CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

In the initial stages of trying to produce this research paper, a few proposals were imposed and discussed. This research does not require any laboratory experiments but focus only on field study. Briefly discussed here are the methods used in preparing this research, which is cross-referenced with journals.

The prime method of the research is where general ideas and the basic conceptions of space rejuvenation will be defined. In terms of data collection, the information that is collected from various articles and journals including the data from the past to present conditions will be stated.

3.2 Selection of Site View

In an attempt to collect data from the stable flow conditions, the study was conducted in a site of the motorcycle path along the Federal Highway, Route 2, in the state of Selangor, Malaysia. There are many locations along the Federal Highway Route 2 that can be considered and taken as a site location. The preferable criteria for a location to be selected must have a good view in the efforts to tabulate data such as speed, flow rate and density.

The final location was selected based on a lane width of within 2.0m to 3.7m, roadway conditions such as geometrical factors, road furniture and existence of a straight road section of least 100m in length to enable riders to overtake confidently in
terms of the sample collected had to be well-distributed to give a true representation of riders. Figure 3.1 presents a detail overview of exclusive motorcycle lane along Federal Highway Route 2.

Figure 3.1: Overview of Exclusive Motorcycle Lane along Federal Highway Route 2
3.3 Selection of Site Location

In this study, three locations are selected as a suitable location of site. The locations selected include KM15.8 at Batu Tiga, KM30.7 at Sungai Way and the KM31.5 at Petaling Jaya, Selangor. Figure 3.2, figure 3.3 and figure 3.4 show the selected site at each location.

Figure 3.2 : Exclusive Motorcycle Lane at KM15.8 – Batu Tiga from Shah Alam, Selangor to Kuala Lumpur

Figure 3.3 : Exclusive Motorcycle Lane at KM30.7 - Sungai Way from Kuala Lumpur to Shah Alam, Selangor
Figure 3.4: Exclusive Motorcycle Lane at KM31.5 - Petaling Jaya from Shah Alam, Selangor to Kuala Lumpur
3.4 Data Collection Process

After choosing the location, the data were collected using video recording technique. One digital video recorder was set up at a high terrain near the study sites, to capture all traffic movements at specified time periods. This technique required two corresponding persons in the field in order to observe proper positions for video recording and install the video.

After that, the filming traffic operations captured on site were converted into (*.avi) format or (*.mpeg) format files. The video data was recorded for two hours where the first of one hour was during the peak hour and the second hour was during non-peaks. Besides that, the collection of video data was done on working days; Monday to Friday. Table 3.1 presents the detail of video data collection in this study.

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Time (Peak Hour)</th>
<th>Time (Non Peak Hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KM15.8 – Batu Tiga (Shah Alam, Selangor to Kuala Lumpur)</td>
<td>8.3.2010 to 12.3.2010</td>
<td>7.15 a.m. to 8.15 a.m.</td>
<td>9.45 a.m. to 10.45 a.m.</td>
</tr>
<tr>
<td>KM30.7 - Sungai Way (Kuala Lumpur to Shah Alam, Selangor)</td>
<td>15.3.2010 to 19.3.2010</td>
<td>7.15 a.m. to 8.15 a.m.</td>
<td>9.45 a.m. to 10.45 a.m.</td>
</tr>
<tr>
<td>KM31.5 – Petaling Jaya (Shah Alam, Selangor to Kuala Lumpur)</td>
<td>22.3.2010 to 26.3.2010</td>
<td>7.15 a.m. to 8.15 a.m.</td>
<td>9.45 a.m. to 10.45 a.m.</td>
</tr>
</tbody>
</table>

Besides that, site surveys on the exclusive motorcycle lanes were done as well. The aim is to get an overview of the situation at the site in terms of the facilities that has provided. It should be noted that the data were collected under good weather and dry pavements.

Other instrument used in this stage is the true meter where it is used to measure the length of road in the exclusive motorcycle lane. The data collection from a traffic flow may be presented in a several ways. It depends on the primary use of the data and the type of data reduction that conducted.
3.5 Data Extraction Process

This is the stage where the video recording was transferred to the computer. Computer software was used to extract all the parameters from the video recordings. Key parameters measured at the study were motorcycle volumes and individual motorcycle spot speed. The computer software used to produce all the parameters in this study is the Semi-Automatic Video Analyzer (Sava) Software.

In addition, the number of vehicles were measured and converted to the passenger car unit (PCU) in order to give the effect of an equivalent numbers of passenger cars on the capacity. Appendix A shows two set of data after the data reduction process that applied in this study.
3.6 Data Reduction Process

The *speed* (km/hr) is defined as the rate of movement of the vehicle. This parameter is obtained by measuring the time of vehicles that pass through an interval point on a lane over the selected distance. The sample calculation of measuring the speed is shown below;

Given, Distance = 100m
= 0.1km
Interval time = 4.00s
= \frac{3600 \text{ hr}}{4.00}

Therefore, Speed, \( v = \frac{(0.1 \times 3600)}{(4.00)} \)
= 90.00 km/hr

The *average speed* (km/hr) is defined as the arithmetic mean of all observed vehicles speeds. This parameter was obtained by sum of all spot speeds divided by the number of recorded speeds. The sample calculation of measuring the average speed is shown below;

Given, Speed Data

<table>
<thead>
<tr>
<th>66.45</th>
<th>47.37</th>
<th>56.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>40.91</td>
<td>57.31</td>
<td>67.39</td>
</tr>
</tbody>
</table>

Therefore, Average Speed, \( u = \frac{66.45+40.91+47.37+57.31+56.25+67.39}{6} \)
= 55.95 km/hr
The *density* (veh/km) is defined as the number of vehicles traveling over a unit length of road at an instant in time. This parameter was obtained by sum of all vehicles at the certain time divided by the selected distance. The sample calculation of measuring the density is shown below;

Given, No. of vehicles  = 7  
Distance  = 100m  
= 0.1km

Therefore, *Density*, \( K = \frac{7}{0.1} \)  
\[ = 70 \text{ veh/km} \]

The *density of direct flow* (veh/km) was obtained by sum of density divided by the number of recorded density at an instant in time. The sample calculation of measuring the density of direct flow is shown below;

Given, Density Data

<table>
<thead>
<tr>
<th></th>
<th>40</th>
<th>30</th>
<th>80</th>
<th>50</th>
<th>70</th>
</tr>
</thead>
</table>

Therefore, *Density of direct flow*, \( K = \frac{40 + 30 + 80 + 50 + 70}{5} \)  
\[ = 54 \text{ veh/km} \]
3.7 Data Analysis Process

Every data that was obtained from the reduction process were transferred and exported to Microsoft Excel Software. This software is used to determine the relationship between average speed and density of direct flow of motorcycle on the exclusive motorcycle lane. A graph of average speed versus density is created to show the relationship of this data.

To illustrate how well field data measurements match with the mathematical models, density and speed values were fitted using least-square regressions, which minimize the difference between the observed data and the relationship calibrated. Table 3.2 presents the four models of Single-Regime Models.

Table 3.2: The Model of Single-Regime Models

<table>
<thead>
<tr>
<th>No.</th>
<th>Model</th>
<th>Equations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Greenshields’ Model (1934)</td>
<td>( u = u_f - \left( \frac{u_f}{k_j} \right) . k )</td>
</tr>
<tr>
<td>2.</td>
<td>Greenberg Model (1959)</td>
<td>( u = u_o \ln \left( \frac{k_j}{k} \right) )</td>
</tr>
<tr>
<td>3.</td>
<td>Underwood Model (1961)</td>
<td>( u = u_f e^{-\left( k/k_o \right)} )</td>
</tr>
<tr>
<td>4.</td>
<td>Drake et al. Model (1967)</td>
<td>( u = u_f e^{-0.5\left( k/k_o \right)^2} )</td>
</tr>
</tbody>
</table>

Initial calibrations were made on speed-density relationships for two reasons. First, the structure of a speed-density curve is monotonically decreasing, and therefore involves simpler mathematical forms than flow-speed or flow-density curves. Secondly, this relationship denotes the most basic interaction of drivers and vehicles on highways [31, 32].
As a result of the linear relationship assumption, the Greenshields’ Model can be directly calibrated using least-square regression. However, a transformation process is required in calibrating non-linear relationships in the models proposed by Greenberg Model, Underwood Model and Drake et al Model.

Assuming that, the relationship is in fact in the form \( y = mx + c \), where \( y \) represents the dependent variable and \( x \) refers to the explanatory variable, the mathematical models can be equivalently expressed in the linear forms as shown in table 3.3.

<table>
<thead>
<tr>
<th>Model</th>
<th>Dependent variable, ( y )</th>
<th>Explanatory variable, ( x )</th>
<th>Intercept, ( a )</th>
<th>Slope, ( b )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenshields’</td>
<td>( u )</td>
<td>( k )</td>
<td>( u_f )</td>
<td>(- \frac{u_f}{k_j})</td>
</tr>
<tr>
<td>Greenberg</td>
<td>( u )</td>
<td>( \ln(k) )</td>
<td>( u_0 \ln(k_j) )</td>
<td>(- u_0)</td>
</tr>
<tr>
<td>Underwood</td>
<td>( \ln(u) )</td>
<td>( k )</td>
<td>( \ln(u_f) )</td>
<td>(- \frac{1}{k_0})</td>
</tr>
<tr>
<td>Drake et al.</td>
<td>( \ln(u) )</td>
<td>( k^2 )</td>
<td>( \ln(u_f) )</td>
<td>(- \frac{1}{2k_0^2})</td>
</tr>
</tbody>
</table>

Table 3.3: Equivalent Linear Forms of Single-Regime Models
3.8 Linear Regression Forms

The data analysis of average speed and density of direct flow were computed in comes up with a new macroscopic model. It was based on speed operation for the motorcycle lane. The Greenshields’ Model, Greenberg Model, Underwood Model and Drake et al. Model were selected for the model development.

The selected models help in developing a model of uninterrupted traffic flow. It can be predicted and explained the trends that are observed in real traffic flows. These models also are powerful where it can be derive relationships between average speed and density with linear regression graphically.

For the purpose of conducting this research, the overall framework in terms of the scope of works and this research method is illustrated in figure 3.5. The figure shows the steps and the process on how this research was conducted.
Figure 3.5: Scope of Work

PREPARATION
• Site Selection

SITE INVESTIGATION
• The three (3) different locations of the exclusive motorcycle lane along the Federal Highway Route 2.

PRELIMINARY FIELD WORK
• Prepare all of the equipments to be used.
• Familiarization with the equipment and the location.

FIELD WORK - apparatus
• Portable video camera & tripod
• Portable Battery Rechargeable
• Laptop with SAVA software
• True Meter

To compare the sensitivity of each model & recommended the suitable model of the traffic flow relationships based on the exclusive motorcycle lane.

Investigate the traffic flow relationships of speed and density of direct flow for road user on the exclusive motorcycle lane.

DATA ANALYSIS
• Establish the table that shows the average speed and density of motorcycle.
• Establish the graph during peak hour and non-peak hour.
• Establish the linear regression of each single-regime models to all locations.

REPORT
• Prepare the thesis & articles from data collection.

Investigate the traffic flow relationships of speed and density of direct flow for road user on the exclusive motorcycle lane.