INTERNATIONAL JOURNAL OF INTEGRATED ENGINEERING
ISSN: 2229-838X e-ISSN: 2600-7916

IJIE

Vol. 17 No. 7 (2025) 113-124
https://publisher.uthm.edu.my/ojs/index.php/ijie

Impact of Advanced Radar Technology on Traffic Volume and Speed Analysis in Urban Expressways at Klang Valley

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DOI: https://doi.org/10.30880/ijie.2025.17.07.012

Article Info

Received: 20 January 2025
Accepted: 9 August 2025
Available online: 23 December 2025

Keywords

Level of Service (LOS), traffic volume, speed, urban expressway, radar technology, peak hour

Abstract

Traffic congestion on urban expressways significantly affects individual productivity by impacting the time drivers spend on the road. Traffic performance, especially during peak hours, is influenced by the simultaneous presence of different vehicle classes. While research on the relationship between traffic volume and speed in congested areas is well-established, contemporary methods and advanced radar technologies, such as Speedlane Pro™ Counter Classifier, offer new insights. This advanced radar technology provides multiple options for gathering accurate traffic data, including traffic volume and vehicle speed, which are crucial for reliable studies. This research focuses on the Klang Valley Expressway in Malaysia, aiming to enhance the understanding of traffic congestion and its correlation with vehicle speed and volume. By calculating the Level of Service (LOS) and examining these parameters, the study aims to provide valuable insights for traffic management and planning. The findings will benefit communities concerned with traffic congestion, offering a basis for improving expressway efficiency and reducing the negative impacts of traffic delays.

1. Introduction

Malaysia's transportation infrastructure has experienced significant growth, with the urban expressway system serving as the main artery for national roads. The traffic flow on these expressways constantly fluctuates, resulting in congestion hotspots. In 2021, the total number of new vehicle registrations in each state was 1,192,592, representing a 2% increase from 1,169,201 in 2020. Traffic volume impacts vehicle speed, particularly during peak hours. Congestion duration refers to the time it takes for a congested event to clear, depending on its characterisation [1]. The country's economic and population growth also contribute to traffic congestion. The booming automobile industry, along with the transportation of goods by commercial vehicles, trailers, and trucks, contributes to the traffic load. Additionally, weather conditions and traffic congestion exacerbate the issue. Insufficient or inadequate public transportation, including scheduling issues and capacity limits, further contributes to traffic jams [2].

Traffic congestion in Malaysia is increasing due to the rising number of vehicles on the road. In 2014, 83.9% of Malaysian families owned at least one car, contributing to the growing population of road users. The Malaysian Highway Authority (MHA) predicts that four million cars will use Malaysia's motorways in one day. Expanding expressways has not alleviated traffic congestion, as peak-hour traffic volume continues to rise due to inadequate public transportation and road users sticking to the same routes [3].

This study aims to analyse traffic volume and speed on the urban expressways in the Klang Valley, focusing on whether vehicle volume affects speed during peak and off-peak hours. Vehicle speed and traffic volume are two parameters that can be used to analyse the causes of congestion. Volume refers to the number of cars on a specific stretch of road, while traffic volume refers to the number of vehicles travelling through a specific section of road or traffic lane in a given time. Distance and time are the two factors used in calculating speed. The objectives of this study are as follows: (i) To determine the Level of Service (LOS) during peak and off-peak periods on urban expressways; and (ii) To identify trends between traffic volume and vehicle speed during peak and off-peak periods on urban expressways.

The relationship between travel speed and traffic volume will be examined empirically, providing valuable insights for managing traffic congestion and suggesting corrective actions to increase traffic safety. The functional form of the speed-volume relationship also helps identify when congestion and incidents begin.

2. Literature Review

2.1 History of Traffic Data Collection

Traffic data collection has been a part of transportation networks since the 1930s and has evolved with technological advancements. Initially, manual counts were the primary method in the 1930s; however, by the 1940s, mechanical measurement techniques were introduced, thereby improving data integrity. The 1970s saw the advent of computerised pneumatic traffic counters, revolutionising traffic data collection. Today, technologies such as radars, video processing, and artificial intelligence (AI) continue to transform traffic data collection, making it more reliable and cost-effective. Despite these advancements, many traffic engineering agencies still rely on older, more expensive, and less reliable systems, such as manual data gathering and pneumatic tubes [4].

Traffic data collection aims to accurately represent an area's real-world traffic conditions. Traffic data can be gathered in various ways and from multiple sources. It helps calculate traditional traffic statistics, optimises traffic control signals, assesses service levels, and implements calming measures. Local transportation authorities and federal agencies use this data for road network planning, design, construction, and operation. Ultimately, traffic data collection and analysis are global efforts used to understand current traffic patterns and predict future trends.

2.2 Review of Relevant Studies

The methodology for data collection for traffic studies, along with the various traffic parameters measured (such as speed and volume) utilised by researchers in Malaysia, is presented in Table 1.

Table 1 *Chronological order by year on the methodology for traffic data collection and related measured traffic parameters*

Authors & Year	Type of Facilities	Area	Methodology Data Collection	Parameters			
				S	F	D	O
Roshandeh et al. [5], 2009	Two-lane highway	Sub-urban	Radar gun detector & traffic counter	√	√	n/a	*n/a*
Saifizul et al. [6], 2010	Two-lane highway	Rural	Weigh-In-Motion (WIM)	√	n/a	n/a	heavy vehicle
Leong & Awang [7], 2011	Two-lane highway, Multi-lane highway	Rural & Sub-urban	Laser gun detector	√	√	n/a	*n/a*
Mashros & Ben-Edigbe [8], 2014	Two-lane highway	Rural	Pneumatic tubes, electromagnetic loops & Automated traffic counter	√	√	√	weather condition
Che Puan et al. [9], 2014a	Two-lane highway	n/a	n/a	√	√	√	n/a
Che Puan et al. [10], 2014b	Two-lane highway	n/a	Global Position System (GPS) with Video Velocity VBox (VBox)	√	√	n/a	n/a
Abdurahman et al. [11], 2015	Two-lane highway	Rural	Video recording method	√	√	n/a	n/a
Hashim et al. [12], 2016	Expressway	Urban	Video recording method & extracted using TRAIS software	√	√	n/a	heavy vehicle

Authors & Year	Type of Facilities	Area	Methodology Data Collection	Parameters			
				S	F	D	O
Sanik et al. [13], 2017	Expressway	Urban	Video recording method & extracted using computer software	√	√	n/a	n/a
Leong & Muhammad [14], 2019	Four-lane, Six-lane, Freeway	Rural	Video recording method & extracted using image processing	√	√	√	headway
Leong et al. [15], 2019	Multi-lane highway,	Rural Suburban	Video recording method & extracted using computer software	√	√	√	n/a
Leong & Mohd Shafie [16], 2019	Two-lane, two-way highway,	Rural	Video recording method & extracted using computer software	√	√	n/a	headway
Leong et al. [17], 2020	Multi-lane highway,	Rural Suburban	Video recording method & extracted using computer software	√	√	n/a	n/a
Mohd Azwari & Kadar Hamsa [18], 2021	Expressway	Urban	Radar gun detector	√	√	n/a	n/a

n/a = information was not provided.
S = Speed; F = Flow; D = Density; O = Others

Table 1 shows various methods for collecting traffic data. The methods can be grouped into three categories; (i) handheld, manually operated instruments that are portable and may be utilized almost anywhere, e.g., stopwatch, radar gun, and laser gun; (ii) in-road devices that are placed into or on top of the road surface, e.g., pneumatic road tube; (iii) out-of-the-way devices that are located above or to the side of the highway, e.g., radar recorders. Each method has various benefits and disadvantages for gathering and interpreting data, which should be considered when deciding which device to use in a particular setting.

According to Stinson ITS [19], the technologies used to collect traffic data are categorised into intrusive and non-intrusive methods. Intrusive devices are any traffic data-gathering equipment that needs installation on or under the roadway's surface. For installation and maintenance, traffic lanes must be closed. At the same time, the non-intrusive devices are traffic data-gathering devices that do not need installation on or under the roadway's surface. These devices are often fixed on poles built near the shoulders or medians, and they seldom need road closures for installation or maintenance. Wisconsin Statewide Speed Management [19] summarises the comparison of traffic data collection methods in Table 2.

Table 2 *Comparison of traffic data collection methods*

Instruments Methods	Parameters	Advantages	Disadvantages
Radar Recorders	Spot speed / instantaneous speed, traffic volumes, vehicle class, traffic flow gaps	Data collection and tabulation involve little effort; Capable of collecting data over extended periods of time; Other traffic-related data may be obtained concurrently.	The user cannot select vehicles at random for the dataset. Some sensors may not gather data correctly for multi-lane highways or establish the directionality of observed cars. Equipment-intensive technique; Required maintenance/calibration.
Pneumatic Road Tube	Spot speed / instantaneous speed, traffic volumes, vehicle class, traffic flow gaps	Little work is required to gather and tabulate data; data can be collected over extended periods, and other traffic-related data can be managed concurrently.	Visible to the general public, which may influence driving behavior; The user cannot choose automobiles randomly for the data set. When snowploughs are present, use is discouraged. The most resource-intensive approach; Requires maintenance and calibration.
Laser Gun	Spot speed / instantaneous speed.	Compared to radar, the equipment is readily portable; the user controls the vehicles sampled since a more concentrated laser beam restricts the readings for non-target vehicles.	The cosine error restricts horizontal and vertical deployment. Scopes and sights may be challenging to operate. Laser beams are more sensitive to environmental changes than radar beams. Required maintenance and calibration.

Instruments Methods	Parameters	Advantages	Disadvantages
Radar Gun	Spot speed / instantaneous speed.	The equipment is conveniently transportable; the user controls the vehicles being sampled. Method for collecting accurate data. The widespread availability of equipment has reduced its cost.	Cosine error limits vertical/horizontal deployment. Closely spaced and heavier cars may generate readings for unintended vehicles. Required maintenance/calibration
Stopwatch	Speed (travel time over distance)	There is little equipment to purchase and maintain; the data collection procedure is straightforward.	Labour-intensive; gathers time data that must be transformed to speed data; often has poor precision.

Referring to Table 2 above, the varied instrumental methods were assessed for their advantages and disadvantages in traffic data collection techniques. In urban expressway zones, gathering, monitoring, and analysing traffic data pose significant challenges owing to the dense traffic flow amidst rapid urban development, which impacts driver behaviour, vehicle conditions, and road characteristics, consequently influencing operational traffic performance. Consequently, the approach to gathering, monitoring, and analysing traffic data in urban locales may differ from previous studies. According to Syed Abbas et al. [20], modern radar technology, which provides comprehensive traffic information in real-time and delivers accurate measurement results, underscores the significance of new methodologies for traffic data collection that are equally beneficial to other experts in the field.

3. Methodology

3.1 Methodological Framework

This study utilised an advanced radar technology device, known as the Speedlane Pro™ Counter Classifier, to gather traffic data for specified parameters on multi-lane urban expressways, utilising cutting-edge radar technology. Traffic data collection aims to obtain data that accurately depicts the area's actual traffic situation. Data was collected at one of the Klang Valley's urban expressways during both peak and off-peak hours. The study will be conducted over three working days, with peak times between 7:00 AM and 8:00 AM and off-peak times between 9:00 AM and 10:00 AM. Modern radar technology provides comprehensive traffic information in real-time with accurate measurement results, making the new methodology for gathering traffic data equally important for other experts.

Fig. 1 illustrates the flowchart for achieving Objective 1: to determine the Level of Service (LOS) during both peak and off-peak periods on urban expressways. Fig. 2 illustrates the flowchart for achieving Objective 2: to identify trends in traffic volume and vehicle speed during peak and off-peak periods on urban expressways.

3.2 Setup of the Advanced Radar Technology

Operating 24 hours a day, seven days a week, the device captures data for each vehicle lane, including speed, vehicle classes, volume, occupancy, gap data, average speed, 85th percentile speed, and headway. This device employs a sophisticated target-tracking approach, built on a proprietary algorithm, that simultaneously identifies, measures, and tracks multiple targets. Additionally, it is equipped with pre-configured " application filters " to enhance performance for a range of applications. Fig. 3 shows the flowchart of the device setup on the urban expressway.

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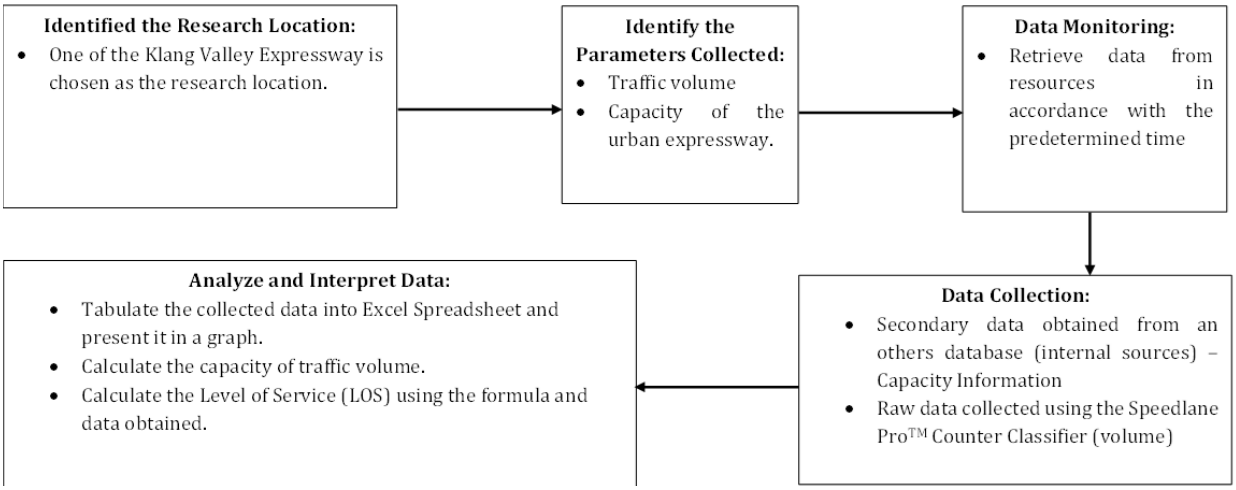

Fig. 1 *Flow chart for achieving objective 1*

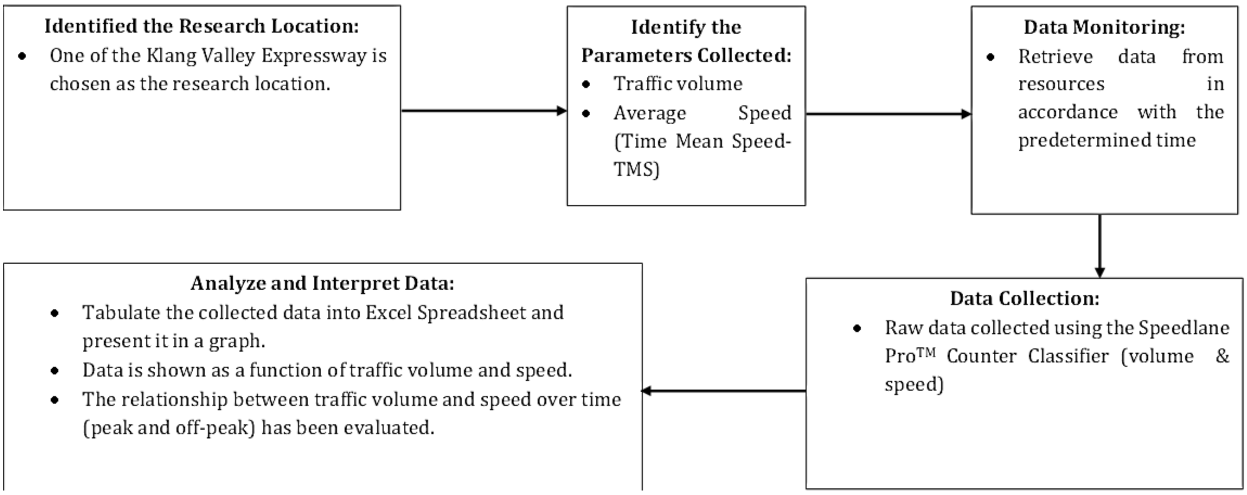

Fig. 2 *Flow chart for achieving objective 2*

Step 1: Select an appropriate location and mounting height

Chose a mounting site where it can best comply with the height and setback guidelines by choosing a location with at least a 20-foot (8-meter) setback but no higher than 18 feet (6m). The radar will work with as little as 6 feet (2m) setback.

↓

Step 2: Preparation to install the SpeedLane™ Pro

- To secure the SpeedLane to the pole, make sure you have steel banding straps that are 0.75" (19 mm) wide (or less).
- Find the 3/16" allen key that is included and use it to loosen the clamp brackets just enough to allow you to turn the tube by hand. When fully tightened, the clamps are made to hold the tube firmly without crushing it.
- Powered the device by finding a suitable +12VDC nominal (28VDC maximum) power source that can deliver 2.5 Watts or more (or 0.21 Amps).
- Installed the provided Houston Radar StatsAnalyzer software on a Windows laptop or PC.

↓

Step 3: Power ON and verify proper connection while still on board

- Turned on the radar and gave it around 45 seconds to fully boot up. Click File->Connect to Radar after starting Houston Radar StatsAnalyzer (or Houston Radar Configuration tool) software.
- Ethernet or Bluetooth are both options for connection. Select "Auto Detect Port" or the port number for the serial port or Bluetooth connection if using Bluetooth, and then clicked "Connect." If using Ethernet, pull down the "Connect to Radar On" list and choose the "Local Network" option.

↓

Step 4: Adjustment and set up Speedlane™ Pro

- Attached the pole mounting bracket to the mounting plate if you're mounting the SpeedLane to a pole. The bracket's level adjustment feature is intended to make up for a pole that is tilting to one side.
- In order to adjust the level while seeing the video/photos from the on-board camera and gyroscope level readings in the wizard, if necessary, gently loosen the bolts before strapping to the pole.

↓

Step 5: Setup your external router/modem/Tetryon Server connection if required

Fig. 3 *Steps for the setup of the advanced radar technology*

According to the Device Manual [21], the advanced radars are generally installed in side-firing configurations that face traffic. For instance, a radar beam positioned at 90 degrees to the road covers one or more lanes. This mode must be used to detect traffic moving at typical highway speeds and accurately measure speed. In this configuration, vehicles moving at highway speeds are detected briefly as they cross the beam, with their velocity being primarily tangential (at a right angle to the beam) and having a negligible radial component.

3.3 Level of Service (LOS) of Multilane Urban Expressway

As per the Malaysian Highway Capacity Manual (MHCM) 2011 [22], the operational status of a road is determined by its Level of Service (LOS). LOS is calculated by dividing the traffic volume on a road by its capacity (v/c ratio). LOS is categorised from A to F, where A indicates optimal operating conditions and F denotes the worst. Table 2 outlines the LOS definitions according to Arahan Teknik Jalan 8/86 (Amendment 2015) [23] and MHCM 2011.

To determine the v/c ratio for the current level of service, road capacity is assessed based on factors such as road gradient, number of lanes, and presence of traffic interruptions (such as signalised junctions), among others. The primary goal of capacity analysis is to estimate the maximum traffic volume that different road sections can accommodate. The formula for calculating the LOS is depicted below:

$$LOS = \frac{V}{C} \tag{1}$$

where V is the maximum hourly traffic volume in pcu, and C is the maximum hourly capacity in pcu.

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Table 3 *Level of services definition based on the Malaysian Highway Capacity Manual (MHCM, 2011) [21], [22]*

LOS	Status	Remarks	Ranges of Volume/Capacity (v/c) Ratio		
			Collector/Ramp (FFS=60km/h) 1,800pcu/hr/ln	Arterial (FFS=70km/h) 1,900pcu/hr/ln	Arterial (FFS=80km/h) 2,000pcu/hr/ln
A	Free flow	Free Flow with individual users virtually unaffected by the presence of other vehicles in the traffic stream. This is a condition of free flow, characterised by low volume and high speed of vehicle travel on highways.	0.00 – 0.23	0.00 – 0.25	0.00 – 0.28
B	Stable flow with a slight delay	Stable traffic flow with a high degree of freedom to select speed and operating conditions, but with some influence from the other users.	0.24 – 0.37	0.26 – 0.39	0.29 – 0.42
C	Stable flow with acceptable delay	Restricted flow that remains stable but with significant interaction with others in the traffic stream. The general level of comfort and convenience decline is noticeable at this level. Speed and manoeuvrability are closely controlled by higher volume. Most drivers are restricted in their freedom to select their speed, change lanes, or pass.	0.38 – 0.53	0.40 – 0.56	0.43 – 0.60
D	Approaching unstable flow with tolerable delay	High-density flow in which speed and freedom to manoeuvre are severely restricted, and comfort and convenience have declined, even though flow remains stable. This level represents unstable flow, with the operating speed being maintained, although considerably affected by changes in operating conditions.	0.54 – 0.73	0.57 – 0.74	0.61 – 0.81
E	Unstable flow	Unstable flow at or near capacity levels with a poor level of comfort and convenience. This level represents operation at a lower operating speed with volume at or near the capacity of the highways. Flows are unstable and stoppage may occur for a momentary duration.	0.74 – 1.00	0.75 – 1.00	0.82 – 1.00
F	Forced Flow	Forced traffic flows in which the amount of traffic approaching a point exceeds the amount that can be served. LOS F is characterised by poor time travel, low comfort, convenience, and increased accident exposure. This condition describes a forced flow operation at low speed where volumes are below the capacity. Speed is substantially reduced, and stoppages may occur for short or extended periods due to the condition of downstream traffic.	≥ 1.00	≥ 1.00	≥ 1.00

3.4 Capacity of the Multi-Lane Urban Expressways

In traffic engineering, "capacity" refers to the maximum number of vehicles or individuals that a transportation infrastructure, such as a road, intersection, or highway lane, can accommodate within a specific time frame. This foundational concept is utilised to analyse and design transportation systems, assess their efficiency, and make informed decisions regarding traffic management and infrastructure enhancements. Factors such as the number of lanes, lane width, intersections, traffic signals, speed limits, and auxiliary lanes (e.g., acceleration and deceleration lanes) all influence road and highway capacity.

The term "passenger car unit" (pcu) is commonly employed to quantify capacity. Under ideal conditions, the potential capacity for uninterrupted flow per lane in a multi-lane scenario is 2000 pcu/hr. In this study, the number of lanes on an urban expressway is multiplied by the hourly passenger vehicle units (PCU) based on the PCU equivalent factors from the MHCM 2011, with PCU factors conforming to the urban expressway standards outlined in Table 4.

4. Results and Discussion

4.1 Level of Service During Peak Hour and Off-Peak at Urban Expressway

The Level of Service (LOS) for urban expressways during peak hours is shown in Table 5, categorised as D and E. LOS C indicates heavy traffic, nearing the route's maximum capacity but still allowing for smooth flow. Congestion is light to moderate, with brief delays during rush hours or at bottlenecks. The worst category, E, is characterised by unstable flow. LOS D typically results in slower vehicle speeds compared to free-flow conditions, with mild congestion or brief slowdowns, leading to significantly longer travel times.

Table 6 shows the Level of Service (LOS) for urban expressways during off-peak hours. LOS A occurs during these times, with both eastbound and westbound lanes indicating free movement due to minimal traffic and ample space for vehicles. Travel times are short, and speeds are often near or at the posted speed limit. The low traffic density and sufficient space between cars provide good driving conditions. Overall, LOS A has no congestion and no noticeable delays or slowdowns in traffic.

Table 5 *Level of service during peak hour*

Day/Date	Traffic Volume (pcu/hr) Peak Hour (7:00 AM – 8:00 AM)		Capacity (pcu/hr)	Level of Services (LOS)			
	East Bound (EB)	West Bound (WB)		EB V/C	LOS	WB V/C	LOS
Monday (20/03/2023)	6879	7124	8000	0.860	E	0.891	E
Tuesday (21/03/2023)	6399	6322	8000	0.800	D	0.790	D
Wednesday (22/03/2023)	5708	7539	8000	0.714	D	0.942	E

Table 6 *Level of service during off-peak hour*

Day/Date	Traffic Volume (pcu/hr) Off-Peak Hour (9:00 AM – 10:00 AM)		Capacity (pcu/hr)	Level of Services (LOS)			
	East Bound (EB)	West Bound (WB)		EB V/C	LOS	WB V/C	LOS
Monday (20/03/2023)	1565	1473	8000	0.196	A	0.184	A
Tuesday (21/03/2023)	858	1859	8000	0.107	A	0.232	A
Wednesday (22/03/2023)	1654	2062	8000	0.207	A	0.258	A

4.2 Relationship Between Speed of Vehicles and Traffic Volume During Peak Hour and Off-Peak at Urban Expressway

4.2.1 Peak Hour at Urban Expressway

Fig. 4 and Fig. 5 below illustrate that the speed of vehicles decreased due to the increasing traffic volume on March 21, 2023. The number of vehicles on the road rises dramatically in the early morning hours as many individuals commute to work or school. This time, there is typically more traffic because of the rush of commuters. Consequently, the roadways can no longer accommodate the growing number of automobiles.

According to Fig. 4, which depicts eastbound traffic, the peak hour occurs at minute 55. In contrast, Fig. 5 shows that the peak hour for westbound traffic occurs at minute 25. Congestion on the road happens when there are more vehicles than the road can handle. As a result, vehicles slow down and occasionally come to a complete stop. Traffic flow decreases as traffic volume increases. Highway ramps, intersections, and other bottlenecks may not be able to handle the increased volume of traffic, resulting in restricted flow and slower speeds.

4.2.2 Off-Peak Hour at Urban Expressway

The graph illustrates the relationship between Tuesday's traffic volume and vehicle speed, as shown in Fig. 6 and Fig. 7. The figures indicate that as traffic volume decreases, vehicle speeds increase. In Fig. 6, it can be seen that from minute 30 to minute 60, the volume of traffic begins to decline, and vehicle speeds start to rise. Meanwhile,

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Fig. 7 shows that although the vehicle speed is inversely related to traffic volume, the traffic volume starts to fall at the 30th minute and continues to decrease until the 45th minute. This condition arises because the urban expressway experiences less congestion and fewer traffic jams during off-peak hours when there are fewer vehicles on the road. The absence of long lines, which normally cause vehicles to move more slowly, allows for greater freedom of movement. Overall, the flow of traffic typically improves when traffic volume declines.

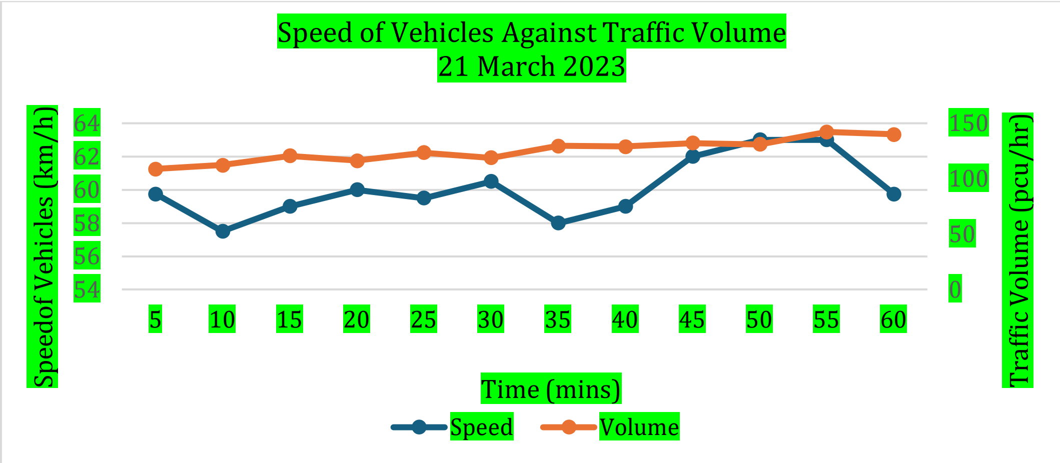

Fig. 4 *Speed of vehicles vs traffic volume of east bound on Tuesday (7:00 AM – 8:00 AM)*

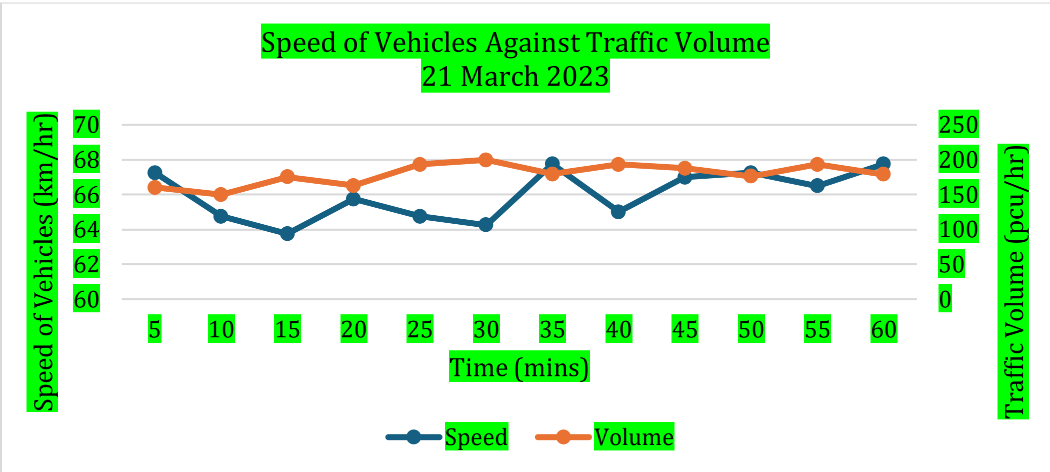

Fig. 5 *Speed of vehicles vs traffic volume of west bound on Tuesday (7:00 AM – 8:00 AM)*

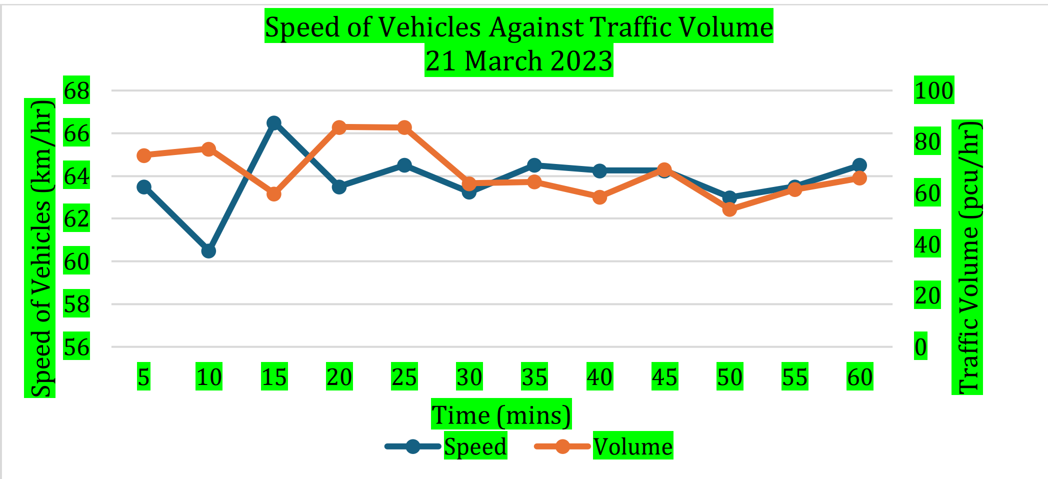

Fig. 6 *Speed of vehicles vs traffic volume of east bound on Tuesday (9:00 AM – 10:00 AM)*

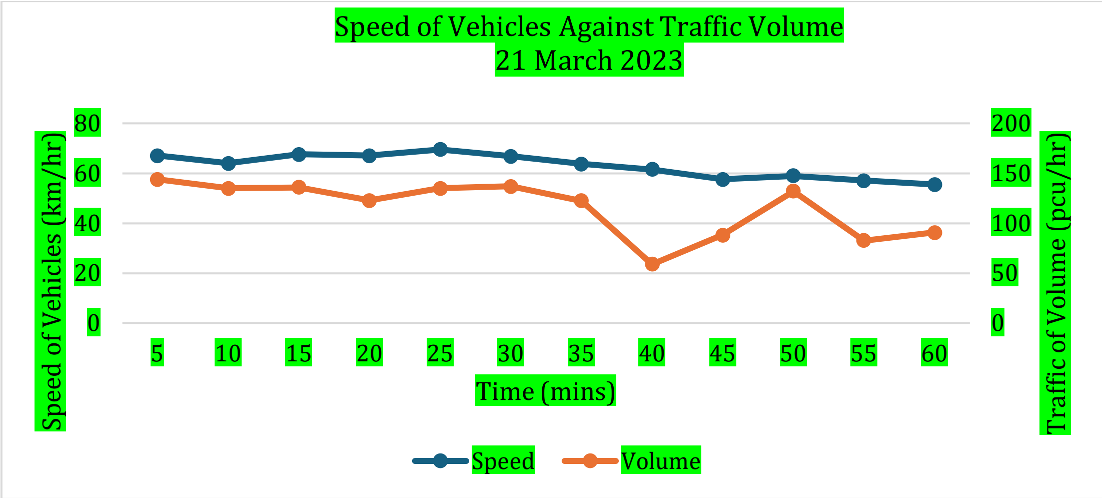

Fig. 7 *Speed of vehicles vs traffic volume of west bound on Tuesday (9:00 AM – 10:00 AM)*

5. Conclusions

This study successfully achieved its objectives by analysing traffic volume and speed on urban expressways in the Klang Valley, focusing on how vehicle volume affects speed during peak and off-peak hours. The investigation highlighted that vehicle speed and traffic volume are critical parameters in understanding the causes of congestion. We gathered valuable insights by examining the number of vehicles on specific road sections and calculating speed using distance and time.

Our empirical examination of the relationship between travel speed and traffic volume provided crucial data for managing traffic congestion and proposing corrective measures to enhance traffic safety. The identified speed-volume relationship's functional form is instrumental in pinpointing the onset of congestion and incidents, thereby aiding in the development of more effective traffic management strategies. The findings from this study offer significant contributions to the ongoing efforts to improve traffic flow and safety on urban expressways in the Klang Valley.

6. Recommendation

Several recommendations are proposed to manage and improve traffic conditions on urban expressways, based on an analysis of traffic volumes and vehicle speeds during both peak and off-peak hours. Enhancing traffic signal timings using adaptive signal control technologies can significantly improve traffic flow during peak hours. Promoting alternative transportation methods, such as public transit, cycling, and walking, and developing dedicated bus and bicycle lanes can reduce congestion. Investigating transportation demand management projects, including congestion pricing, high-occupancy vehicle (HOV) lanes, and dedicated parking spaces for carpoolers, will help reduce the number of single-occupancy vehicles during peak times.

Increasing roadway capacity by adding new lanes, improving existing infrastructure, and constructing bypasses or alternative routes where feasible can help alleviate congestion. Encouraging flexible work schedules and telecommuting options can stagger commute times, reducing peak-hour traffic. Providing incentives for carpooling, such as reduced toll fees, preferential parking, access to HOV lanes, and public awareness campaigns, can further promote carpooling and alternative transportation methods.

Educating the public on the benefits of these methods and implementing regular monitoring and evaluation of traffic patterns will ensure the effectiveness of these measures. By adopting a multifaceted approach, including infrastructure improvements, policy changes, and public awareness, traffic congestion can be effectively managed, leading to a safer, more efficient, and more enjoyable transportation system.

Acknowledgement

This research was funded by Universiti Teknologi MARA (UiTM) and Kreatif Apps Sdn. Bhd., under the University-Industry Collaboration (UIC 2021) grant project. RMI File No: 600-TNCPI 5/3/DDF (FKA) (008/2021) & 100-TNCPI/PRI 16/6/2 (031/2023).

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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Author Contribution

The authors confirm contribution to the paper as follows: ***Study conception and design:*** *Syed Khairi Syed Abbas;* ***data collection:*** *Amin Nurliyana Mat Yusoff and Adi Yazid Rosli;* ***Analysis and interpretation of results:*** *Syed Khairi Syed Abbas and Amin Nurliyana Mat Yusoff;* ***Draft manuscript preparation:*** *Syed Khairi Syed Abbas, Jezan Md Diah and Muhammad Akram Adnan. All authors reviewed the results and approved the final version of the manuscript.*

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