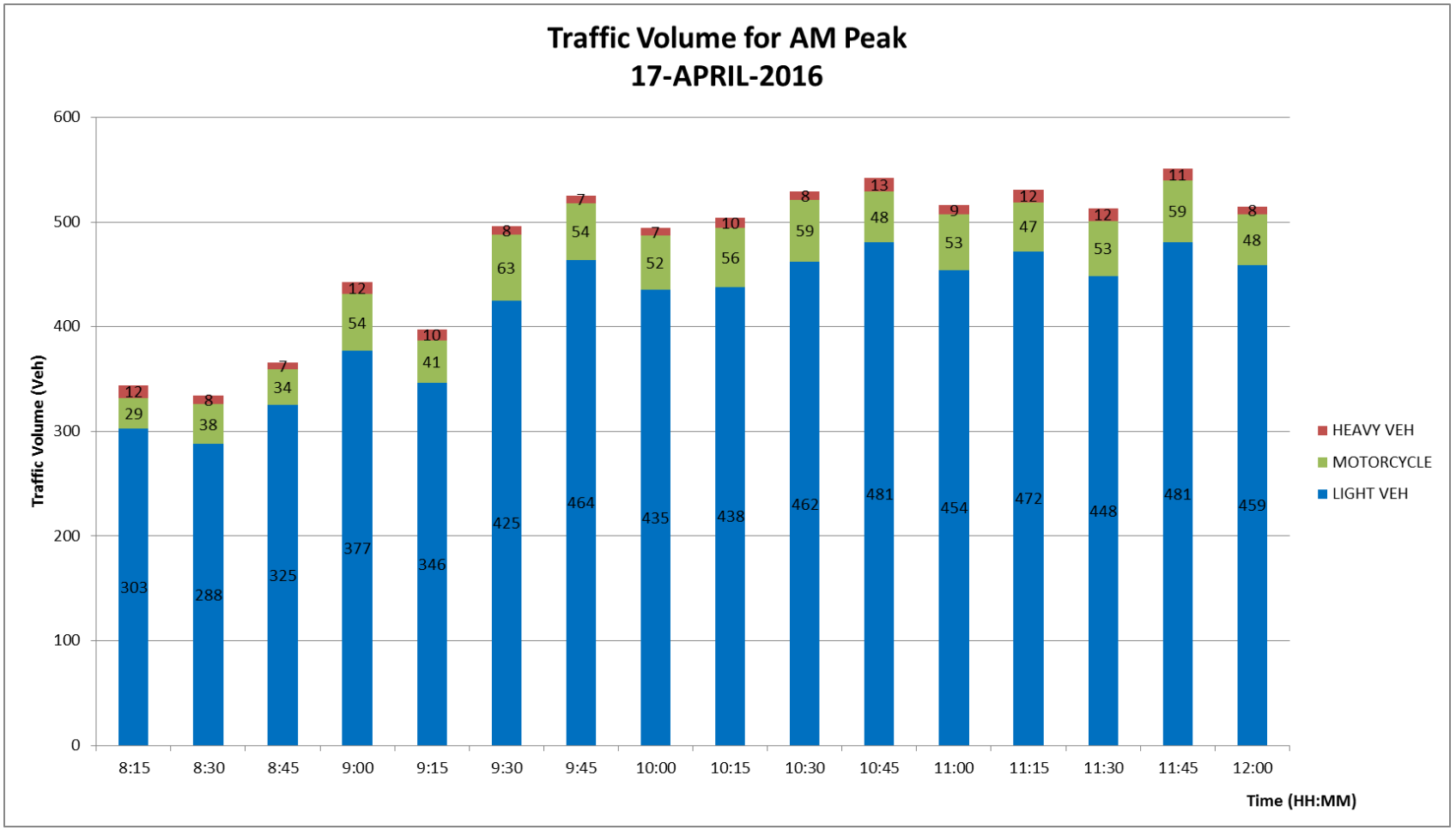



**Figure 4.9:** Variation of Traffic Volume for AM Peak (Weekend Survey) according to Vehicle Classes

A weekend study is conducted on a typical Sunday in the same section of survey. This survey is conducted as an extra survey to understand the traffic variation pattern during a typical weekend along the stretch of road.

From the data obtained, it can be seen that the pattern of variation in traffic volume between quarter hour is fairly consistent. Traffic volume increased gradually from 8am to 9am. This can be deduced such that the citizens who live in proximity in Kuantan city started to move into the city for their Sunday activities, mostly leisure activities during Sunday.

After a dip in volume from 9am to 9:15am, the traffic has increased up to 500 vehicles per quarter hour after 9:30 am. For the forthcoming 2 and a half hour, the traffic volume pattern is consistent, maintaining above 500 vehicles per hour.

## 4.5 TRAFFIC COMPOSITION BREAKDOWNS ACCORDING TO CLASSIFICATION OF VEHICLES

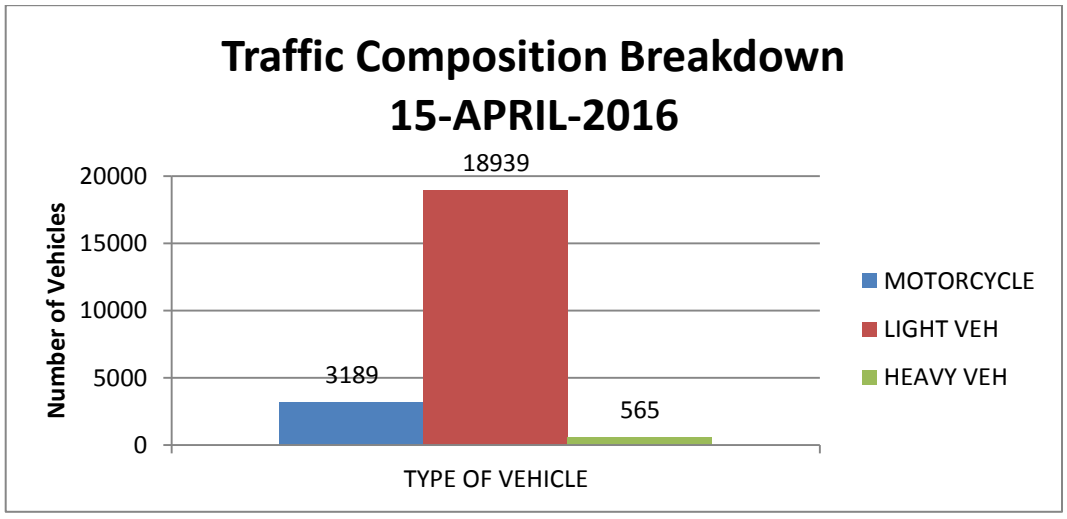



**Figure 4.10:** Traffic Composition Breakdown for 15-April-2016 Survey

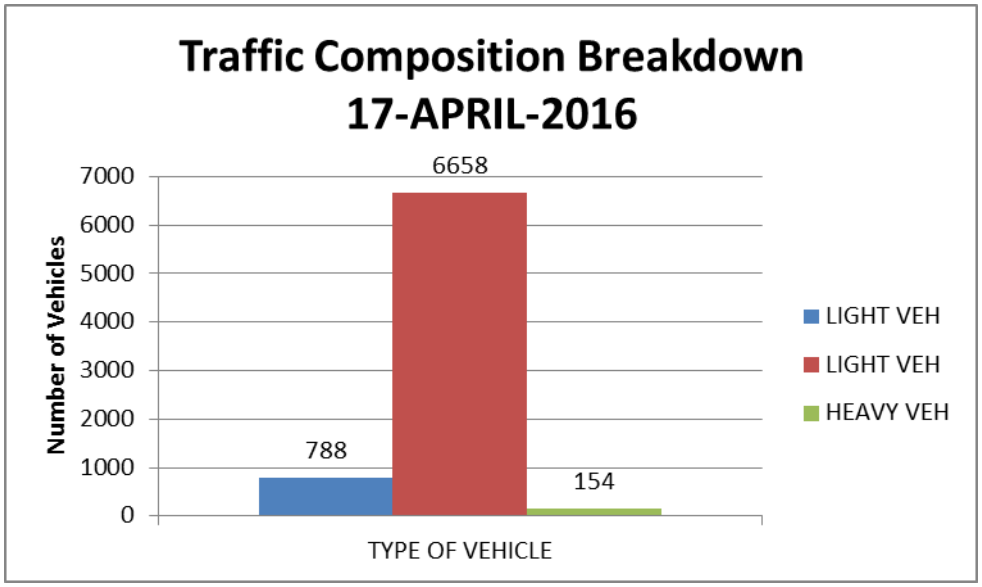



**Figure 4.11:** Traffic Composition Breakdown for 17-April-2016 Survey

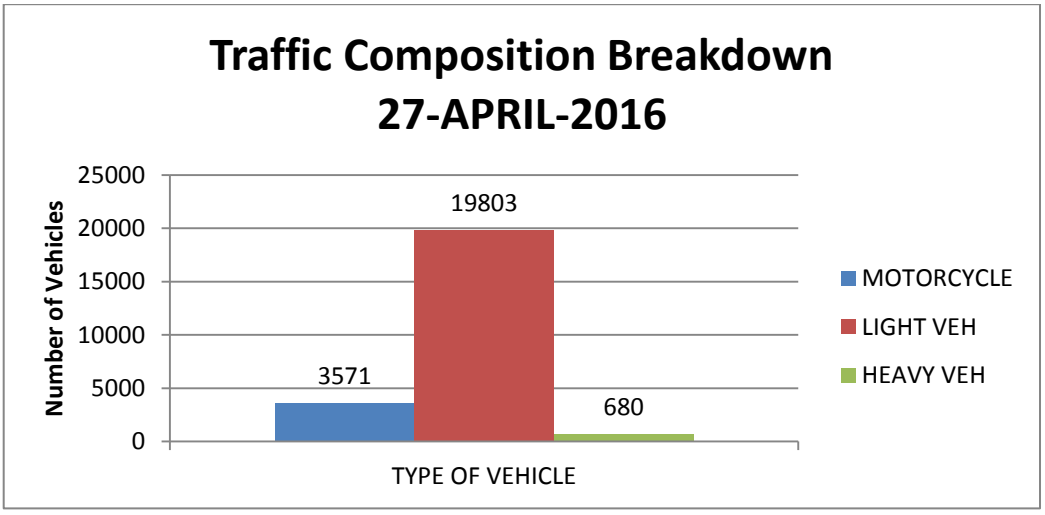



**Figure 4.12:** Traffic Composition Breakdown for 27-April-2016 Survey

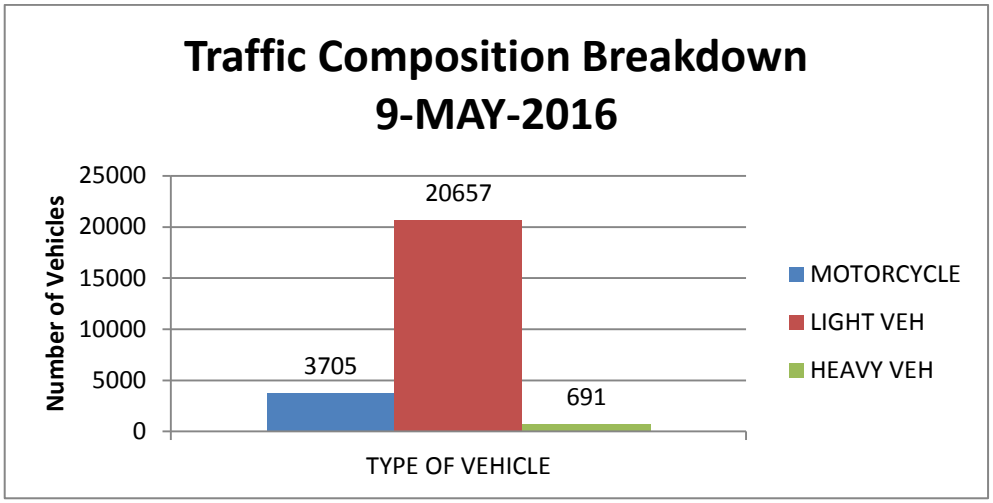



**Figure 4.13:** Traffic Composition Breakdown for 9-May-2016 Survey

The Figure 4.10, 4.11, 4.12, and 4.13 shows the breakdown of composition for vehicles travelling through the road section surveyed on Jalan Tun Ismail. From the bar chart produced, it can be observed that light vehicles have highest composition in traffic while heavy vehicles have the lowest.

The composition is summarised into table below according to weekday and weekend surveys

.

**Table 4.1:** Vehicle Classification Breakdown for Weekday Surveys

| Time | Motorcycle | Light Vehicles | Heavy Vehicles | Total |
|---|---|---|---|---|
| **Vehicle Classification Composition (%)** | | | | |
| 15-April | 14.05 | 83.46 | 2.49 | 100 |
| 27-April | 14.85 | 82.33 | 2.83 | 100 |
| 8-May | 14.79 | 82.45 | 2.76 | 100 |
| **Statistical Parameters** | | | | |
| Average | 14.56 | 82.75 | 2.69 | |
| Variance | 0.1985 | 0.3852 | 0.0322 | |

**Table 4.2:** Vehicle Classification Breakdown for Weekend Survey

| Time | Motorcycle | Light Vehicles | Heavy Vehicles | Total |
|---|---|---|---|---|
| | | **Vehicle Classification Composition (%)** | | |
| 17-April | 10.37 | 87.61 | 2.03 | 100 |

From the tables 4.1 and 4.2, the traffic composition of vehicles passing through the section of road surveyed can be interpreted.

For weekday studies, there are three sets of data to be compared. It can be interpreted that the composition of vehicles in the three weekday studies are consistent.

In average, motorcycles occupied about 14.56% of traffic passing through the road. On top of the composition, light vehicles occupied about 82.75% in average for three day of the weekdays. Meanwhile, heavy vehicles have the lowest composition, which is about 2.69% in average. In terms of variances in compositions, heavy vehicles are having the most consistent composition, by having the lowest variance. On the other side of the spectrum, composition of light vehicles varies by the most, giving the variance of 0.3852.

Meanwhile, for weekend study, the breakdown composition shows that the ranking for the three classes of vehicles are still similar to the weekdays'. However, motorcycles have their share dropped to 10.37%, as comparison, the mean of composition of motorcycles during weekdays is 14.56%. This drop is accompanied by a rise in composition for light vehicles, which is 87.61%, compared to 82.75% in average for the weekdays. Meanwhile, composition of heavy vehicles during weekends dropped from 0.63% to 2.03%.

The difference in weekday and weekend compositions is the reflection of traffic generation in terms of mode of transportation against purpose of travelling. During weekdays, a large chunk of traffic is travelling for working and education purpose. Meanwhile, during weekend, most of the citizens are having their holidays. A switch of mode of travel from motorcycle to light vehicles due to difference in travel purpose caused the difference of compositions in traffic.

## 4.6 TRAFFIC CONDITION EVALUATION

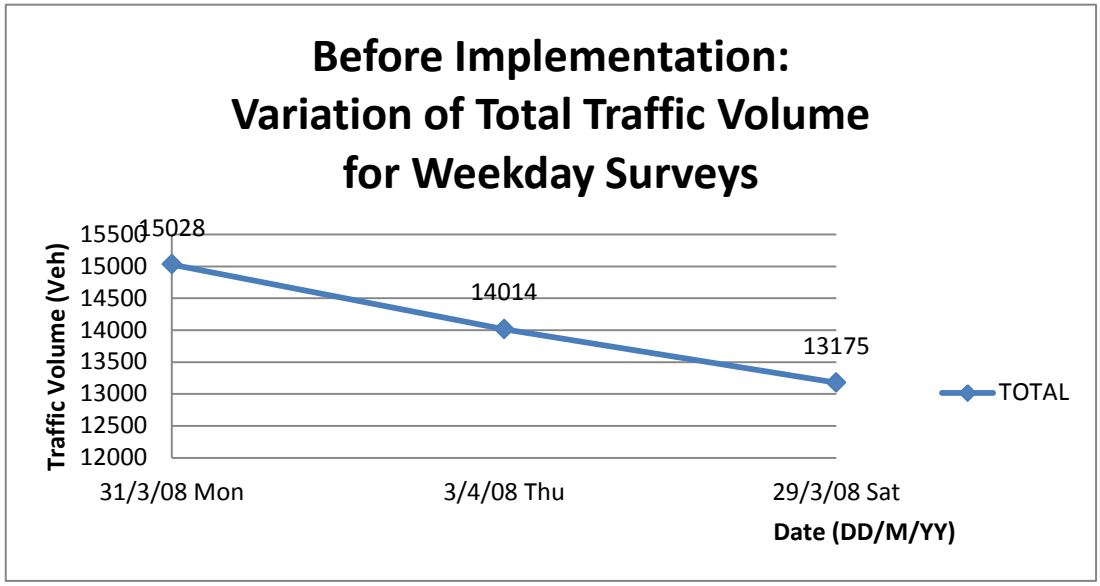



**Figure 4.14:** Traffic Data before Implementation of One Way traffic in Jalan Tun Ismail

Source: Sharifah et al. (2015)

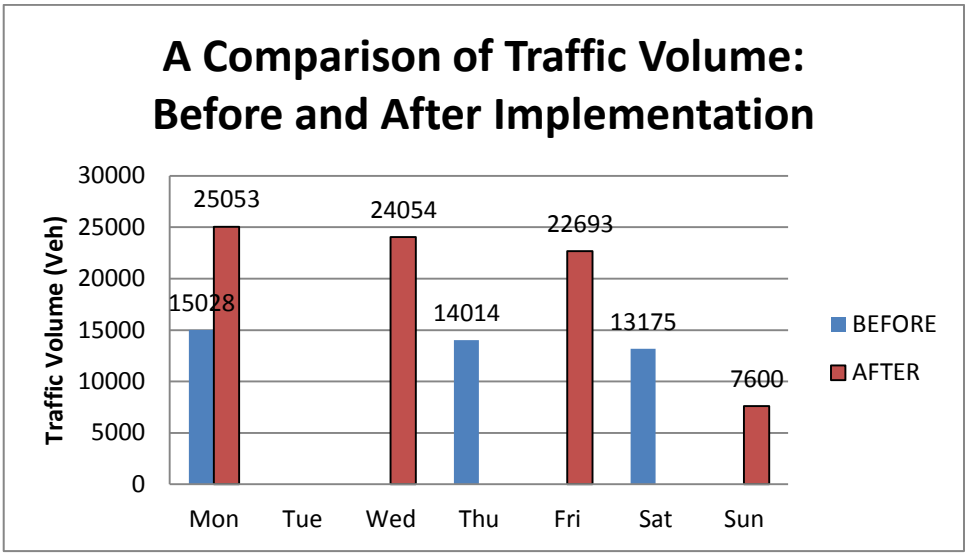



**Figure 4.15:** Comparison of total traffic volume for different survey days, before and after implementing one way traffic system

The traffic data before implementing one way traffic system comes in form of daily peak hour total volume. Thus, in Figure 4.14, the results are sorted into ascending days in a week, regardless of the sequence in which the surveys were carried.

Comparing the data, it can be obviously seen that the traffic volume that passed through Jalan Tun Ismail has almost grown by one fold. It also has to be noted that since no Saturday survey was carried out in this study, the weekend result in not comparable as Saturday and Sunday will produce different traffic pattern.

To compare the traffic condition, traffic condition has been observed. Throughout the four days of study, except for half an hour during PM peak of Monday, no queue is formed on the section of Jalan Tun Ismail surveyed.

In the event of queue formed on the section of road surveyed, it is observed that only rightmost two lanes were standing still with little movement. This is due to the congested intersection at Jalan Beserah-Teluk Sisek Intersection. Meanwhile, the two leftmost lanes produced no queue, allowing vehicles to make left turn at diverging end of Jalan Tun Ismail, heading to Air Putih and thus Kemaman direction.

In contrast, long queues are formed in both directions of the section surveyed before changing the road to one way street, due to saturated intersection at end of Jalan Tun Ismail. After implementation of one way traffic, only temporary queue is formed for almost half an hour. This is accompanied by the fact that the traffic volume facilitated by Jalan Tun Ismail has grown two fold of its before-implementation value.

This observation has proven that the implementation of one way traffic on Jalan Tun Ismail is effective in terms of relieving congestion at previously signalised Jalan Tun Ismail-Jalan Beserah intersection. While facilitating much higher traffic volume, the traffic is able to flow freely for most of the time, even during peak hours.

## 4.7 PROBLEMS DUE TO ONE WAY TRAFFIC ON JALAN TUN ISMAIL

As discussed in Chapter 3, in order to evaluate the implementation of one way traffic system on Jalan Tun Ismail, possible problems and hazards are determined, beside evaluation in terms of traffic volume.

In this section, the identified problems are discussed in detail. The problems should not be taken for granted as it affects the safety and serviceability of the road itself.

### 4.7.1 Frequent Lane Change

Before the changing of road system into one way street, Jalan Tun Ismail is a two way four lane urban road with two lanes on each direction. After conversion, Jalan Tun Ismail has turned into a four lane one way road along its stretch. At the end of the stretch of this road, the road diverges into left turn to Jalan Beserah, heading to Kemaman direction. Right turn into Jalan Beserah heads to Tj.Lumpur. The two leftmost lanes allows only left turn into Jalan Beserah, heading to Air Putih. On the other two lanes, only right turn is allowed. This stretch of road eventually ends at Persimpangan Jalan Teluk Sisek-Tj Lumpur.

In this survey, frequent lane changing by road users has been observed. There are a few reasons to change lanes.

First of all, lane changes are done to overtake slowly moving vehicles ahead. The vehicles on the road move at different speed. It has to be noted that this road is not designated as a roadway for high speed purpose. Thus, 'keep left unless overtaking' rule does not apply in this road. Thus, many vehicles have to change lane(s) to avoid vehicles that are moving slow, to achieve their desired driving speed. This condition is categorised into a Discretionary Lane Change.

Besides, drivers on Jalan Tun Ismail who driver on the leftmost lane have to change lane in order to avoid merging traffic from Jalan Tun Ismail 1. Acceleration/Deceleration lanes, or known as speed-change lanes or auxiliary lanes, are lanes designed to provide vehicles an opportunity to change speed (either slow down or speed up) in a space not used by a higher-speed through traffic. Acceleration lane provided for the vehicles exiting form Jalan Tun Ismail 1 is observed to be too short and narrow. This has caused the vehicles to perform forced-merging into the traffic stream coming from Jalan Tun Ismail. Such condition has caused the vehicles moving at high speed from Jalan Tun Ismail to change lane to avoid reduction in travel speed or even to collide with merging traffic. This condition is categorized under Discretionary Lane Change.

Besides, drivers have to change lanes to follow the lane to the right exit. As mentioned in sections before, the end of this Jalan Tun Ismail is a divergence into Jalan Berserah, two lanes in each direction. Thus, drivers have to change their direction into the right lane such that they can go to the right direction. Despite needing the drivers to make sure of being on the right lane, there is not enough of road markings and signage are installed to give direction to the drivers. As a result, it can be observed that some drivers have to perform last-minute lane change at the approaching chevron to traffic diverge. These lane changing actions are dangerous as they have to change lanes while avoiding from colliding onto the traffic island.

Lastly, it can be also observed that some drivers deliberately jumping the queue on the right turn exit by changing lane at the chevron approach , forming a temporary third lane. This act has caused interrupted traffic flow during peak hours.

### 4.7.2 Vehicles Crossing 4 lanes to enter Berjaya Megamall via Minor Entrance

There is a minor entrance and an exit of Berjaya Megamall located at the rightmost of Jalan Tun Ismail. The entrance and exit function to facilitate the movement of vehicle into and out of Berjaya Megamall directly from Jalan Tun Ismail. Previously, these access roads are only available for the vehicles travelling from Jalan Beserah to Jalan Tun Ismail, which is opposite flow to the current traffic flow direction.

The existence of such junction has provided drivers from Jalan Tun Ismail an access to and from Berjaya Megamall without going through Jalan Tun Ismail 8, which involves a U-turn at the roundabout, as shown in diagram below.


**Figure 4.16:** The 'shortcut' taken by vehicles exiting Jalan Tun Ismail 1 via "red route' instead of 'orange route'

Source: Google Map Screenshot

It is observed that some drivers chose to cross the four lane road to get into Berjaya Megamall's exit from Jalan Tun Ismail 1. Such act has to be done in very short period, provided by all red period of the signalized intersection at Jalan Tun Ismail Intersection. Drivers have to accelerate to very high speed to enter a narrow entrance.

Thus, it is a hazardous act, not only to the crossing vehicle itself, but also to incoming traffic from Jalan Tun Ismail.

### 4.7.3 Frequent illegal crossing by pedestrian and motorcycles

Jalan Tun Ismail is located at one of busiest business area of Kuantan. It serves as one of the major arterial road in Kuatan Central Business District. On the right hand side of the current forward traffic flow, there locates Berjaya Megamall, which houses several well-known eateries, supermarket, and other outlets. On the other side of the road, there is a busy commercial area which houses numerous commercial and business activities, including banks, offices, and other business activities.

It is observed that illegal road crossing by pedestrians, and even motorcyclists, happens frequently throughout the survey period. However, the crossing activity is observed to happen most frequent during lunch hours (12pm to – 2pm).

However, there is no road crossing facilities provided for the pedestrians to cross the road safely. The pedestrians have to make their judgments to cross the road occupied by heavy traffic, based on their judgment and instinct. Therefore, it can be frequently observed that the pedestrians have to sprint across the road with four lanes in order to get to another side.

More worryingly, some of the pedestrians choose to cross the road in phases. They decided to cross only two or three lanes of the road, standing on the road marking line, before crossing the remaining lanes. This causes great hazard, not only onto the pedestrians themselves for the risk of being collided into by fast moving vehicles. This is also a hazard for the vehicles passing by as the drivers have to maneuver their car about the pedestrians. Some are observed to have braked hard, while in some cases drivers have to change lanes to avoid from crashing into the standing still pedestrians.

### 4.7.4 Vehicles moving too fast

Previously designed to cater vehicles in both directions, Jalan Tun Ismail is a U5 arterial road with speed limit of 60 km/h. Heavy traffic in both directions causes the traffic to flow in a lower speed.

However, implementation of one way traffic has not only increased the daily traffic volume by almost two fold. This change has also caused the vehicles to travel at a higher speed, due to the long, straight stretch of road before heading into two sharp turns for each direction to left or right, into Jalan Beserah. Getting rid of traffic congestion allows the traffic to flow freely and thus vehicles to travel in high speed

Due to resource limitation and technical constraint, speed study is not done for this study. However, as increase in vehicular speed is too obvious, this problem is discussed here as one of the problems that are observed.

As per discussed above, Jalan Tun Ismail is located at the heart of Central Business District of Kuantan City. It acts as an arterial road, especially after one way traffic system has been implemented.

Hence, the main objective of introducing one way street system is to smoothen the flow of traffic as well as to provide high quality of traffic management to the road users. In other words, increasing car speed is not the aim for the conversion.

Moreover, as discussed above, frequent illegal crossings by pedestrian over this road happen frequently, especially during peak hours. The conflicts between approaching high speed vehicles and pedestrians whom travel in transverse direction across the road may cause fatal consequences to either or both the vehicle occupants or the pedestrians themselves.

### 4.7.5 A sequence of chained reaction of problems

From the four major problems discussed above, it can be seen that the problems are not causing effect as individual cause-consequence. In fact, these problems are inter-related and it is causing a series of chained reaction of urban traffic issues on the stretch of road studied. One of the typical scenarios is shown as below:

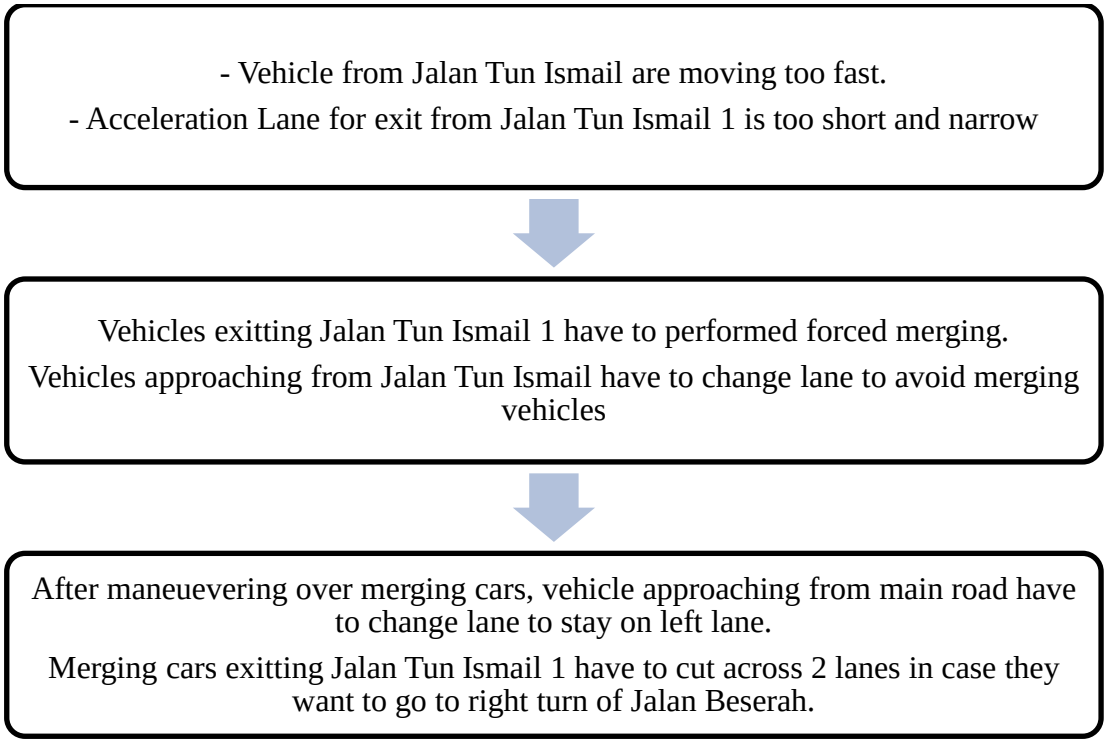



**Figure 4.17:** Typical Scenario for Chained Reaction of Problems

## 4.8 PROPOSING IMPROVEMENT TO JALAN TUN ISMAIL

In order to further improve the serviceability of Jalan Tun Ismail after its conversion to one way traffic, a few solutions are proposed. These proposed improvements are suggested as response and methods to solve the issues.

### 4.8.1 Installation of Instructional Road Signage

One of the major problems discussed above is frequent lane change done by the drivers. It can be observed that while some have deliberately done it, some of the drivers are not made aware of which lane they have to follow. They have only realised that they are not following the right lane when they are approaching to the traffic island at the end of Jalan Tun Ismail, where the road diverges into left turn and right turn respectively. Unfortunately, it is also observed that there is no adequate signage and road markings to provide the drivers with information on the direction of the lane ending at.

Thus, informative signage and road marking have to be furnished along the road. Despite having several signboards, the drivers are not made aware of the destination of the lanes they are taking on Jalan Tun Ismail, especially for those who are not familiar with Kuantan CBD area. The existing signage is placed too far from the end of Jalan Tun Ismail, in which the drivers are not reminded well enough when they approach to the divergence of the road.

Thus, in order to show clear directional instruction to the drivers, it is proposed that the following sign boards are erected in suitable locations according to standard specification as per instructed in technical standards published by JKR Malaysia.

(i) Signboard reminding drivers to drive on the correct lane, written with "*Pastikan Lorong Anda*"


**Figure 4.18:** Signboard written *Pastikan Lorong Anda*

Source: Blog Jalan Raya Malaysia Facebook Page

(ii) Overhead gantry signboards indicating the direction of each lane is heading to


**Figure 4.19:** Example of Overhead Gantry Indicating Lanes to Follow

Source: America.pink Website (url: http://america.pink/road-signs-malaysia_3761582.html)

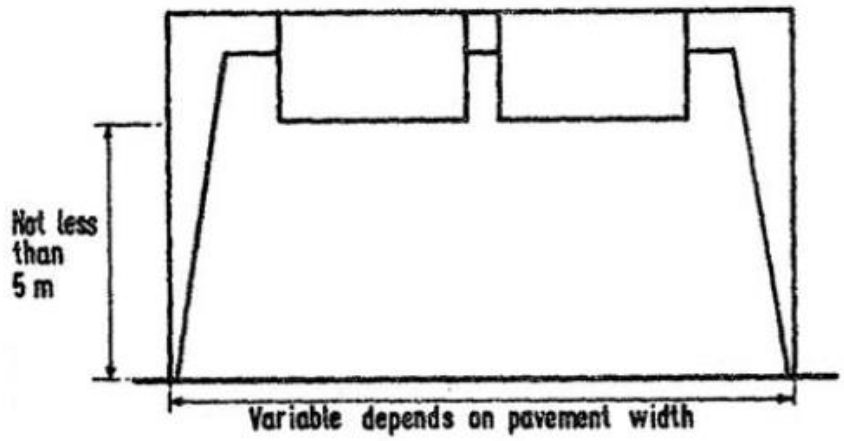



**Figure 4.20:** Minimum clearance for a typical Overhead Gantry

Source: Arahan Teknik (Jalan) 2B/85: Traffic Sign Application, JKR Malaysia,

(iii) Speed limit warning signs

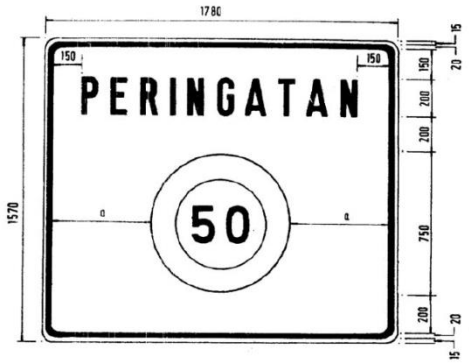



**Figure 4.21:** Speed limit reminding signboard

Source: Arahan Teknik (Jalan) 2E/85: Guide Signs Design and Application, JKR Malaysia,

### 4.8.2 Directional Road Marking

In order to keep the drivers informed of the direction in which the lanes are leading to, informative road marking which indicates the destination of each lane is heading to have to be marked.


**Figure 4.22:** Directional Road Markings as done is Jalan Mahkota, Kuantan

### 4.8.3 Adjustment to Intersection and Junctions

One of the problems discussed above is about the difficulty of vehicles exiting Jalan Tun Ismail 1 merging into higher speed traffic from Jalan Tun Ismail, due to narrow and short acceleration lanes. Forced merging has to be made by the vehicles exiting Jalan Tun Ismail 1.

Since widening and upgrading of acceleration lane is not feasible due to lack of space along road reserve, it is proposed that the rules where 'turn left when exit is clear' is made not applicable on this left turn exit. By stopping the vehicles from exiting freely onto the major traffic flow, conflicts between vehicles moving in major traffic stream and merging traffic can be avoided. Conflicts happen when vehicles which are allowed to 'left turn freely when exit is clear' force merge with the traffic approaching from Jalan Tun Ismail. Controlling the vehicles from exiting Jalan Tun Ismail 1 via left turn by means of traffic signal is one feasible solution to avoid such conflict.

Besides, smooth traffic flow can be achieved by not allowing free left turn of vehicles exiting Jalan Tun Ismail 1.The free flowing flow of traffic approaching from Jalan Tun Ismail is frequently interrupted by vehicles exiting Jalan Tun Ismail 1 via left turn. Such condition has usually caused a mini bottleneck at the leftmost lane on Jalan Tun Ismail, causing distruption to the traffic flow. Thus, by adding a traffic light and control the flow of vehicles exiting Jalan Tun Ismail 1, a safer and smoother traffic flow from Jalan Tun Ismail main Road can be achieved

As discussed in section above, some vehicles performed dangerous four-lane crossing to get into Berjaya Megamall's minor entrance, straight after exiting Jalan Tun Ismail 1 via left turn. By giving an exclusive stage for exiting, preventing them from making such cross when traffic from other directions are incoming, this conflict can be avoided..

Some may argue that it is known that adding traffic signal may increase the waiting time for vehicles for other right of ways. However, the proposed addition helps reduce conflicts, in which such conflicts triggering other problems as discussed in section above. Road safety is always on the top list of priority in traffic engineering.

**Figure 4.23:** Left turn exit from Jalan Tun Ismail 1

Source: Google Map Street View Screenshot


**Figure 4.24:** Map of location for junction to be added with traffic light. Orange circle indicates the location of new traffic light proposed

Source: Google Earth Image Screenshot

### 4.8.4 Pedestrian bridge

In urban traffic management, pedestrians are a part of important component. The problem such that the pedestrians have to make dangerous illegal crossings is to be solved as soon as possible before any serious incidents could happen.

Thus, it is proposed that pedestrian bridge to be built across the busy road of Jalan Tun Ismail. This is proposed such that the pedestrians can cross the road safely. Besides, conflict between approaching vehicles and illegally crossing pedestrians can also be minimised, if not totally avoided.

However, it is known that the cost of building a pedestrian bridge is high, and usually involves monetary resources at 7-digit magnitude. Building a pedestrian bridge in an area where road reserve area is very restricted could pose serious challenge to the engineers as well as the contractors responsible for the construction work.

Nevertheless, building a pedestrian bridge is a must-do for this stretch of road. The cost of building such facilities is necessary. From the other aspect, the cost of building one bridge is not comparable when it comes to livability of citizens as well as their road safety.


**Figure 4.25:** Proposed location for pedestrian bridge

Source: Google Earth Image Screenshot

### 4.8.5 Traffic Calming

The scenario where cars are travelling at high speeds is a serious issue to be tackled. This must be tackled effectively to ensure that the vehicles are travelling at safe speed, in accordance to speed limits as well as the design speed for the road.

While vehicles travelling above speed limit are punishable by traffic law, traffic calming can be done to reduce the speed of vehicles moving on Jalan Tun Ismail. For the stretch of road which is included in this study, it is proposed that the flexible pavement of the road is replaced with textured pavement.

This method involves the use of stamped pavement materials to create an uneven surface for vehicles to move on. Uneven road surface will in turn slow down the travel speed of vehicle. Textured pavement also alerts the driver about the need for particular care.

This method is applied by engineers in Kuantan city along part of the stretch of Jalan Tanah Putih, where bricks are laid for traffic calming purpose as well as beautification purpose.

To reduce the cost of replacement to the entire stretch of Jalan Tun Ismail, textured pavement can be built at regular interval. Flexible brick is the material suggested for this purpose, as the brick is relatively cheaper than other materials, and is easily obtained in this region.

Besides, marking traverse markings on certain area of the road is also another way to slow the traffic. It should be used in alternate with textured pavement, such that both functions the same, which is to slow traffic down without interrupting the flow as well as the make aware of the drivers that they should not drive fast on that stretch.

**Figure 4.26:** Textured pavement in Jalan Tanah Putih, Kuantan

Source: Google Steet View Image Screenshot

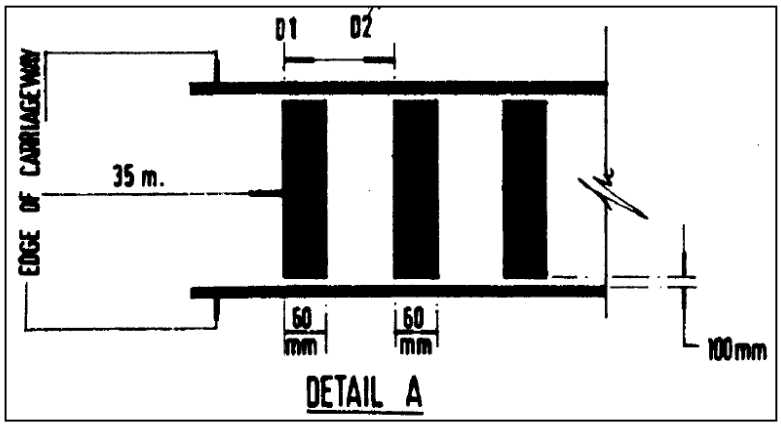



**Figure 4.27:** Specification example for traverse bar marking

Source: Arahan Teknik (Jalan) 2D/85, JKR Malaysia

# CHAPTER 5

# CONCLUSION

## 5.1 CONCLUSION

Implementation of one way traffic is an effort carried out by Kuantan Municipal Council, supported by researches from Universiti Malaysia Pahang, in order to relieve traffic congestion problem in Kuantan Central Business District. The effect of changing traffic system into one way flow is assessed in terms of volume as well as implications it brought to the traffic. The study such effect is carried out along a middle section of Jalan Tun Ismail.

From the outcome of this study, the variation of traffic volume in weekdays as well as a weekend has been determined. In general, traffic volume is highest during Monday, and gradually decreasing up to Friday, for the case of weekday variation. Evening peaks are showing the highest quarter hours volume as well as peak hour volume for respective days. For weekend, it is found that the traffic volume throughout the morning until noon is fairly consistent, and almost half as low as usual weekday noon.

The composition of traffic is also determined. Light vehicles have the largest share of vehicles travelling on Jalan Tun Ismail, followed by motorcycles, and heavy vehicles being the least. Bar charts showing vehicle composition in traffic volume for each survey days are also plotted.

Comparing traffic data for both pre-implementation and post-implementation of one way traffic, it can be shown that the traffic volume that is facilitated by the section of Jalan Tun Ismail studied has grown by significantly. While volume is increased, the traffic flow is smooth except for a brief period of time in one of the four survey days, in contrast to the pre-implementation condition where all the lanes of Jalan Tun Ismail tend to be having very slow traffic flow or even standing still during peak hours. This has proven that implementing one way traffic is effective in relieving traffic congestion problem in terms of traffic volume and traffic flow.

Several issues related to traffic due to implementation of one way traffic have been discussed. Frequent lane change done by the drivers have caused disruption to traffic flow besides being hazardous. The short and narrow acceleration lane extending from the left turn exit of Jalan Tun Ismail 1 has caused the exiting vehicles to perform forced merging into the traffic from the main road. Some vehicles choose to cross the four lane road to enter to the Berjaya Megamall minor entrance, despite knowing the danger of doing so. On the other hand, pedestrians perform illegal crossing across Jalan Tun Ismail due to lack to crossing facility. Due to smooth traffic flow, the drivers are driving their vehicles at high speed, causing danger to other road users. All the problems mentioned above are within a chain reaction of problems that happens due to changing into one way traffic system.

To improve the condition, several changes have been proposed. Directive signboards indicating direction for each lanes as well as overhead gantry signboard may be installed. Prohibitive signboard should as be erected to warn the drivers about the speed limit within city centre. A traffic light should be installed at the left turn exit from Jalan Tun Ismail 1 in order to control the exit movement of the vehicles. Traffic calming by means of textured pavement and traverse bars should also being implemented.

## 5.2 RECOMMENDATION

In order to carry out the study in more comprehensive manner, a few improvements can be made.

First of all, in order to obtain more comprehensive traffic volume data, traffic surveys should be carried out on more days, for say 1 whole week. In this study, resource constraint has caused the researcher to only conduct surveys on four different days. By doing surveys on more days, a clearer picture of traffic data can be obtained.

Besides, more traffic parameters should be studied. By studying only traffic volume, the traffic condition could not be comprehensively reflected on the data. The next researchers should carry out other studies, especially spot speed studies, which data is used to form average speed, in order to obtain a Level of Service rating for the road.

Other than that, survey should be carried out in at least more than one point. As mentioned, survey is only done by means of middle block section on Jalan Tun Ismail due to inadequate human resources. The future researchers should carry out the survey in at least two points on the loop of one way traffic street in order to obtain more accurate results.

Lastly, it is also recommended that data collection is done on the other major stretches involved in one way traffic system. The stretch of Jalan Tun Ismail in the whole loop of one way traffic is short. Thus, studying other major roads involved in this conversion, such as Jalan Bukit Ubi, Jalan Besar, and Jalan Gambut. A more comprehensive and complete result can be obtained by combining the studies on all the routes as mentioned.

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# APPENDIX A1

## TRAFFIC VOLUME FOR WEEKDAY SURVEYS

**Table A1.1:** Quarter Hour Volume for A.M. Peak of 15th April 2016

| Traffic Volume (Veh) | | | | |
|---|---|---|---|---|
| AM Peak | Motorcycle | Light | Heavy | **Total** |
| 7:15 | 18 | 129 | 3 | **150** |
| 7:30 | 64 | 412 | 4 | **480** |
| 7:45 | 87 | 489 | 9 | **585** |
| 8:00 | 96 | 525 | 10 | **631** |
| 8:15 | 67 | 436 | 17 | **520** |
| 8:30 | 71 | 468 | 20 | **559** |
| 8:45 | 59 | 462 | 26 | **547** |
| 9:00 | 66 | 421 | 19 | **506** |
| 9:15 | 70 | 416 | 16 | **502** |
| 9:30 | 74 | 518 | 16 | **608** |
| 9:45 | 57 | 484 | 29 | **570** |
| 10:00 | 61 | 496 | 20 | **577** |

**Table A1.2:** Quarter Hour Volume for Noon Peak of 15th April 2016

| Traffic Volume (Veh) | | | | |
|---|---|---|---|---|
| AM Peak | Motorcycle | Light | Heavy | **Total** |
| 12:15 | 101 | 666 | 24 | **791** |
| 12:30 | 118 | 738 | 20 | **876** |
| 12:45 | 103 | 633 | 19 | **755** |
| 13:00 | 81 | 650 | 20 | **751** |
| 13:15 | 60 | 551 | 21 | **632** |
| 13:30 | 60 | 555 | 14 | **629** |
| 13:45 | 104 | 697 | 21 | **822** |
| 14:00 | 123 | 743 | 27 | **893** |

**Table A1.3:** Quarter Hour Volume for A.M. Peak of 15th April 2016

| Traffic Volume (Veh) | | | | |
|---|---|---|---|---|
| AM Peak | Motorcycle | Light | Heavy | **Total** |
| 16:15 | 108 | 664 | 23 | **795** |
| 16:30 | 86 | 620 | 17 | **723** |
| 16:45 | 117 | 643 | 22 | **782** |
| 17:00 | 119 | 693 | 23 | **835** |
| 17:15 | 204 | 794 | 16 | **1014** |
| 17:30 | 151 | 744 | 19 | **914** |
| 17:45 | 156 | 713 | 18 | **887** |
| 18:00 | 163 | 727 | 15 | **905** |
| 18:15 | 143 | 724 | 13 | **880** |
| 18:30 | 138 | 718 | 17 | **873** |
| 18:45 | 142 | 721 | 14 | **877** |
| 19:00 | 122 | 689 | 13 | **824** |

**Table A1.4:** Quarter Hour Volume for A.M. Peak of 27th April 2016

| Traffic Volume (Veh) | | | | |
|---|---|---|---|---|
| AM Peak | Motorcycle | Light | Heavy | **Total** |
| 7:15 | 21 | 148 | 7 | **176** |
| 7:30 | 78 | 503 | 13 | **594** |
| 7:45 | 92 | 527 | 16 | **635** |
| 8:00 | 93 | 593 | 21 | **707** |
| 8:15 | 79 | 481 | 28 | **588** |
| 8:30 | 62 | 498 | 19 | **579** |
| 8:45 | 68 | 515 | 31 | **614** |
| 9:00 | 72 | 568 | 23 | **663** |
| 9:15 | 92 | 573 | 20 | **685** |
| 9:30 | 86 | 513 | 26 | **625** |
| 9:45 | 71 | 526 | 32 | **629** |
| 10:00 | 79 | 533 | 27 | **639** |

**Table A1.5:** Quarter Hour Volume for Noon Peak of 27th April 2016

| Traffic Volume (Veh) | | | | |
|---|---|---|---|---|
| AM Peak | Motorcycle | Light | Heavy | **Total** |
| 12:15 | 121 | 603 | 21 | **745** |
| 12:30 | 98 | 698 | 18 | **814** |
| 12:45 | 82 | 562 | 18 | **662** |
| 13:00 | 92 | 582 | 21 | **695** |
| 13:15 | 96 | 502 | 16 | **614** |
| 13:30 | 91 | 532 | 18 | **641** |
| 13:45 | 107 | 679 | 23 | **809** |
| 14:00 | 118 | 717 | 22 | **857** |

**Table A1.6:** Quarter Hour Volume for P.M. Peak of 27th April 2016

| Traffic Volume (Veh) | | | | |
|---|---|---|---|---|
| AM Peak | Motorcycle | Light | Heavy | **Total** |
| 16:15 | 102 | 679 | 25 | **806** |
| 16:30 | 97 | 643 | 19 | **759** |
| 16:45 | 129 | 703 | 25 | **857** |
| 17:00 | 143 | 737 | 28 | **908** |
| 17:15 | 237 | 821 | 21 | **1079** |
| 17:30 | 190 | 802 | 24 | **1016** |
| 17:45 | 187 | 795 | 21 | **1003** |
| 18:00 | 182 | 814 | 19 | **1015** |
| 18:15 | 178 | 783 | 16 | **977** |
| 18:30 | 152 | 724 | 22 | **898** |
| 18:45 | 132 | 748 | 19 | **899** |
| 19:00 | 144 | 701 | 21 | **866** |

**Table A1.7:** Quarter Hour Volume for A.M. Peak of 9th May 2016

| Traffic Volume (Veh) | | | | |
|---|---|---|---|---|
| AM Peak | Motorcycle | Light | Heavy | **Total** |
| 7:15 | 25 | 169 | 9 | **203** |
| 7:30 | 81 | 521 | 16 | **618** |
| 7:45 | 98 | 564 | 23 | **685** |
| 8:00 | 112 | 628 | 23 | **763** |
| 8:15 | 104 | 597 | 27 | **728** |
| 8:30 | 88 | 573 | 21 | **682** |
| 8:45 | 79 | 578 | 30 | **687** |
| 9:00 | 87 | 601 | 22 | **710** |
| 9:15 | 79 | 579 | 23 | **681** |
| 9:30 | 74 | 575 | 21 | **670** |
| 9:45 | 68 | 531 | 26 | **625** |
| 10:00 | 76 | 527 | 27 | **630** |

**Table A1.8:** Quarter Hour Volume for Noon Peak of 9th May 2016

| Traffic Volume (Veh) | | | | |
|---|---|---|---|---|
| AM Peak | Motorcycle | Light | Heavy | **Total** |
| 12:15 | 118 | 612 | 19 | **749** |
| 12:30 | 95 | 703 | 22 | **820** |
| 12:45 | 86 | 571 | 21 | **678** |
| 13:00 | 94 | 593 | 18 | **705** |
| 13:15 | 91 | 514 | 19 | **624** |
| 13:30 | 85 | 541 | 21 | **647** |
| 13:45 | 112 | 691 | 24 | **827** |
| 14:00 | 101 | 687 | 18 | **806** |

**Table A1.9:** Quarter Hour Volume for P.M. Peak of 9th May 2016

| Traffic Volume (Veh) | | | | |
|---|---|---|---|---|
| AM Peak | Motorcycle | Light | Heavy | **Total** |
| 16:15 | 105 | 691 | 21 | **817** |
| 16:30 | 95 | 673 | 24 | **792** |
| 16:45 | 108 | 695 | 17 | **820** |
| 17:00 | 153 | 746 | 27 | **926** |
| 17:15 | 246 | 854 | 23 | **1123** |
| 17:30 | 217 | 839 | 19 | **1075** |
| 17:45 | 198 | 820 | 25 | **1043** |
| 18:00 | 193 | 826 | 22 | **1041** |
| 18:15 | 185 | 804 | 21 | **1010** |
| 18:30 | 174 | 795 | 19 | **988** |
| 18:45 | 142 | 778 | 25 | **945** |
| 19:00 | 136 | 781 | 18 | **935** |

# APPENDIX A2

## TRAFFIC VOLUME FOR WEEKEND SURVEY

**Table A2.1:** Quarter Hour Volume for A.M. Peak of 17th April 2016

| Traffic Volume (Veh) | | | | |
|---|---|---|---|---|
| AM Peak | Motorcycle | Light | Heavy | **Total** |
| 8:15 | 29 | 303 | 12 | **344** |
| 8:30 | 38 | 288 | 8 | **334** |
| 8:45 | 34 | 325 | 7 | **366** |
| 9:00 | 54 | 377 | 12 | **443** |
| 9:15 | 41 | 346 | 10 | **397** |
| 9:30 | 63 | 425 | 8 | **496** |
| 9:45 | 54 | 464 | 7 | **525** |
| 10:00 | 52 | 435 | 7 | **494** |
| 10:15 | 56 | 438 | 10 | **504** |
| 10:30 | 59 | 462 | 8 | **529** |
| 10:45 | 48 | 481 | 13 | **542** |
| 11:00 | 53 | 454 | 9 | **516** |
| 11:15 | 47 | 472 | 12 | **531** |
| 11:30 | 53 | 448 | 12 | **513** |
| 11:45 | 59 | 481 | 11 | **551** |
| 12:00 | 48 | 459 | 8 | **515** |

## APPENDIX A3

## TRAFFIC VOLUME FOR PRE-IMPLEMENTATION OF ONE WAY TRAFFIC

**Table A3:** Traffic Data Provided by Previous Researchers

| Traffic Volume (Veh) | | |
|---|---|---|
| Date | | Total Volume |
| 29th March 2008 | (Saturday) | 13175 |
| 31st March 2008 | (Monday) | 15028 |
| 3rd April 2008 | (Thursday) | 14014 |

Source: Sharifah et al. (2014)

# APPENDIX B

## PHOTOS TAKEN DURING SURVEYS

**Figure B1:** Surveyors Conducting Traffic Volume Survey

**Figure B2:** Pedestrians Waiting to Cross the Road


**Figure B3:** Pedestrians Crossing the Road when the Traffic is Temporarily Clear