ESTABLISHMENT OF PASSENGER CAR UNIT (PCU) VALUES FOR URBAN INTERSECTIONS USING DRONES

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DECLARATION OF THE CANDIDATE AND THE SUPERVISOR

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Abstract

The Passenger Car Unit (PCU) serves the purpose of transforming diverse traffic conditions into a consistent traffic flow rate during the planning of roads and intersections. The influence stemming from a mixed traffic environment, particularly prevalent in developing nations, distinguishes it from parameters utilized in analogous countries. Furthermore, the specificity of each country is heightened by considerations such as vehicle operating characteristics, road-related parameters, and environmental conditions. Given that the Passenger Car Unit (PCU) factors presently employed in Sri Lanka have surpassed two decades and thus may be deemed outdated, there is a compelling need for a comprehensive revision to formulate a contemporary set of PCU factors reflective of the current context. In general, the pragmatic challenges entailed in data collection and the intricate nature of methodologies have impeded the timely execution of such revisions, particularly within the context of developing countries. Nevertheless, recent studies have been conducted to discern suitable Passenger Car Unit (PCU) factors for both four-lanes and two-lanes in Sri Lanka; however, comparable investigations for intersections remain absent.

The utilization of drones for traffic engineering purposes is increasingly prevalent, and it has demonstrated efficacy in overcoming various challenges encountered in the field. Notably, the adoption of drones has addressed longstanding impediments, including cost considerations associated with data collection through multi-video cameras and human observers, along with the provision of requisite facilities. Moreover, the application of drones has significantly mitigated practical difficulties inherent in the data collection and processing phases of traffic engineering activities. The precision of video footage is notably enhanced when captured from a stable bird's eye view perspective. Consequently, unmanned aerial vehicles, commonly known as drones, have proven to be efficacious in diverse applications within the domain of traffic engineering. The primary aim of this research is to formulate a methodology for the derivation of Passenger Car Unit (PCU) factors through the analysis of drone-captured videos.

Within the scope of this investigation, the area occupancy of distinct vehicle categories under diverse traffic compositions is juxtaposed against conditions characterized by exclusively passenger cars, all operating at equivalent stream speeds. Recognizing the capability of video-based traffic data to furnish precise insights into vehicle dynamics and associated characteristics, the study employed drone-captured videos to meticulously gather traffic data at a designated intersection. Addressing challenges associated with drones, including limitations such as brief flight durations, susceptibility to adverse weather conditions, and potential wireless connectivity issues, this study employed the Basic Headway Method. The objective was to formulate a comprehensive framework for calculating Passenger Car Unit (PCU) factors. The developed method was subsequently applied to derive PCU factors for a total of ten distinct vehicle categories.

The scope of this study is confined to the establishment of Passenger Car Unit (PCU) factors exclusively for intersections, with a specific focus on informing traffic signal design. Nevertheless, given the demonstrated precision of the proposed methodology and its associated practical advantages, characterized by cost-effectiveness and simplified data collection procedures, there exists a considerable prospect for extending this method to ascertain PCU factors for various other road segments, including arterials, highways, and freeways, in future applications.

Keywords: *PCU, intersection, drone, signal design*

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LIST OF ABBRIVIATIONS

Abbreviation	Description
TRB	Transportation Research Board
PCU	Passenger Car Unit
HCM	Highway Capacity Manual
PCE	Passenger Car Equivalent
PC	Passenger Car
PCS	Passenger Car-Small
VN	Van
MC	Motor Cycle
TW	Three Wheeler
MB	Medium Bus
LB	Large Bus
SCV	Small Commercial Vehicles
MCV	Medium Commercial Vehicles
LCV	Large Commercial Vehicles
TO	Through Only
RO	Right Turn Only

1. INTRODUCTION

1.1 General Background

The challenges of urban transportation are familiar not only to traffic engineers but also to the general public. The bottlenecks in urban transportation systems have arisen due to cities not being planned and constructed to accommodate the current population volume they house. Traffic comprises both bidirectional freedom vehicles, such as two or three-wheeled vehicles, and unidirectional vehicles, such as four-wheelers, coexisting with various traffic modes. (Bajad M.N., Yogeshwari Ghule, 2016)

The escalation in traffic volume at intersections has resulted in issues such as road accidents, conflicts, and congestion. Addressing these challenges entails implementing effective traffic signal control at intersections to facilitate the continuous and efficient flow of vehicles. Crucial to this is the timing of traffic signals, determining the duration of the green light for vehicles and the pedestrian walk signal. Conducting traffic volume studies is imperative to ascertain the quantity, movement, and classification of vehicles at a specific location. These studies yield data that are instrumental in understanding the regular traffic flow and assessing the impact of heavy vehicles or pedestrians on vehicular traffic volume.

With the development of the transportation sector, all countries must cater to various vehicle categories' needs. They were different from the main operation & dimensions. (Hossain., 1999)

The variation in the physical & operating characteristics of various classes of vehicles interacting along a road poses numerous challenges for traffic engineers and planners in mixed traffic conditions. The adoption of a prevalent practice involves the transformation of all vehicular entities into a common unit defined as a passenger car unit (PCU). This study is implemented to overcome the issues in both the static and dynamic characteristics. Typically, the manifestation of this metric is articulated in terms of passenger car units (PCU) per hour. Passenger car units (PCUs) have been consistently employed in the fields of traffic and highway design and planning. Their utilization extends to the estimation of road capacity and the prognostication of forthcoming traffic volumes. (Board T. R., 2000)

In contemporary times, a broader range of vehicles is produced, with some featuring automatic transmission and others utilizing a combination of electric and fuel power (hybrid vehicles). The driver's conduct, the attributes of roadways, and the composition of traffic significantly differ from the conditions prevailing during the derivation of the current PCU values in 1998. Hence, it is possible that the existing PCU factors may not accurately represent the contemporary conditions of roadways and traffic. (Fan., 1990)

The computation of Passenger Car Units (PCU) for diverse vehicle categories involves the utilization of a standard passenger car as a reference point. However, it is noteworthy that Sri Lanka exhibits a broad spectrum of passenger car types currently in active operation. Vehicles categorized as hatchbacks and sedans comprise the spectrum of passenger cars traversing Sri Lankan roadways. Henceforth, it is imperative to delineate the specific characteristics of the standard passenger car. (Kumarage, 1996)

The majority of current analytical approaches relying on field data are constrained by an underlying assumption of homogeneity, which deviates significantly from the diverse variations in driver and vehicle characteristics present in mixed traffic conditions. (Sheela Alex, Kuncheria P. Isaac, 2015)

In developed countries, cars constitute 70-80% of the traffic flow. In Sri Lanka, it is only around 20-30%. Thus, the correctness of the factors given for the non-car vehicles is much more important in Sri Lanka. (Kumarage, 1996). Therefore, the accuracy of the PCU factors is generally an essential aspect, of particular prominence is the heightened significance observed in developing nations, notably exemplified in the case of countries such as Sri Lanka, which have a very high proportion of non-car vehicles. By the variation of the proportion of non-car cars, the PCU factor may updated according to its conditions. Also, there shall be an easily applicable method for updating the PCU factors frequently.

Sri Lanka's roads accommodate diverse traffic, featuring various traffic modes with distinct physical dimensions, contributing to the heterogeneity of the road space. Unacceptable practices encompass driver behaviour, lax lane discipline, and inadequate adherence to proper car-following protocols. Also, the vehicle speed varies due to vehicle characteristics and driver perspective differences. Most vehicles tend to adopt a trajectory that appears more advantageous rather than strictly adhering to marked lanes. (Kumaratunga P.C.I, 2018)

Considering the above, it complicates the computing of PCU using multiple heuristic techniques. Numerous international studies have been conducted to ascertain passenger car unit (PCU) values across diverse vehicle types, taking into account a range of road and traffic conditions.

Prior investigations have conclusively demonstrated that the passenger car unit (PCU) is a dynamic parameter, subject to variations influenced by both traffic and geometric conditions. Numerous scholars have proposed diverse methodologies for the computation of PCU values, relying on alterations in key performance metrics, including but not limited to headway, density, speed, travel time, delay, vehicle hours, and queue discharge. (Sheela Alex, Kuncheria P. Isaac, 2015)

It is also observed that with the variation of the performance measures, it is required to update PCU Values frequently to include them in a proper traffic flow analysis. Considering all the performance measures, it is not easy to update the PCU frequently, though it makes a high cost such as data collection & analysis. (Chandra, 1995)

To overcome these issues, it is required to develop a methodology to evaluate the PCU values. The developed method shall be easily adapted to the situation and the various Locations.

The calculation of PCU values for diverse vehicle categories was conducted using a standard passenger car as the reference point. Presently, PCU values were derived by the Road Development Authority more than 22 Years ago. (RDA, 1998)

More than 95% of A, B Class roads are paved asphalt roads. In earlier epochs, the quality of road surface conditions did not meet the contemporary standards of improvement observed today. Furthermore, routine maintenance practices had not been consistently implemented up to the present time.

Compared to Vehicle Population statistics in Sri Lanka, the total vehicle population has increased by more than 100% in the registration of different vehicle classes (Traffic, 2017). When evaluating vehicle characteristics, it is noteworthy that contemporary vehicles exhibit different traits compared to the time when the analysis of PCU factors was conducted. As an example, dimensions, power, acceleration capacity, breaking capacity, etc, have considerable variations compared to the situation 20 years ago. (Chandra, 1995)

The number of reported accidents due to driver behaviour rapidly increased from 1998 to 2007 (Prasanjana.C. K, 2014). In the context of driver behaviour, there exists a notable departure from past practices. Presently, drivers are inclined to exploit situations with relaxed lane discipline.

Under the increment of the population, traffic flow characteristics vary, which mainly affects the PCU values such as pedestrian volume, traffic volume, stream composition, and main stream speed. (Traffic, 2017)

In this context, the focus is on assessing the validity of the presently employed PCU values or whether revisions are necessary for signalized intersections in the presence of heterogeneous traffic conditions.

1.2 Objectives

The precise aim of this investigation is to ascertain the passenger car unit (PCU) factors for several types of vehicles at signalized intersections, employing a method of PCU factor determination that is both accurate and cost-effective, allowing for frequent revisions with minimal resource requirements.

In other words, we are developing a sustainable PCU factor determination process for all types of vehicles in signalized intersections and roundabouts.

1.3 Problem Statement

Compared to the last PCU values revision in Sri Lanka, there is a considerable variation in the technical and physical aspects of current manufacturing vehicles, which mainly affects the PCU Value. (eg. Dimensions, Electric/Hybrid Power etc). Additionally, there exists a significant disparity in both road characteristics and traffic flow/mix compared to the conditions prevalent during the derivation of the current PCU values in 1996.

Therefore, available PCU factors do not reflect the present roadway and traffic conditions. The PCU factors needed to be updated to adhere to the current Sri Lankan Context.

1.4 Scope of the Report

Chapter 1 : Introduction

Chapter 2 : Literature Review

Chapter 3 : Methodology and Data Collection

Chapter 4 : Analysis and Discussion

Chapter 5 : Conclusions, Recommendation

2. LITERATURE REVIEW

Varied traffic compositions and uniform traffic conditions demand distinct planning tools to discern the factors that distinguish heterogeneous traffic flow from its homogeneous counterpart.

Furthermore, a substantial disparity is discernible in the characteristics of traffic flow. The exclusive means of rectifying this lack of uniformity is the standardization into a common unit. The Passenger Car Unit (PCU) value assigned to a vehicle is subject to variations contingent upon the prevailing conditions of both traffic and the roadway. (RDA, 1998)

The transport and road research laboratory (TRRL) has defined the passenger car unit (PCU) value as follows: In a defined road segment under extant traffic conditions, the introduction of a particular single vehicle per hour results in a commensurate reduction in the mean speed of the other vehicles. This effect is comparable to the consequence of integrating a specified number, denoted as n, of average-sized cars per hour. Consequently, one vehicle of the specified type is deemed equivalent to n PCU. In instances involving bottlenecks, particularly at intersections, if a particular vehicle type necessitates n times the duration at the intersection under saturated conditions compared to the time required for a standard car, then said vehicle type is assigned an equivalence of n PCU. (Kumarage, 1996)

Numerous references provide detailed explanations of diverse methodologies employed to ascertain Passenger Car Unit (PCU) values applicable to various vehicle types.

a) Methods Based on Headway (Greenshields B.D., 1947), (Werner, A., and Morrall, J., 1976), (Seguin. E., 1982), (Cunagin. W. D., 1982), (Krammes. R., 1986),
b) HCM Method (Cunagin. W. D., 1982)
c) Methods Based on Travel Time (Keller., 1984)
d) Methods Based on V/C Ratio (Fan., 1990)
e) Methods Based on Speed (Chandra, 1995), (Van Aerde., 1983)
f) Methods Based on Vehicle hours (Sumner., 1984)
g) Methods Based on Flow Rate and Density (John., 1976), (Huber., 1982),

h) Methods Based on Delays (Werner, A., and Morrall, J., 1976), (Craus J., 1980),
i) Methods Based on Queue Discharge Flow (Ahmed Al-Kaisy, 2004),

The majority of these techniques were designed specifically for multilane highways, and several approaches were also applied in the context of road intersections.

2.1 Methods Based on Headway

Headway, whether quantified temporally or spatially, functions as an indicator of a vehicle's spatial occupancy. (Greenshields B.D., 1947) The PCU value was assessed using the equation, and this approach is recognized as the fundamental headway method.

$$PCU_i = H_i/H_c$$

Where, PCU_i = Passenger car unit of vehicle type
H_i = Average headway of vehicle type
H_c = Average Headway of passenger car

(Werner, A., and Morrall, J., 1976) Advocates for the establishment of passenger car units (PCU) through the utilization of headway measurements in situations where the roadway experiences significant congestion on flat terrain.

This basic headway method was only considered the average headway between vehicles. It did not account for the effect of the stream & roadway characteristics which are the main effecting factors to the PCU Value. Although the PCU is a comparative value, it can be considered the stream & roadway characteristics are constant.

$$PCU = (H_M/H_B - P_C) / P_T$$

Where, H_M = Average headway for a sample including all vehicle types

H_B = Average headway for a sample of passenger cars only

P_C = Proportion of cars

P_T = Proportion of Trucks

In this context, aside from the examination of average headway, due consideration was given to the influence of trucks within the traffic stream. Notably, in the Sri Lankan context, as compared to the initial research conducted in India, the presence of trucks was found to be negligible in proportion. (Traffic, 2017)

Therefore, the proportion of the trucks does not significantly affect the outcome of the PCU value.

(Seguin. E., 1982) In the provided structure, the passenger car unit (PCU) is characterized as the outcome obtained by dividing the average time gap for a particular vehicle category by the average time gap for a passenger car.

$$PCU_{ij} = H_{ij} / H_{pcj}$$

Where, PCU_{ij} = PCU of Vehicle Type I under conditions j

H_{ij} = Average headway for vehicle type i

H_{pcj} = Average headway for passenger car for conditions j

In this method, the basic headway is developed for a third-party condition. It will affect based on the condition which includes the characteristics of the traffic flow stream.

Therefore, this method can be adopted depending on the considered condition for an intersection.

(Cunagin. W. D., 1982) The inquiry examined the impact on traffic flow by analyzing time headway while accounting for lane width, volume, and type of headway. The findings indicate that the integration of trucks into the stream corresponds to an elevation in the average headway.

$$PCU_{ij} = H_{ij} / HB$$

Where H_{ij} = Mean lagging headway of vehicle type I under conditions j

H_B = Mean lagging headway of passenger cars

(Krammes. R., 1986) The derived passenger car unit (PCU) equation is constructed with the relative significance of three contributing factors influencing the cumulative impact of trucks in a roadway.

$$PCU = [(1-P_T) + pH_{TT}] / H_p$$

Where,	P_T	=	Proportion of Trucks
	H_{TP}	=	Lagging headway of trucks following passenger cars
	H_{TT}	=	Lagging headway of Trucks following trucks
	H_p	=	Lagging headway of cars following either vehicle type

The above two methods were developed mainly depending on the effect of the Trucks. As described before, the effect of the Trucks can be neglected according to the previous statistics (Traffic, 2017). Therefore, a methodology shall be built not only considering the Trucks effect.

The evaluation of Passenger Car Units (PCU) at signalized intersections primarily hinges on headway as the principal parameter. A multitude of researchers have consistently adopted headway as the foundational criterion for estimation within this domain. (Greenshields B.D., 1947) (Werner, A., and Morrall, J., 1976)

Considering the all above facts, assisting the headway to build up a methodology will be a benefit to avoid the other effects of governing parameters of the PCU Value.

Discerning the headways among drivers who are not in a stable state to adhere to lane discipline presents a challenge. The assumption that drivers consistently maintain a steady state in their lane represents a limitation of the headway method. (Metkari., 2012)

2.2 HCM Method

In two-lane roadways, the determination of Passenger Car Unit (PCU) values was conducted by analyzing speed distributions for both cars and trucks under specific volume and grade levels. (Cunagin. W. D., 1982)

Speed distribution is a characteristic which only applicable to highways. It is not a parameter to govern the PCU Values in an intersection. Therefore, the HCM method does not reflect the requirement of the PCU values in intersections.

2.3 Methods Based on Travel Time

(Keller., 1984) Proposed within the context of an urban arterial network, a passenger car equivalent (PCE) has been recommended for heavy vehicles. The ascertained passenger car equivalent (PCE) values are contingent upon factors such as volume of traffic, classifications of vehicles & settings in signals. The methodology is on the fundamental assumption that the decrease in capacity is intricately connected to the delay introduced by the presence of heavy vehicles within the traffic stream. The quantification of the passenger car unit (PCU) involves determining the ratio between the aggregated travel times of vehicles traversing a city road network. This relationship can be expressed as below:

$$PCU = TT_i / TT_o$$

Where, TT_i = Total Travel time of vehicle type I over the network hours

TT_o = Total travel time of base vehicle over the network in hours

The PCU was developed using a variable ratio which is mainly applicable only for a constant traffic flow in a road section, not for a scenario in a signalized intersection.

Therefore, this method won't be able to adhere to the intersections where the data analysis is to be done.

2.4 Methods Based on V/C Ratio

(Fan., 1990) A study conducted to determine passenger car equivalents (PCE) for expressways employs the volume-to-capacity (V/C) ratio, eschewing density & level of service metrics. The investigation concentrates on congested flow conditions, delineated by a V/C ratio exceeding a significant value, with an explicit omission of calculating PCUs during a stream condition of uncongested. By employing mathematical analysis, wherein the observed flow is multiplied by the volume-to-capacity (V/C) ratios, it was determined that commercial vehicles, encompassing all trucks, and buses, generally manifest passenger car unit (PCU) high values, particularly on level terrain.

Depending on the parameters which are going to be measured, it wouldn't be able to apply to both highways and intersections. However, the researches were done in congested flow conditions and only for situations when the volume-to-capacity ratio was higher than a significant value. Therefore, this method was accounted methodology derivation.

2.5 Methods Based on Speed

(Aggarwal, 2008) Proposed is a method for calculating passenger car equivalent (PCE) by taking into account the relative speeds of each vehicle type moving in the primary direction and the collective speeds of all vehicles in the opposite direction. Their discovery indicated a reduction in PCE as speed percentiles increase. The application of a linear regression model structure for speed analysis is as follows,

Percentile Speed = free speed + C_1 (number of passenger cars)
+ C_2 (number of passenger trucks) + C_3 (number of RVs)
+ C_4 (number of other vehicles) + C_5 (number of opposing vehicles)

Where, C_1 to C_5 = Coefficient of speed reductions of each vehicle type

The calculation of the PCU for a specific vehicle type n involves utilizing the speed reduction coefficients:

$$PCU_n = C_n / C_1$$

Where C_n = Speed reduction coefficient for vehicle type n

C_1 = Speed reduction coefficient for passenger cars

(Chandra, 1995) Proposed an approach for estimating PCE values under conditions of mixed traffic. They derived PCE values by considering the relationship between vehicle area and speed. Following their methodology, the passenger car equivalent (PCE) for a specific vehicle is articulated by the following equation.

$$PCU_i = (V_c / V_i) / (A_c / A_i)$$

Where,

V_c & V_i = Mean speeds of cars and type I vehicles respectively, in a traffic stream
A_c & A_i = their respective projected rectangular areas (length x width) on the road

As described earlier, speed distribution is a characteristic which only applicable to highways & not a parameter to govern the PCU Values in an intersection. Therefore, the methods derived using the speed are neglectable for the intersections.

2.6 Methods Based on Vehicle hours

The determination of peak period length and magnitude, capacity evaluation, as well as the assessment of geometric design and traffic control, relies on the utilization of hourly traffic.

(Sumner., 1984) Proposed a methodology employed for the computation of passenger car equivalent (PCE) values along urban arterial roads, specifically between consecutive signalized intersections, entails the utilization of microscopic simulation, namely NETSIM. These values are ascertained through the computation of the augmentation in vehicle-hours of road utilization arising from the integration of large vehicles into the traffic flow. The outcomes represent cumulative values over the road segments between junctions, and the computations of passenger car units (PCU) are expressed in terms of additional vehicle-hours. The study encompasses the generation of values for a wide range in types of vehicles, conducted under varying flow conditions, across different types of urban arterial roads. This is a simulation development & only be applicable for a road section.

2.7 Methods Based on Flow Rate and Density

In the field of highway engineering, the expression of traffic flow rate is employed to represent the hourly quantity of vehicles passing through a specified location within a defined time interval. The computation of passenger car equivalent (PCE) is contingent upon factors such as the percentage of grade, the composition of mixed vehicle flow & the ratio of capacity against truck volume. (John., 1976)

$$PCU = \frac{q_B - q_M (1 - P_T)}{q_M \times P_T}$$

Where q_B = equivalent passenger car only flow rate for a given v/c ratio

q_M = mixed flow rate

P_T = truck proportion in the mixed traffic flow

(Huber., 1982) A model has been devised for the estimation of passenger car unit (PCU) values applicable to vehicles operating in multi-lane conditions under free-flowing traffic scenarios. The derivation of passenger car unit (PCU) values is based on establishing the correlation between the volumes of two traffic streams. The equation employed for calculating the PCU value is as follows:

$$PCU = \frac{1}{P_T}\left(\frac{q_B}{q_M} - 1\right) + 1$$

(Sumner., 1984) Enhanced Huber's method through the incorporation of multiple truck types within the traffic stream.

$$PCU = \frac{1}{\nabla P}\left(\frac{q_B}{q_S} - \frac{q_B}{q_M}\right) + 1 \, .$$

Where q_S = additional subject flow rate

∇P = proportion of subject vehicles

Applying a deterministic traffic flow model to assess the impedance-flow relationship, the researchers proposed a connection between the values of passenger car unit (PCU) and the speed & length characteristics of individual vehicles. The observed correlation was found to vary in accordance with the percentage of trucks within the traffic flow. Drawing reference to the highway capacity manual (HCM), the researchers asserted that density stands as the paramount governing parameter for the determination of the Level of Service (LOS). It is noteworthy to mention that, despite its definition encompassing both density and speed, density was emphasized as the primary factor influencing LOS according to the stipulations of the HCM. The given explanation elucidates that density serves as a metric for quantifying the closeness of vehicles to other vehicles within the traffic flow. Consequently, it serves as an indicator of the level of manoeuvrability within the aforementioned stream. (Keller., 1984)

In an intersection, with the operation of a traffic signal, the traffic flow rate is a variable parameter. Also, the flow rate has an exponential graphical representation in an intersection. (Sheela Alex, Kuncheria P. Isaac, 2015)

So, the flow rate is not a capital parameter to represent the PCU Values in an Intersection.

Considering the density, It is applicable for an intersection and it also plays an effective role when computing the PCU Values. (Sumner., 1984)

2.8 Methods Based on Delays

The methodology hinges on evaluating the proportional decrease in capacity caused by heavy vehicles. This assessment is directly linked to the extra delay induced by these vehicles as compared to passenger cars.

(Werner, A., and Morrall, J., 1976) The walker method was employed to ascertain passenger car equivalent (PCE) values. A fundamental premise underlying the walker method posits that swifter vehicles encounter no impediments in overtaking slower counterparts, thereby preventing the formation of queues.

$$PCU = \frac{(OT_i/VOL_i)[1/SP_M] - [1/SP_B]}{(OT_{LPC}/VOL_{LPC})[1/SP_{PC}] - [1/SP_B]}$$

Where,

OT_i	= number of overtaking of vehicle type I by passenger cars
VOL_i	= volume of vehicle type i
OT_{LPC}	= number of overtaking of lower performance passenger cars by PS
VOL_{LPC}	= volume of lower-performance passenger cars
SP_M	= mean speed of the mixed traffic stream
SP_B	= mean speed of the base traffic stream with only high-performance PS
SP_{PC}	= mean speed of the traffic stream with only passenger cars

Within the framework of the equivalent-delay method, an assumption is posited, wherein it is asserted that faster vehicles consistently experience the occurrence of impediments stemming from slower vehicles resulting in the formation of queues.

Utilizing this fundamental principle, the calculation of passenger car unit (PCU) values entails a combination of equivalent delay methodologies. These computations are carried out individually for each intermediate volume level. (Craus J., 1980)

In their methodology, the authors accounted for the disparity in delays resulting from heavy vehicles in comparison to standard passenger cars, as well as delays attributed to slower passenger cars in relation to passenger cars. The equation encapsulates the tangible disruption by;

$$PCU = d_{kt} / d_{kp}$$

Where, d_{kt} = average delay time caused by one truck

D_{kp} = average delay time caused by one passenger car

(Cunagin. W. D., 1982) Formulated a method for estimating passenger car units (PCU) grounded in considerations of distribution of traffic & volume of traffic. The determination of PCU values was achieved through the application of walker's spatial-headway method and the equivalent-delay method. The formulated methodology for estimating passenger car equivalents (PCEs) entailed the computation of the ratio between the delay incurred by a passenger car attributable to non-passenger vehicles and the delay endured by a passenger car resulting from interactions with other passenger cars.

$$PCU = (D_{ij} - D_{base}) / D_{base}$$

Where D_{ij} = delay to passenger cars due to vehicle type I under conditions j

D_{base} = delay to standard passenger cars due to slower passenger cars

Reviewing all methods which use the delay parameter to find the PCU Value, the delay is not acceptable to adopt for the intersections. Because, in an intersection, it is mainly happening the acceleration & de-acceleration in a traffic flow.

Therefore, delay parameters shall be neglected when developing a methodology for the intersections.

2.9 Methods Based on Queue Discharge Flow

(Ahmed Al-Kaisy, 2004) The presented methodology for ascertaining Passenger Car Equivalents (PCE) involves employing Queue-Discharge flow (QDF). The methodology is developed under conditions characterized by a homogeneous traffic stream exclusively comprising passenger cars, the variability in queuing discharge flow (QDF) capacity observations would be negligible. Vehicle counts obtained from QDF capacity observations are employed in formulating a nonlinear programming problem, with the objective function aimed at minimizing variations in QDF capacity. The study reveals that the influence of heavy vehicles on a freeway is more pronounced during oversaturated operational conditions. Moreover, the research suggests that passenger car equivalent (PCE) values demonstrate no notable distinctions, irrespective of weather conditions, or in the presence of road maintenance activities. The optimization procedure was given to determine PCU:

Objective function : Minimize Z (C*) (Z=Coefficient of variation=standard deviation/Mean)

Design variable : PCE factor

Constraints : C*>X1 (X1=1600 pcphpl at site 1, X1=1400 pcphpl at site 2)

: C*<=X2 (X2=2800 pcphpl at site 1, X2=2600 pcphpl at site 2)

PCE >=X3 (X3=1.0)

PCE<=X4 (X4=10.0)

Here, the method was developed only depending on the queue discharge flow, other effecting factors are considered constant. This method can be applied to an intersection, but when the data collection is done, it shall be developed a graphical relationship between the variables in a trial and error method. The relationship can be developed using a traffic model.

It was found that from the literature review, various approaches are available for PCU values estimation.

2.10 Factors affecting PCU Values

PCU factor depends on the followings: (Bajad M.N., Yogeshwari Ghule, 2016),

1. Vehicle Characteristics (Physical and Mechanical)
    a) Total Length
    b) Width of the Vehicle
    c) Power Capacity
    d) Acceleration Performance
    e) Deceleration Performance
    f) Braking characteristics.

2. Flow Characteristics
    a) Flow speed
    b) Gap distribution of vehicles.
    c) Speed characteristics like Speed Distribution.
    d) Stream composition.
    e) Traffic V/C ratio
    f) Pedestrian Volume
    g) Flow Conditions

3. Carriageway characteristics
    a) Alignment
    b) Location
    c) Stretch
    d) Skid resistance
    e) Traffic regulations
    f) Lanes
    g) Pavement width

4. Environmental characteristics
    a) Ambience
    b) Obstructions in the location
    c) Location
    d) Condition of the Terrain.

5. Climatic conditions
   a) Fog, mist
   b) Rainy, dry

6. Controls
   a) Limit of Speed
   b) Vehicle segregations
   c) Access controls

Though there were such effecting characteristics for the PCU, it is needed to be most of the conditions remained uniform for the analysis.

2.11 PCU Value Evaluation in the Sri Lankan Context

Several researches were done in the Sri Lankan Context since 1996. (Kumarage, 1996) used a methodology developed using speed flow relationship for two-lane roads as follows.

$$V_j = C_j - \beta_i Q$$

Where V_j = observed mean space mean speed of vehicle type j

Q = observed flow rate in PCUs per hour

C_j = theoretical mean free speed of vehicle type j under free flow

βt = rate at which speed of vehicle type j will diminish for a unit increase in flow rate

Road Development Authority, Sri Lanka published the PCU Values to be used for the national highways in 1998. They have used an evaluation method using the headway. (RDA, 1998)

(Weerasinghe, 2015), (Kumaratunga P.C.I, 2018) & (Jayaratne., 2016) used a methodology developed by the (Chandra, 1995) to evaluate the PCU values for roads in Sri Lanka.

2.12 Research Gap

In Sri Lanka, the highways and intersections experience heterogeneous traffic conditions, with the carriageway accommodating various modes of traffic. Furthermore, there exist diverse physical characteristics of vehicles and there is a noticeable absence of lane discipline. These facts affect the data to be collected as stream characteristics. For example, speed, lateral clearance, composition, and traffic volume can be defined.

Therefore, the data collection method shall be highly accurate and easily adapted to high sample evaluation.

Since PCU values were evaluated more than 20 years ago considering the Sri Lankan context, a new methodology shall be adaptable to update the PCU evaluation easily. In addition, the data collection methodology shall be cost-effective and relatively easy to carry out.

Out of the various data collection methods, the research gap shall be eliminated by using the bird's eye view data collection.

3. METHODOLOGY

3.1 Methods of Calculating PCU Value

Based on the literature review, basic headway methods and methods based on density were found to be suitable methods to evaluate PCU values for signalized intersections in the Sri Lankan context.

Within the framework of a signalized intersection, it is asserted, as expounded in the literature review, that the headway of vehicles more precisely delineates the crucial space required for vehicular movement compared to other parameters. Therefore, the analysis employed the central parameter of area occupancy of vehicles, encompassing the impact of all vehicular interactions originating from the surrounding environment.

It employed the headway method due to its simplicity and straightforward application.

The computation of the Passenger Car Unit (PCU) for through/right-turn vehicles involves a comparison of headways associated with a specific vehicle type to those of automobiles proceeding straight through or executing a right turn within the intersection. Consequently, the PCU is derived through the utilization of equation (1):

$$PCU_{(x\text{-}x)} = h_{A(x\text{-}x)} / h_{A(c\text{-}c)} \qquad (1)$$

Where,

$h_{A(c\text{-}c)}$ = Adjusted mean headway of a car followed by a car

$h_{A(x\text{-}x)}$ = Adjusted mean headway of a type x vehicle followed by a type x vehicle

The correlation between headway and time establishes a direct relationship between volume and time;

$$t_i = C + \alpha_i \sum q_{ij} \qquad (2)$$

Where t_i = time taken by platoon i

q_{ij} = number of vehicles of type j in platoon i

C = Constant time loss per platoon

α_j = flow rate (sec/veh) for vehicle type j

Considering all the above facts & literature review, the basic headway method was adopted. The other characteristics identified in the literature review are considered to remain constant during the PCU value determination.

3.2 Data collection

According to the chosen methodology, it is necessary to collect time headway data at the intersections. In this context, data collection will be exclusively conducted through the use of video footage.

Using a drone camera for traffic flow measurements offers several advantages over traditional ground-level fixed cameras, particularly in a road junction scenario:

Drones can be easily maneuvered to cater for a more comprehensive view of the junction. They can capture footage from various angles and heights, allowing for a more detailed analysis.

Ground-level fixed cameras may have limited visibility due to obstructions such as buildings, trees, or other structures. Drones can navigate around such obstacles, ensuring unobstructed views of the required area.

While initial investment costs for drones may be higher, they can ultimately be more cost-effective than installing and maintaining multiple fixed cameras at different locations. Drones can cover larger areas with fewer devices.

This accessibility allows for more frequent and comprehensive data collection without disrupting traffic flow.

The research gathered temporal headway data from prominent signalized intersections characterized by substantial traffic volume, a heterogeneous array of vehicle types, and a prohibition on parking along the approach to the intersections.

Utilizing the drone videotaping technique, the movements of each vehicle in both directions were documented during peak hours. The recording was observed using a software Solution (Adobe Premier) for the time headway of each vehicle.

The data collection locations are selected randomly. The Locations are;

i. Palamthuna Junction, Battaramulla

   This junction is located near Battaramulla city which is considered the administration city of Sri Lanka connecting several key roads and facilitating the movement of vehicles within the city. The peak time of the junction coincides with rush hours which occurs during morning & evening time.

ii. Kimbulawala Junction, Kimbulawala.

   This junction is not a notable intersection compared to the congested intersections of the urban city limits. But considering the connectivity to the congested corridors, a geographic focal point for commercial and residential activity region will reflect significant traffic flow.

iii. Pelawatta Junction, Pelawatta.

   Since this junction is located between highly commercial & residential congested areas of Battaramulla and Thalawathugoda, it experiences a high volume of vehicles passing through on a daily basis. The peak hours are considered as the morning and evening time.

iv. Battaramulla Junction, Battaramulla.

   This Junction is a significant junction located in the urban context which is a suburb of Colombo. The peak time can be considered in the morning and evening time which occurs due to the sign-in and sign-off time of most government and some private offices.

v. Thalawathugoda Junction, Thalawathugoda.

   This junction serves as a crucial transport hub connecting several main roads including the Colombo Batticaloa highway (A4), Pannipitiya Road and the Thalawathugoda Road. As an urban junction, Thalawathugoda experiences high traffic volume, particularly during peak hours which commonly occur during morning & evening times.

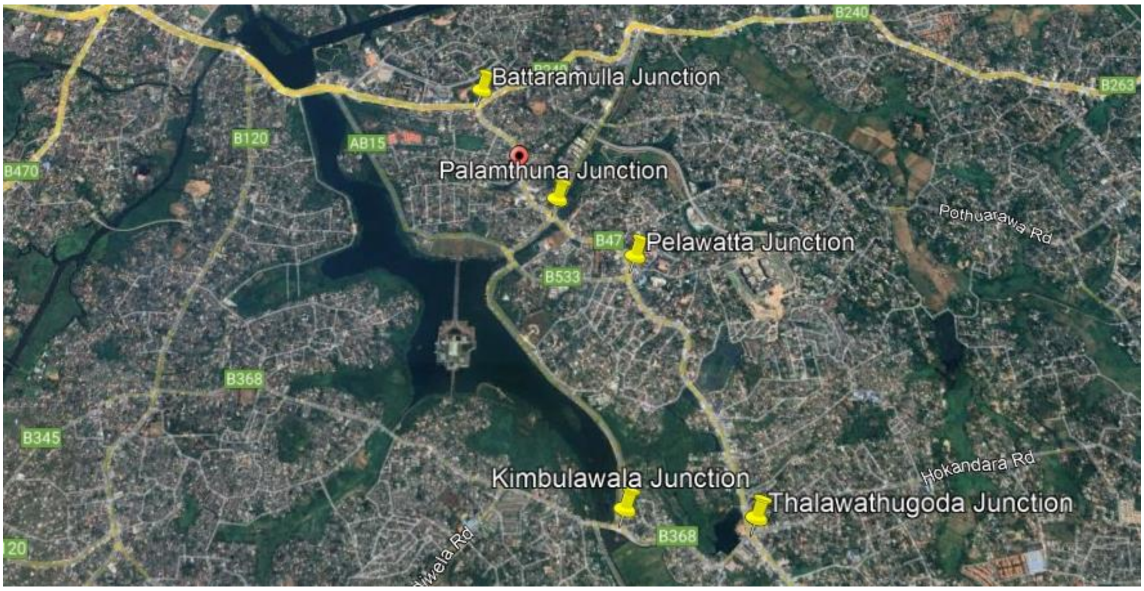

Figure 1 Data collection locations

The figures below depict the conditions and the bird's eye view of each location.

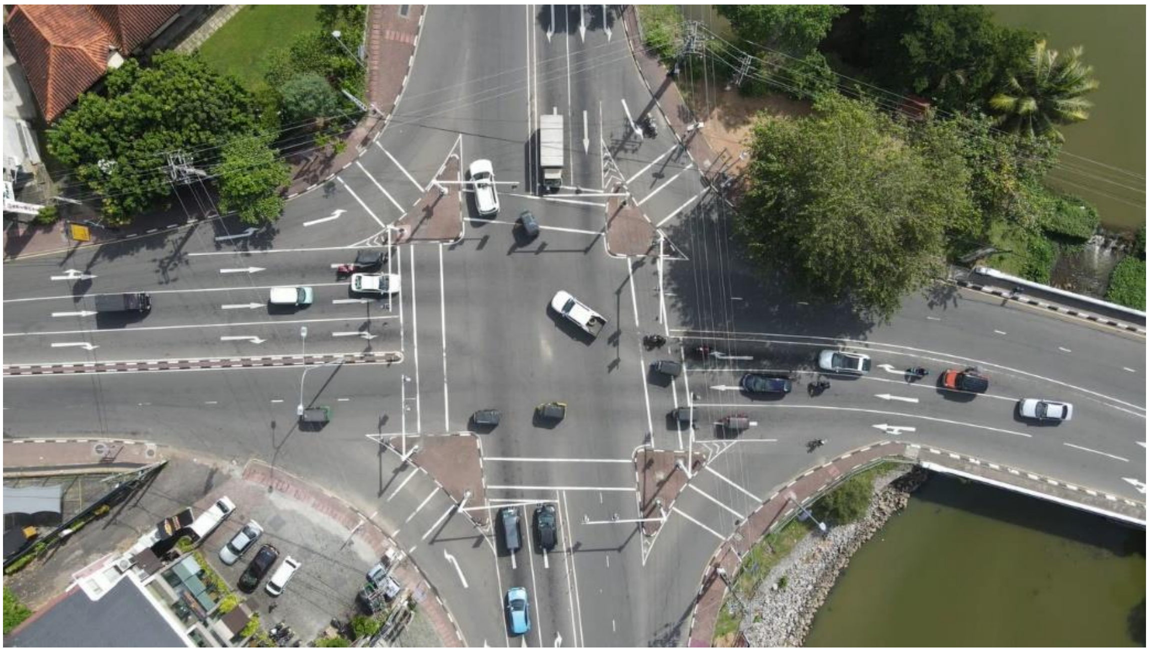

Figure 2 Palamthuna Junction - Drone View

Figure 3 Palamthuna Junction, Battaramulla

Figure 4 Kimbulawala Junction, Kimbulawala – Drone View

Figure 5 Kimbulawala Junction, Kimbulawala

Figure 6 Kimbulawala Junction – Drone Operation

Figure 7 Pelawatta Junction, Pelawatta.-Drone View

Figure 8 Pelawatta Junction - Drone Operation

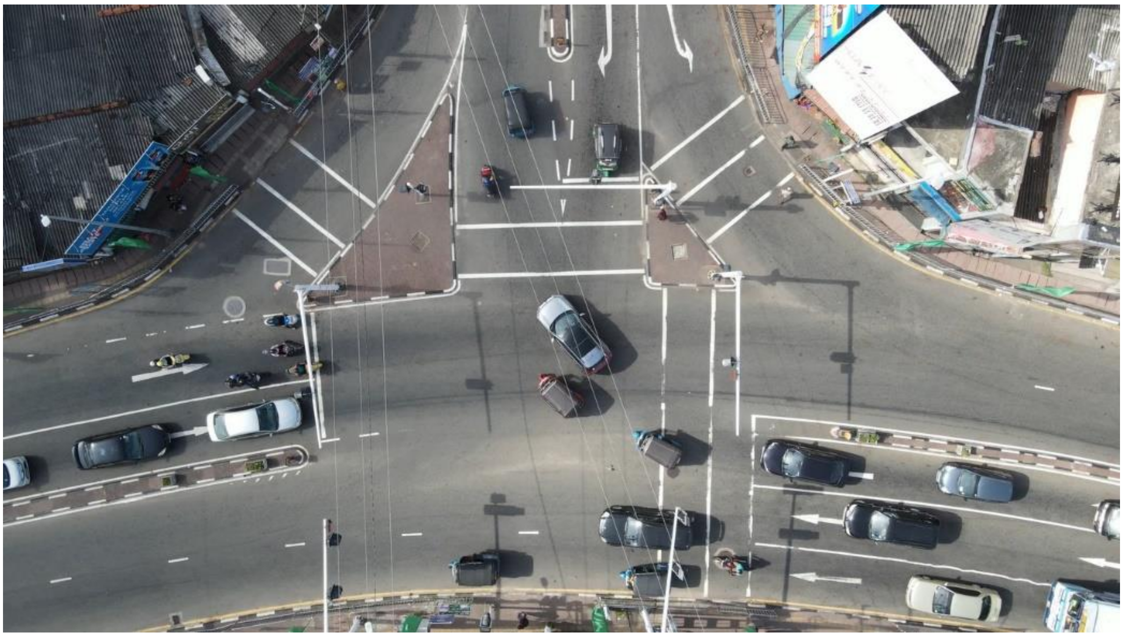

Figure 9 Battaramulla Junction, Battaramulla – Drone View

Figure 10 Battaramulla Junction, Battaramulla

Figure 11 Thalawathugoda Junction, Thalawathugoda – Drone View

Figure 12 Thalawathugoda Junction, Thalawathugoda

Figure 13 Thalawathugoda Junction - Drone Operation

Vehicles are classified into ten categories and the turning movement is also categorized into two categories to determine the PCU factors in each,

Vehicle Categories

a) Passenger Car (PC)
b) Passenger Car-Small (PCS)
c) Van (VN)
d) Motor Cycle (MC)
e) Three Wheeler (TW)
f) Medium Bus (MB)
g) Large Bus (LB)
h) Commercial Vehicles-Small (SCV)
i) Commercial Vehicles-Medium (MCV)
j) Commercial Vehicles-Large (LCV)

Turning Movements

a) Through Only (TO)
b) Right Turn Only (RO)

It is recorded the time of the entry and the exit of the junctions by each vehicle under the saturated flow conditions in order to process the analysis.

In the data collection process, the following issues were raised

a) Stringent rules and regulations governing drone operations in Sri Lanka.
b) Constraints arising from the pandemic and emergency situations in Sri Lanka.
c) Technical limitations arise from drone constraints, including altitude restrictions, flight duration limits, and adverse weather conditions.
d) Not functioning of traffic signals continuously.
e) Frequent electricity cutoffs.
f) Restriction of the local authorities.
g) Bad driver behaviours and collisions.

4. ANALYSIS AND DISCUSSION

The analysis of the data was carried out for each category defined above, for each location and each movement.

The summary of the calculated PCU values based on the basic headway method using equations (1) & (2) for each movement is shown in the below graph.

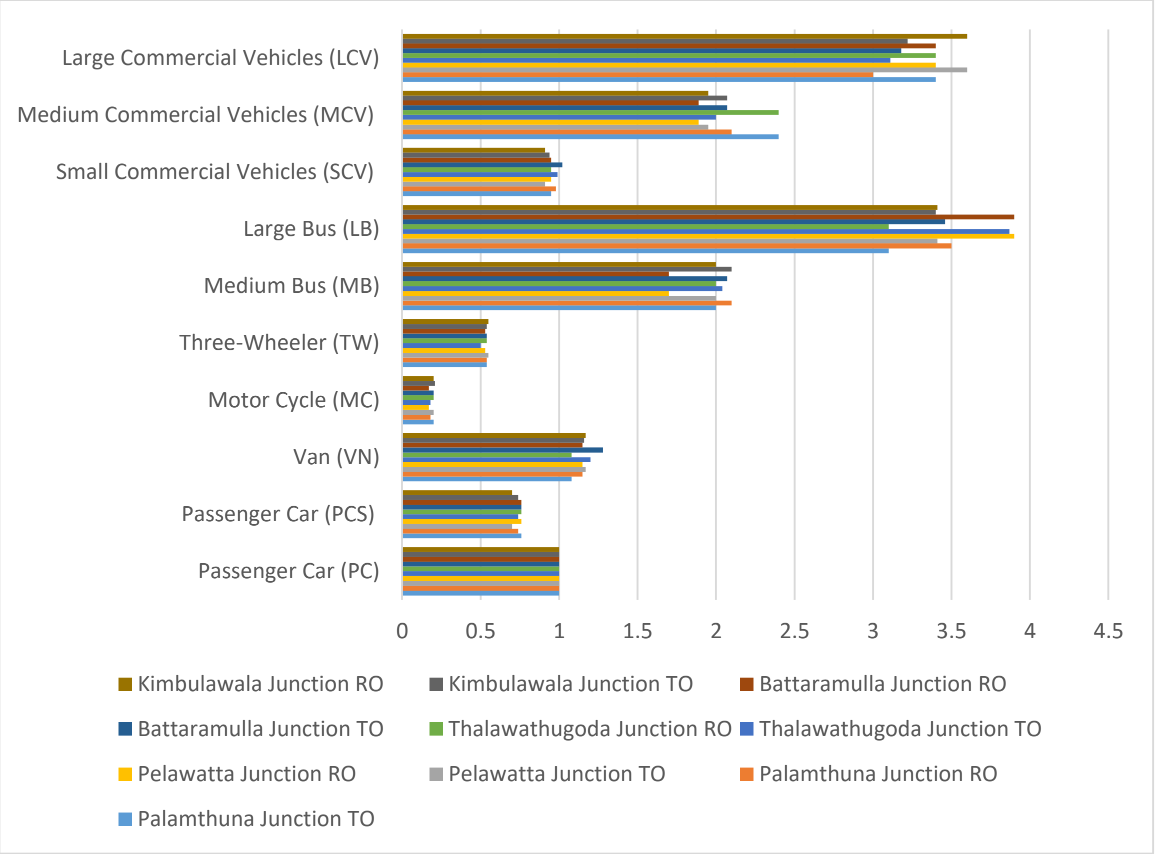

Figure 14 PCU Variation in Movement

Then the average PCU values of each location were analyzed and tabulated in Table 1.

Table 1 Calculated PCU Values at Different Locations

Vehicle Classification	PCU Values				
	Palamthuna Junction	Pelawatta Junction	Thalawathugoda Junction	Battaramulla Junction	Kimbulawala Junction
Passenger Car (PC)	1	1	1	1	1
Passenger Car (PCS)	0.75	0.75	0.74	0.76	0.74
Van (VN)	1.1	1.16	1.2	1.28	1.16
Motor Cycle (MC)	0.19	0.18	0.18	0.2	0.21
Three-Wheeler (TW)	0.54	0.52	0.5	0.54	0.54
Medium Bus (MB)	2.07	1.8	2.04	2.07	2.1
Large Bus (LB)	3.4	3.39	3.87	3.46	3.4
Commercial Vehicles-Small (SCV)	0.97	0.94	0.99	1.02	0.94
Commercial Vehicles-Medium (MCV)	2.09	1.94	2	2.07	2.07
Commercial Vehicles-Large (LCV)	3.17	3.5	3.11	3.18	3.22

A graphical variation for PCS, VN, MC, TW & LB can be shown as below,

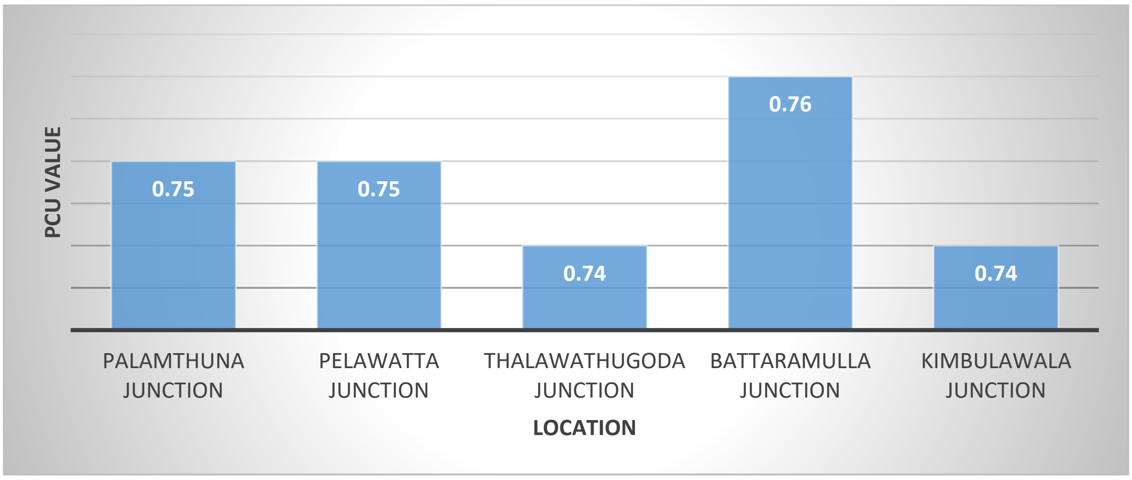

Figure 15 Passenger Car Small (PCS) - PCU Variation

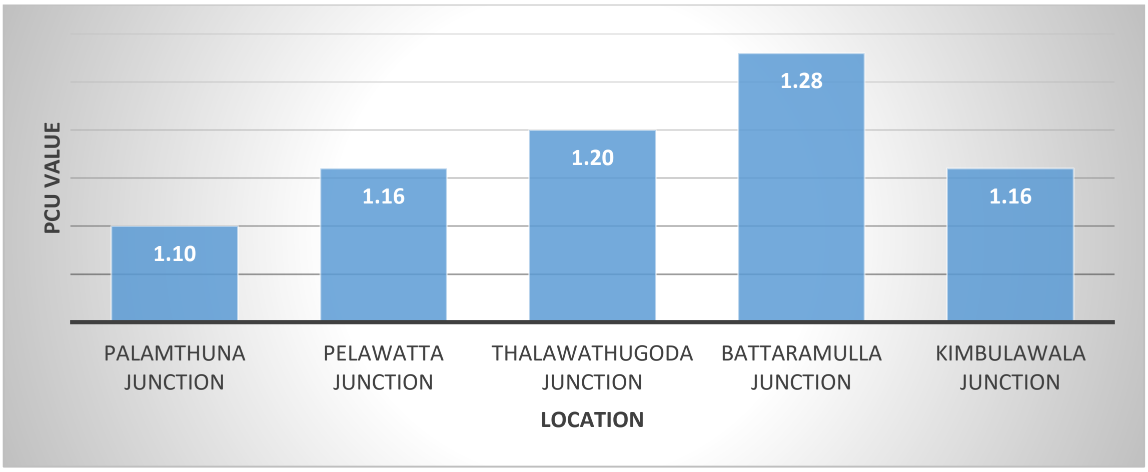

Figure 16 Van (VN) - PCU Variation

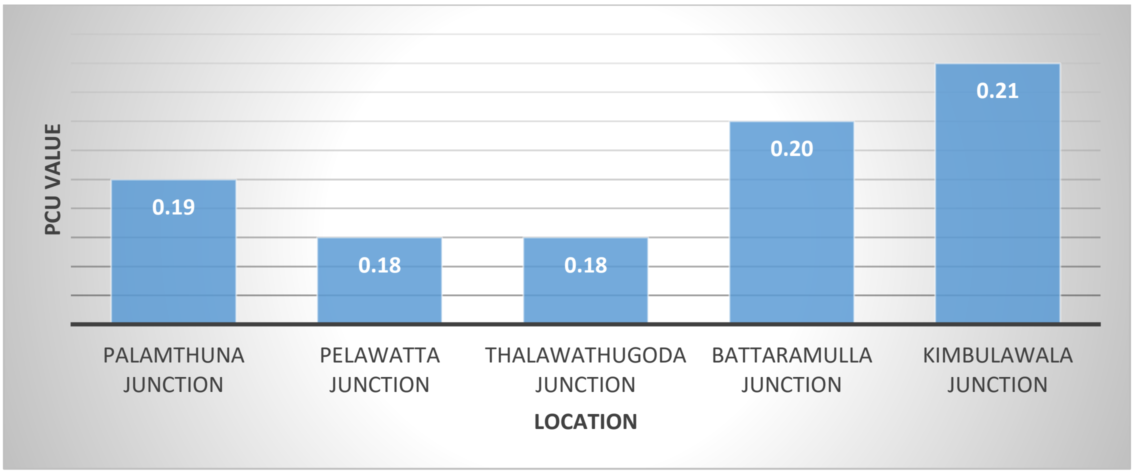

Figure 17 Motor Cycle (MC) - PCU Variation

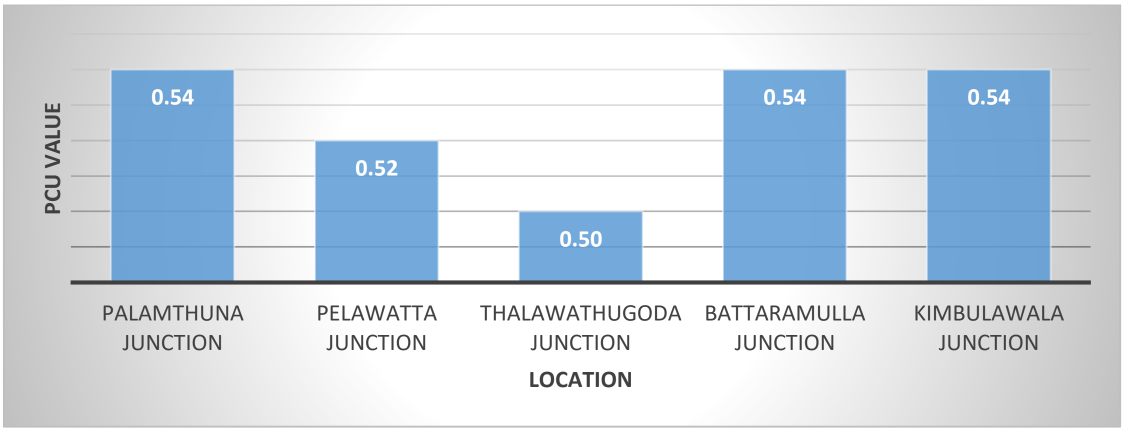

Figure 18 Three Wheeler (TW) - PCU Variation

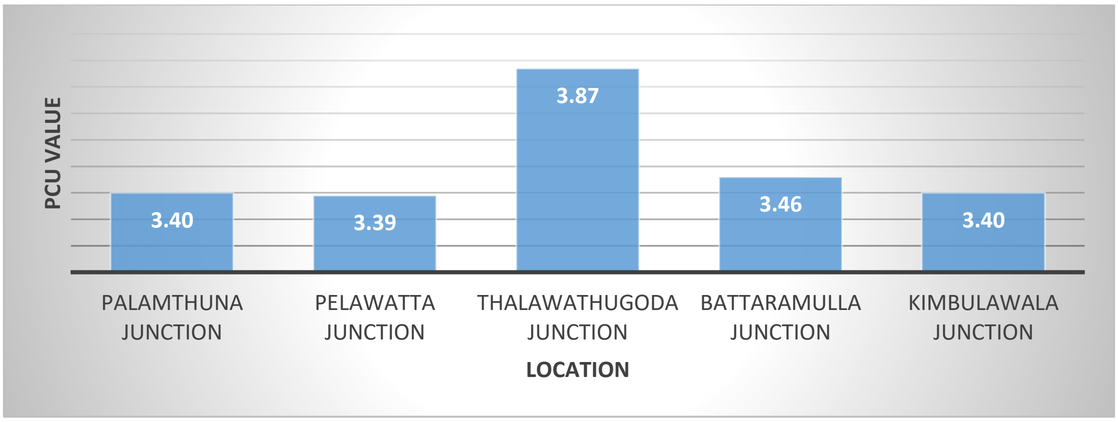

Figure 19 Large Bus (LB) - PCU Variation

The analysis was conducted for each category of vehicles utilizing simple linear analysis. As the analyzed data exhibited a normal distribution, the simple arithmetic mean was computed accordingly.

The calculated values are presented in Table 2.

Table 2 Average PCU Values

Vehicle Classification	PCU Value
Passenger Car (PC)	1
Passenger Car (PCS)	0.76
Van (VN)	1.1
Motor Cycle (MC)	0.19
Three-Wheeler (TW)	0.49
Medium Bus (MB)	2.05
Large Bus (LB)	2.2
Commercial Vehicles-Small (SCV)	0.96
Commercial Vehicles-Medium (MCV)	2.1
Commercial Vehicles-Large (LCV)	3.2

Though the observed number of vehicles in a junction was similar in each location, non-reliable data can be easily identified when comparing the average PCU values.

It could be observed that the average PCU value of motorcycles in Kimbulawala Junction and the average PCU Value of three-wheelers and large busses in

Thalawathugoda Junction are not reliable compared to the average PCU values of the same in other locations.

While the traffic conditions exhibit similarities, the observed vehicle speeds remain consistent with those observed at other locations. This suggests uniformity in driver behaviour.

4.1 Comparison of PCU Values

A comparison of PCU values is delineated in the below table, adjacent findings from literature with values obtained through past research studies conducted in Sri Lanka.

Table 3 Comparison of PCU Values

Vehicle Classification	This Study	Kumarage (1996)	RDA (1998)	Jayaratne et al., (2016)
Passenger Car	1.00	1.00	1.00	1.00
Passenger Car (Small)	0.75	-	-	-
Van	1.16	1.1	-	1.2
Motor Cycle	0.20	0.5	0.4	0.2
Three-Wheeler	0.53	0.75	0.8	0.6
Medium Bus	2.06	1.6	1.8	-
Large Bus	3.41	2.4	2.4	4.1
Commercial Vehicles-Small (SCV)	0.97	1.5	1.5	1.2
Commercial Vehicles-Medium (MCV)	2.03	2.0	2.0	-
Commercial Vehicles-Large (LCV)	3.36	3.8	3.8	3.2

A graphical view of the comparison is shown in Figure 20.

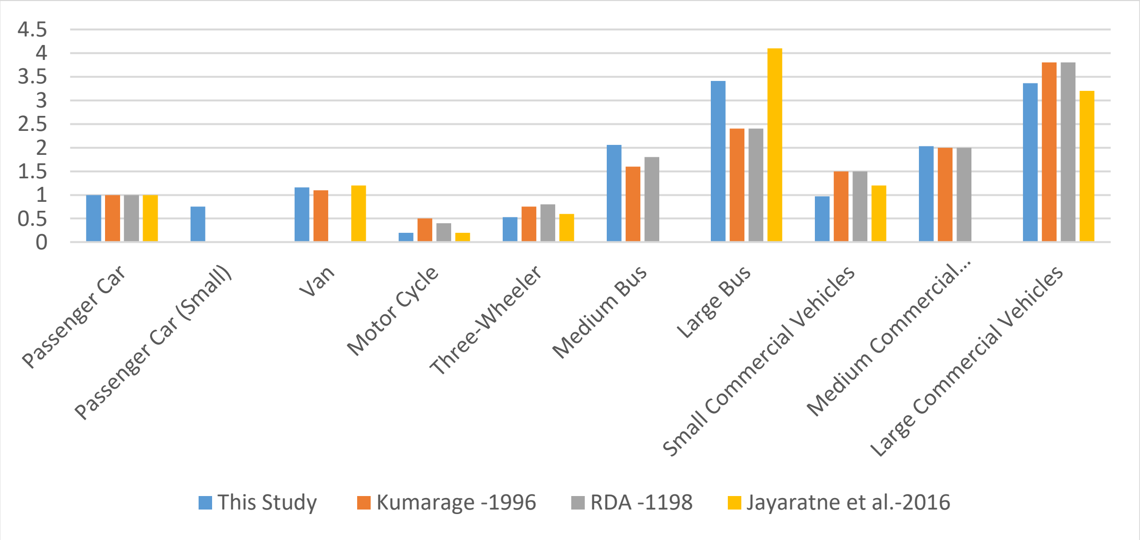

Figure 20 This Study PCU Value Comparison with Literature Values

4.2 Discussion

As per the Road Development Authority's publications,the PCU values were derived in 1996.. The last study for the signalized intersection (Kumarage, 1996) was also done with the same conditions as terrain, obstructions, climate, and speed limits.

Also, when comparing the present and 1996 road condition, it can be observed that the roads were not improved & maintained as now. The vehicle characteristics, such as the dimensions and performance, environmental conditions, and driver behaviour, also differed from the present situation.

With the development of the infrastructure in Sri Lanka, the physical environment and the driver's behaviour changed drastically. So, there is a requirement to derive the PCU values that reflect the current road environment.

The average headway of each vehicle in each movement type has been analyzed against the intermediate headway of a car in the same movement type. The headway method is the basic approach to this data analysis. In a signalized intersection, the analysis is commenced on the assumption that vehicles being discharged from a traffic signal will leave at their capacity or a saturated flow condition. The time laps are considered for the record of the data since it is the trackable parameter for the intersection movements.

More than 5,000 vehicle movements have been observed in this analysis for the PCU estimation of signalized intersections in randomly selected locations with various corridors. The PCU values of similar turning movements were considered with different intersections. The outcomes have been aggregated, and the mean value was assessed with the coefficient of variation.

In separate locations, there is a variation between the outcomes. It mainly shows the non-uniformity of conditions among the selected locations—non-conformity generated due to the various environmental conditions and diversity of the flow characteristics.

Upon comparison with the existing literature, the calculated Passenger Car Unit (PCU) values exhibited marginal variations. This disparity can be attributed to the fact that the literature results were obtained under circumstances where the road surface condition and maintenance had not undergone improvements up to the present. Additionally, it is noteworthy that Sri Lanka experiences heterogeneous traffic conditions, further contributing to the observed differences.

Derivation of a general PCU value for each vehicle category would be more desirable for planning and design calculation purposes. Also, it updates and validates the existing values.

5. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

The literature review confirms that there are many methods have been used in many studies & countries to derive PCU factors for separate vehicle categories. They are applicable under different conditions & scenarios. The headway method is the most suitable method for heterogeneous type traffic conditions to derive PCU. Among several headway methods, the essential headway was used considering the conditions of signalized intersections in Sri Lanka.

Owing to the marginal discrepancies noted between the outcomes of the present study and the prevailing Passenger Car Unit (PCU) values, it can be inferred that the employed PCU factors are outdated and no longer reflective of contemporary road characteristics and driver behaviour. Hence, it is imperative to regularly derive updated PCU factors.

The findings emanating from the investigation into the determination of Passenger Car Unit (PCU) values lead to the conclusion that the PCU values associated with a particular vehicle type ought to be acknowledged as dynamic, subject to variation based on prevailing environmental conditions.

The PCU values derived from this study will serve as valuable tools for estimating the capacity of signalized intersections. Additionally, these findings will aid planning and traffic analysis engineers in examining the fluctuations in flow and capacity at signalized intersections.

Considering the carried out data collection methodology, it is a very efficient methodology in terms of bird eye observing the vehicle movement, workforce, minimum error, quick analyzable & applicable under any environmental conditions.

Numerous challenges were encountered during the data collection phase of movement observations, and the majority of errors and issues were successfully addressed by implementing a pilot survey at each location by the conclusion of the day. General problems such as traffic signals not always functioning due to frequent electricity cutoffs and drivers not following traffic laws and regulations were unsolved as they were out of control.

5.2 Recommendations

This research likely stands as the inaugural endeavour conducted to ascertain Passenger Car Unit (PCU) values through a comprehensive aerial data collection analysis within the context of Sri Lanka.

Due to the exclusive focus of data collection and analysis on signalized junctions with three and four-way configurations & considering the characteristics that affect the PCU value, the results only be applicable to the same scenarios.

It is advisable to carry out further investigations using this methodology to gather additional data and explore PCU values at various locations. This is essential to validate the findings obtained in this study before applying them in practical scenarios.

During the past few years, there has been a vast variation in the physical characteristics of the vehicles and the road conditions. Hence, it is suggested to determine the PCU value for these newly manufactured vehicle types.

Accordingly, present PCU factors under the standard guideline in Sri Lanka needs to be revised for the current context and shall be updated considering a dynamic value.

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APPENDIX-A : Traffic Data - Palamthuna Junction, Battaramulla

Location : Palamthuna Junction, Battaramulla			
SN	**Vehicle Type**	**Entry Time**	**Exit Time**
L1-V1	PC	1.11	1.17
L1-V2	PCS	1.20	1.24
L1-V3	VN	1.29	1.37
L1-V4	MC	1.38	1.43
L1-V5	TW	1.41	1.50
L1-V6	MB	1.50	1.53
L1-V7	LB	1.55	1.58
L1-V8	SCV	2.10	2.14
L1-V9	MCV	2.14	2.20
L1-V10	LCV	2.20	2.29
L1-V11	LCV	2.26	2.34
L1-V12	PC	2.32	2.39
L1-V13	MC	2.39	2.43
L1-V14	PCS	2.48	2.51
L1-V15	VN	3.12	3.22
L1-V16	LB	3.18	3.23
L1-V17	MCV	3.22	3.25
L1-V18	TW	3.29	3.38
L1-V19	MB	3.35	3.43
L1-V20	SCV	3.44	3.50
L1-V21	TW	3.51	3.56
L1-V22	MB	3.56	4.00
L1-V23	PC	4.03	4.10
L1-V24	LCV	4.08	4.18
L1-V25	MC	4.26	4.32
L1-V26	LB	4.31	4.40
L1-V27	MCV	4.40	4.45
L1-V28	PCS	4.45	4.53
L1-V29	VN	4.53	4.57
L1-V30	SCV	4.57	5.00
L1-V31	VN	5.03	5.10
L1-V32	MB	5.11	5.14
L1-V33	LCV	5.12	5.22
L1-V34	MCV	5.21	5.26
L1-V35	LB	5.29	5.37

SN	Vehicle Type	Entry Time	Exit Time
L1-V36	PC	5.38	5.44
L1-V37	TW	5.46	5.55
L1-V38	SCV	5.54	5.58
L1-V39	VN	6.07	6.14
L1-V40	LB	6.17	6.22
L1-V41	MC	6.23	6.33
L1-V42	LCV	6.34	6.37
L1-V43	TW	6.40	6.49
L1-V44	VN	6.47	6.53
L1-V45	MB	6.52	6.59
L1-V46	MCV	7.05	7.13
L1-V47	PCS	7.14	7.21
L1-V48	SCV	7.16	7.19
L1-V49	MC	7.24	7.34
L1-V50	LB	7.32	7.37
L1-V51	MB	7.41	7.49
L1-V52	PCS	7.49	7.53
L1-V53	LCV	7.52	7.58
L1-V54	TW	8.07	8.13
L1-V55	SCV	8.12	8.19
L1-V56	MCV	8.29	8.39
L1-V57	VN	8.37	8.40
L1-V58	PC	8.42	8.47
L1-V59	MC	8.47	8.56
L1-V60	TW	8.57	8.61
L1-V61	LCV	8.59	9.05
L1-V62	SCV	9.03	9.11
L1-V63	VN	9.11	9.18
L1-V64	PCS	9.27	9.37
L1-V65	MB	9.41	9.44
L1-V66	LB	9.53	9.58
L1-V67	MCV	10.00	10.09
L1-V68	SCV	10.10	10.14
L1-V69	VN	10.14	10.21
L1-V70	PC	10.17	10.23
L1-V71	LCV	10.26	10.34
L1-V72	TW	10.38	10.48
L1-V73	LB	10.40	10.43

SN	Vehicle Type	Entry Time	Exit Time
L1-V74	MCV	10.54	10.59
L1-V75	MB	11.11	11.20
L1-V76	MC	11.17	11.21
L1-V77	VN	11.24	11.31
L1-V78	SCV	11.31	11.37
L1-V79	PCS	11.35	11.43
L1-V80	LCV	11.43	11.53
L1-V81	LB	11.51	11.54
L1-V82	PC	11.55	11.58
L1-V83	MCV	12.05	12.14
L1-V84	VN	12.22	12.26
L1-V85	MB	12.27	12.34
L1-V86	TW	12.34	12.40
L1-V87	SCV	12.46	12.54
L1-V88	MC	12.49	12.59
L1-V89	VN	12.51	12.54
L1-V90	PCS	12.53	12.58
L1-V91	LCV	13.03	13.12
L1-V92	LB	13.13	13.17
L1-V93	MB	13.21	13.28
L1-V94	SCV	13.23	13.29
L1-V95	TW	13.30	13.38
L1-V96	PC	13.38	13.48
L1-V97	MCV	13.45	13.48
L1-V98	VN	13.53	13.58
L1-V99	MC	14.06	14.15
L1-V100	LCV	14.10	14.14
L1-V101	MB	14.15	14.22
L1-V102	PCS	14.22	14.28
L1-V103	LB	14.32	14.40
L1-V104	TW	14.39	14.49
L1-V105	SCV	14.46	14.49
L1-V106	VN	14.55	15.00
L1-V107	MC	15.09	15.18
L1-V108	TW	15.15	15.19
L1-V109	MB	15.25	15.32
L1-V110	LCV	15.38	15.44
L1-V111	PCS	15.46	15.54

SN	Vehicle Type	Entry Time	Exit Time
L1-V112	SCV	15.51	15.57
L1-V113	MCV	15.56	15.59
L1-V114	LB	15.59	15.64
L1-V115	VN	16.04	16.13
L1-V116	MB	16.08	16.12
L1-V117	MC	16.10	16.17
L1-V118	VN	16.19	16.25
L1-V119	SCV	16.29	16.37
L1-V120	LCV	16.34	16.44
L1-V121	PCS	16.43	16.46
L1-V122	PC	16.51	16.59
L1-V123	TW	17.04	17.13
L1-V124	LB	17.10	17.14
L1-V125	MCV	17.19	17.26
L1-V126	VN	17.23	17.29
L1-V127	LB	17.30	17.38
L1-V128	MB	17.36	17.46
L1-V129	SCV	17.44	17.47
L1-V130	TW	18.02	18.07
L1-V131	LCV	18.09	18.18
L1-V132	MC	18.18	18.22
L1-V133	PCS	18.27	18.34
L1-V134	VN	18.32	18.38
L1-V135	LCV	18.39	18.47
L1-V136	MB	18.44	18.54
L1-V137	TW	18.54	18.57
L1-V138	VN	19.09	19.14
L1-V139	MC	19.18	19.27
L1-V140	SCV	19.24	19.28
L1-V141	PCS	19.30	19.37
L1-V142	LB	19.37	19.43
L1-V143	MCV	19.42	19.50
L1-V144	PC	19.51	19.59

*Continued up to Serial No: L1-V658

APPENDIX-B : Traffic Data - Kimbulawala Junction, Kimbulawala

Location : Kimbulawala Junction, Kimbulawala			
SN	**Vehicle Type**	**Entry Time**	**Exit Time**
L2-V1	MB	1.1	1.18
L2-V2	LCV	1.14	1.2
L2-V3	SCV	1.23	1.28
L2-V4	PCS	1.32	1.39
L2-V5	LCV	1.36	1.4
L2-V6	MB	1.49	1.58
L2-V7	PC	1.52	1.59
L2-V8	TW	2.04	2.14
L2-V9	MC	2.05	2.1
L2-V10	VN	2.14	2.25
L2-V11	TW	2.32	2.38
L2-V12	PC	2.36	2.43
L2-V13	MCV	2.42	2.52
L2-V14	VN	2.5	2.54
L2-V15	LCV	2.58	2.67
L2-V16	LB	3.05	3.16
L2-V17	SCV	3.15	3.23
L2-V18	MCV	3.2	3.26
L2-V19	LCV	3.27	3.32
L2-V20	LB	3.33	3.4
L2-V21	PC	3.44	3.48
L2-V22	MB	3.48	3.58
L2-V23	TW	3.52	3.59
L2-V24	MCV	4.03	4.09
L2-V25	SCV	4.23	4.34
L2-V26	LB	4.33	4.41
L2-V27	VN	4.46	4.53
L2-V28	TW	4.52	4.59
L2-V29	MC	5.15	5.2
L2-V30	PC	5.21	5.31
L2-V31	LCV	5.28	5.37
L2-V32	MCV	5.34	5.4
L2-V33	SCV	5.45	5.53
L2-V34	VN	5.5	5.59
L2-V35	VN	5.58	5.65

SN	Vehicle Type	Entry Time	Exit Time
L2-V36	MCV	6.03	6.07
L2-V37	TW	6.07	6.12
L2-V38	LCV	6.1	6.2
L2-V39	VN	6.16	6.22
L2-V40	MB	6.27	6.36
L2-V41	SCV	6.41	6.52
L2-V42	MC	6.44	6.51
L2-V43	PC	6.53	6.57
L2-V44	LCV	6.54	6.58
L2-V45	LB	6.59	7.1
L2-V46	LCV	7.07	7.17
L2-V47	VN	7.14	7.2
L2-V48	PCS	7.2	7.31
L2-V49	MCV	7.25	7.34
L2-V50	SCV	7.3	7.37
L2-V51	LB	7.35	7.39
L2-V52	VN	7.39	7.47
L2-V53	TW	7.46	7.51
L2-V54	MB	7.52	7.59
L2-V55	PC	8.03	8.14
L2-V56	SCV	8.15	8.21
L2-V57	LCV	8.23	8.3
L2-V58	VN	8.25	8.34
L2-V59	MB	8.32	8.36
L2-V60	MC	8.35	8.43
L2-V61	PC	8.41	8.51
L2-V62	LB	8.52	8.57
L2-V63	TW	8.55	8.59
L2-V64	VN	9.03	9.1
L2-V65	MB	9.07	9.16
L2-V66	LB	9.17	9.21
L2-V67	MC	9.25	9.33
L2-V68	LCV	9.3	9.35
L2-V69	SCV	9.37	9.47
L2-V70	MCV	9.41	9.47
L2-V71	VN	9.47	9.58
L2-V72	TW	9.5	9.57
L2-V73	LB	9.54	10.01

SN	Vehicle Type	Entry Time	Exit Time
L2-V74	MB	10.04	10.09
L2-V75	PCS	10.12	10.2
L2-V76	TW	10.27	10.37
L2-V77	SCV	10.3	10.34
L2-V78	LCV	10.34	10.41
L2-V79	MCV	10.37	10.43
L2-V80	VN	10.43	10.54
L2-V81	MC	10.51	10.6
L2-V82	MB	10.58	11.09
L2-V83	LCV	11.08	11.16
L2-V84	VN	11.1	11.2
L2-V85	SCV	11.15	11.19
L2-V86	VN	11.17	11.24
L2-V87	LB	11.28	11.39
L2-V88	PC	11.32	11.38
L2-V89	LCV	11.47	11.56
L2-V90	MCV	11.56	11.61
L2-V91	SCV	12.04	12.12
L2-V92	MB	12.15	12.25
L2-V93	PCS	12.19	12.23
L2-V94	MB	12.23	12.3
L2-V95	MC	12.31	12.37
L2-V96	VN	12.37	12.48
L2-V97	LB	12.4	12.49
L2-V98	TW	12.46	12.51
L2-V99	MCV	12.55	12.63
L2-V100	LCV	13.01	13.11
L2-V101	MB	13.14	13.18
L2-V102	PC	13.23	13.3
L2-V103	LCV	13.33	13.44
L2-V104	VN	13.42	13.48
L2-V105	LB	13.5	13.59
L2-V106	SCV	13.51	13.56
L2-V107	MCV	14.06	14.14
L2-V108	MC	14.16	14.26
L2-V109	LB	14.2	14.24
L2-V110	VN	14.29	14.36
L2-V111	VN	14.31	14.37

SN	Vehicle Type	Entry Time	Exit Time
L2-V112	LB	14.44	14.55
L2-V113	PC	14.48	14.57
L2-V114	TW	14.52	14.57
L2-V115	SCV	15.02	15.1
L2-V116	MB	15.04	15.14
L2-V117	VN	15.13	15.17
L2-V118	LCV	15.22	15.29
L2-V119	MCV	15.29	15.4
L2-V120	LB	15.36	15.42
L2-V121	VN	15.51	15.6
L2-V122	LCV	16.02	16.07
L2-V123	MCV	16.12	16.2
L2-V124	SCV	16.17	16.27
L2-V125	MB	16.2	16.24
L2-V126	PCS	16.29	16.36
L2-V127	LCV	16.38	16.44
L2-V128	TW	16.41	16.52
L2-V129	MC	16.47	16.56
L2-V130	PC	16.49	16.54
L2-V131	MB	16.59	16.67
L2-V132	SCV	17.03	17.13
L2-V133	VN	17.14	17.18
L2-V134	TW	17.2	17.27
L2-V135	LCV	17.36	17.47
L2-V136	LB	17.51	17.57
L2-V137	VN	17.56	17.65
L2-V138	MCV	18.03	18.08
L2-V139	SCV	18.08	18.16
L2-V140	LB	18.14	18.24
L2-V141	VN	18.24	18.28
L2-V142	PC	18.32	18.39
L2-V143	LCV	18.4	18.46
L2-V144	MB	18.47	18.58

*Continued up to Serial No: L2-V641

APPENDIX-C : Traffic Data - Pelawatta Junction, Pelawatta

Location : Pelawatta Junction, Pelawatta			
SN	**Vehicle Type**	**Entry Time**	**Exit Time**
L3-V1	VN	1.05	1.14
L3-V2	LCV	1.14	1.19
L3-V3	MCV	1.23	1.31
L3-V4	MB	1.32	1.38
L3-V5	TW	1.36	1.43
L3-V6	LCV	1.49	1.53
L3-V7	MCV	1.59	7.03
L3-V8	SCV	2.04	2.12
L3-V9	PC	2.05	2.09
L3-V10	VN	2.14	2.23
L3-V11	MB	2.32	2.39
L3-V12	LCV	2.36	2.42
L3-V13	VN	2.42	2.47
L3-V14	TW	2.50	2.54
L3-V15	PC	2.58	3.05
L3-V16	LB	3.05	3.13
L3-V17	SCV	3.15	3.22
L3-V18	TW	3.20	3.26
L3-V19	LCV	3.27	3.36
L3-V20	VN	3.33	3.38
L3-V21	SCV	3.44	3.48
L3-V22	LB	3.48	3.58
L3-V23	MCV	3.58	4.05
L3-V24	MC	4.03	4.11
L3-V25	LCV	4.23	4.29
L3-V26	SCV	4.33	4.42
L3-V27	TW	4.46	4.50
L3-V28	VN	4.59	5.06
L3-V29	MCV	5.15	5.25
L3-V30	PC	5.21	5.28
L3-V31	VN	5.28	5.36
L3-V32	LCV	5.34	5.40
L3-V33	MCV	5.45	5.50
L3-V34	MC	5.50	5.54
L3-V35	MB	5.58	6.08

SN	Vehicle Type	Entry Time	Exit Time
L3-V36	LCV	6.03	6.13
L3-V37	SCV	6.07	6.14
L3-V38	VN	6.10	6.18
L3-V39	PC	6.16	6.22
L3-V40	TW	6.27	6.31
L3-V41	LCV	6.41	6.46
L3-V42	SCV	6.44	6.53
L3-V43	MCV	6.53	7.00
L3-V44	LB	6.56	7.04
L3-V45	TW	6.59	7.08
L3-V46	MB	7.07	7.13
L3-V47	VN	7.14	7.18
L3-V48	LCV	7.20	7.25
L3-V49	PC	7.25	7.34
L3-V50	LB	7.30	7.37
L3-V51	MCV	7.35	7.45
L3-V52	MB	7.39	7.47
L3-V53	VN	7.46	7.52
L3-V54	SCV	7.52	7.56
L3-V55	LCV	8.03	8.08
L3-V56	PC	8.15	8.24
L3-V57	SCV	8.23	8.30
L3-V58	MB	8.25	8.35
L3-V59	MC	8.32	8.40
L3-V60	MCV	8.35	8.41
L3-V61	VN	8.41	8.45
L3-V62	LCV	8.52	8.57
L3-V63	SCV	8.57	9.02
L3-V64	TW	9.03	9.10
L3-V65	LCV	9.07	9.17
L3-V66	MCV	9.17	9.25
L3-V67	LB	9.25	9.31
L3-V68	PC	9.30	9.34
L3-V69	TW	9.37	9.42
L3-V70	VN	9.41	9.50
L3-V71	MB	9.47	9.54
L3-V72	SCV	9.50	9.59
L3-V73	LCV	9.54	10.00

SN	Vehicle Type	Entry Time	Exit Time
L3-V74	MCV	10.04	10.10
L3-V75	MC	10.12	10.16
L3-V76	LCV	10.27	10.32
L3-V77	VN	10.30	10.39
L3-V78	MB	10.34	10.41
L3-V79	TW	10.37	10.47
L3-V80	LCV	10.43	10.51
L3-V81	MCV	10.51	10.57
L3-V82	VN	10.58	11.05
L3-V83	LB	11.08	11.13
L3-V84	SCV	11.10	11.19
L3-V85	VN	11.15	11.22
L3-V86	MC	11.17	11.27
L3-V87	MCV	11.28	11.36
L3-V88	SCV	11.32	11.38
L3-V89	LCV	11.47	11.51
L3-V90	VN	11.56	12.03
L3-V91	PC	12.04	12.13
L3-V92	LB	12.15	12.22
L3-V93	VN	12.19	12.29
L3-V94	MCV	12.23	12.31
L3-V95	MB	12.31	12.37
L3-V96	TW	12.37	12.41
L3-V97	LCV	12.40	12.45
L3-V98	SCV	12.46	12.55
L3-V99	MCV	12.55	13.05
L3-V100	PC	13.01	13.11
L3-V101	LB	13.14	13.22
L3-V102	MC	13.23	13.29
L3-V103	VN	13.33	13.37
L3-V104	SCV	13.42	13.47
L3-V105	LCV	13.50	13.59
L3-V106	MB	13.51	13.58
L3-V107	VN	14.06	14.16
L3-V108	TW	14.16	14.24
L3-V109	MCV	14.20	14.26
L3-V110	LB	14.29	14.33
L3-V111	PC	14.31	14.36

SN	Vehicle Type	Entry Time	Exit Time
L3-V112	SCV	14.44	14.53
L3-V113	MCV	14.48	14.55
L3-V114	LCV	14.52	14.59
L3-V115	TW	15.02	15.10
L3-V116	SCV	15.04	15.10
L3-V117	MB	15.13	15.17
L3-V118	LB	15.22	15.27
L3-V119	VN	15.29	15.38
L3-V120	MCV	15.36	15.43
L3-V121	VN	15.51	16.00
L3-V122	SCV	16.02	16.10
L3-V123	LB	16.12	16.18
L3-V124	MB	16.17	16.21
L3-V125	LCV	16.20	16.25
L3-V126	MCV	16.29	16.38
L3-V127	PC	16.38	16.45
L3-V128	LCV	16.41	16.51
L3-V129	VN	16.47	16.55
L3-V130	TW	16.49	16.55
L3-V131	MB	16.59	17.05
L3-V132	MC	17.03	17.08
L3-V133	SCV	17.14	17.23
L3-V134	MCV	17.20	17.27
L3-V135	LCV	17.36	17.46
L3-V136	PC	17.51	17.59
L3-V137	LB	17.56	18.03
L3-V138	VN	18.03	18.07
L3-V139	VN	18.08	18.13
L3-V140	MB	18.14	18.23
L3-V141	TW	18.24	18.31
L3-V142	SCV	18.32	18.42
L3-V143	MC	18.40	18.48
L3-V144	LCV	18.47	18.53
L3-V145	LCV	19.07	19.11
L3-V146	MCV	19.12	19.17
L3-V147	PC	19.18	19.27
L3-V148	VN	19.30	19.37

*Continued up to Serial No: L3-V623

APPENDIX-D : Traffic Data - Battaramulla Junction, Battaramulla

Location : Battaramulla Junction, Battaramulla			
SN	**Vehicle Type**	**Entry Time**	**Exit Time**
L4-V1	LCV	1.06	1.14
L4-V2	MB	1.18	1.25
L4-V3	VN	1.27	1.32
L4-V4	MCV	1.35	1.44
L4-V5	PC	1.42	1.53
L4-V6	PCS	1.48	1.54
L4-V7	MC	1.51	1.61
L4-V8	LCV	1.59	1.63
L4-V9	VN	2.03	2.08
L4-V10	TW	2.14	2.22
L4-V11	MC	2.18	2.24
L4-V12	LB	2.27	2.36
L4-V13	SCV	2.39	2.50
L4-V14	LCV	2.46	2.53
L4-V15	LB	2.51	2.55
L4-V16	MC	3.03	3.13
L4-V17	PCS	3.11	3.19
L4-V18	VN	3.20	3.25
L4-V19	LCV	3.26	3.32
L4-V20	MB	3.37	3.48
L4-V21	SCV	3.47	3.54
L4-V22	TW	3.56	4.02
L4-V23	SCV	4.02	4.11
L4-V24	MCV	4.14	4.24
L4-V25	LB	4.19	4.24
L4-V26	PC	4.30	4.36
L4-V27	LB	4.34	4.42
L4-V28	VN	4.41	4.52
L4-V29	MCV	4.47	4.54
L4-V30	MC	4.56	4.60
L4-V31	LCV	5.02	5.11
L4-V32	TW	5.24	5.34
L4-V33	LB	5.28	5.33
L4-V34	VN	5.38	5.46
L4-V35	MB	5.44	5.50

SN	Vehicle Type	Entry Time	Exit Time
L4-V36	MCV	5.47	5.54
L4-V37	LB	5.54	5.65
L4-V38	LCV	6.04	6.08
L4-V39	PC	6.20	6.29
L4-V40	LB	6.27	6.32
L4-V41	VN	6.33	6.43
L4-V42	TW	6.45	6.53
L4-V43	SCV	6.50	6.56
L4-V44	MC	6.53	6.59
L4-V45	LCV	6.59	7.06
L4-V46	MB	7.07	7.11
L4-V47	MCV	7.08	7.17
L4-V48	VN	7.14	7.19
L4-V49	TW	7.18	7.28
L4-V50	LB	7.25	7.33
L4-V51	SCV	7.32	7.38
L4-V52	MC	7.39	7.46
L4-V53	PCS	7.56	8.02
L4-V54	MCV	8.06	8.10
L4-V55	PC	8.15	8.24
L4-V56	MB	8.17	8.22
L4-V57	LCV	8.29	8.39
L4-V58	VN	8.40	8.48
L4-V59	LCV	8.51	8.57
L4-V60	MC	8.55	9.00
L4-V61	SCV	8.59	9.03
L4-V62	LB	9.01	9.05
L4-V63	TW	9.09	9.18
L4-V64	VN	9.09	9.14
L4-V65	MCV	9.20	9.30
L4-V66	PC	9.35	9.43
L4-V67	MB	9.37	9.43
L4-V68	MC	9.45	9.52
L4-V69	LCV	9.53	9.64
L4-V70	LB	10.08	10.12
L4-V71	PCS	10.13	10.22
L4-V72	TW	10.17	10.22
L4-V73	VN	10.23	10.33

SN	Vehicle Type	Entry Time	Exit Time
L4-V74	SCV	10.29	10.37
L4-V75	LB	10.40	10.46
L4-V76	MC	10.49	10.56
L4-V77	MB	10.53	10.64
L4-V78	VN	10.59	11.02
L4-V79	MCV	11.09	11.18
L4-V80	LB	11.15	11.20
L4-V81	LCV	11.32	11.42
L4-V82	LB	11.35	11.43
L4-V83	TW	11.41	11.47
L4-V84	PC	11.51	11.58
L4-V85	VN	11.53	12.02
L4-V86	LCV	12.03	12.07
L4-V87	MCV	12.09	12.18
L4-V88	MC	12.17	12.22
L4-V89	MB	12.21	12.31
L4-V90	VN	12.26	12.34
L4-V91	SCV	12.35	12.41
L4-V92	LCV	12.41	12.48
L4-V93	LB	12.48	12.59
L4-V94	VN	13.05	13.09
L4-V95	TW	13.07	13.16
L4-V96	LB	13.16	13.21
L4-V97	MCV	13.22	13.32
L4-V98	MB	13.42	13.50
L4-V99	LCV	13.47	13.53
L4-V100	SCV	13.59	14.03
L4-V101	PCS	14.03	14.14
L4-V102	LB	14.16	14.20
L4-V103	MC	14.22	14.31
L4-V104	VN	14.29	14.34
L4-V105	LCV	14.37	14.47
L4-V106	LB	14.47	14.55
L4-V107	VN	14.51	14.57
L4-V108	SCV	15.03	15.10
L4-V109	MB	15.10	15.21
L4-V110	MCV	15.14	15.18
L4-V111	TW	15.22	15.31

SN	Vehicle Type	Entry Time	Exit Time
L4-V112	MC	15.26	15.31
L4-V113	LCV	15.36	15.46
L4-V114	PCS	15.59	16.05
L4-V115	MB	16.04	16.10
L4-V116	VN	16.11	16.18
L4-V117	LCV	16.20	16.31
L4-V118	VN	16.23	16.27
L4-V119	LB	16.32	16.41
L4-V120	MC	16.39	16.44
L4-V121	LCV	16.50	16.60
L4-V122	SCV	16.55	17.03
L4-V123	TW	17.03	17.09
L4-V124	MB	17.20	17.27
L4-V125	PCS	17.30	17.41
L4-V126	MC	17.41	17.45
L4-V127	MCV	17.44	17.53
L4-V128	VN	17.51	17.56
L4-V129	LCV	17.56	18.05
L4-V130	LB	18.06	18.14
L4-V131	TW	18.14	18.20
L4-V132	LCV	18.19	18.26
L4-V133	VN	18.26	18.37
L4-V134	SCV	18.35	18.39
L4-V135	MB	18.47	18.56
L4-V136	LCV	18.55	19.02
L4-V137	LB	19.07	19.17
L4-V138	MC	19.10	19.18
L4-V139	VN	19.14	19.20
L4-V140	MCV	19.24	19.31
L4-V141	LB	19.33	19.44
L4-V142	LCV	19.46	19.50
L4-V143	TW	19.51	19.60
L4-V144	PCS	19.58	20.05
L4-V145	MB	20.00	20.10
L4-V146	LCV	20.00	20.08
L4-V147	VN	20.00	20.06
L4-V148	MC	20.00	20.07

*Continued up to Serial No: L4-V689

APPENDIX-E : Traffic Data - Thalawathugoda Junction, Thalawathugoda

Location : Thalawathugoda Junction, Thalawathugoda.			
SN	**Vehicle Type**	**Entry Time**	**Exit Time**
L5-V1	MB	1.00	1.05
L5-V2	MCV	1.10	1.18
L5-V3	MC	1.20	1.29
L5-V4	LB	1.25	1.36
L5-V5	LCV	1.30	1.36
L5-V6	LB	1.40	1.47
L5-V7	TW	1.50	2.00
L5-V8	TW	2.05	2.10
L5-V9	LCV	2.10	2.14
L5-V10	SCV	2.20	2.32
L5-V11	LCV	2.25	2.31
L5-V12	MB	2.35	2.44
L5-V13	VN	2.40	2.48
L5-V14	VN	2.50	2.57
L5-V15	VN	2.55	2.60
L5-V16	TW	3.05	3.15
L5-V17	SCV	3.10	3.14
L5-V18	MB	3.15	3.21
L5-V19	LCV	3.20	3.32
L5-V20	PC	3.30	3.39
L5-V21	MC	3.40	3.51
L5-V22	MCV	3.45	3.50
L5-V23	PC	3.55	4.02
L5-V24	PC	4.05	4.13
L5-V25	SCV	4.15	4.25
L5-V26	MC	4.20	4.24
L5-V27	LCV	4.25	4.31
L5-V28	LCV	4.35	4.46
L5-V29	PC	4.40	4.49
L5-V30	SCV	4.50	4.55
L5-V31	VN	4.55	5.03
L5-V32	VN	5.05	5.13
L5-V33	MCV	5.10	5.20
L5-V34	MB	5.15	5.27
L5-V35	LCV	5.30	5.36

SN	Vehicle Type	Entry Time	Exit Time
L5-V36	LCV	5.35	5.44
L5-V37	TW	5.40	5.44
L5-V38	TW	5.55	6.01
L5-V39	LB	6.05	6.12
L5-V40	SCV	6.10	6.21
L5-V41	TW	6.20	6.28
L5-V42	MC	6.25	6.35
L5-V43	MCV	6.30	6.39
L5-V44	MB	6.35	6.41
L5-V45	LCV	6.45	6.57
L5-V46	VN	6.55	7.03
L5-V47	SCV	7.10	7.17
L5-V48	PC	7.15	7.19
L5-V49	LB	7.25	7.33
L5-V50	VN	7.30	7.41
L5-V51	MCV	7.35	7.45
L5-V52	LB	7.40	7.49
L5-V53	LCV	7.50	7.56
L5-V54	MB	7.55	8.00
L5-V55	TW	8.05	8.12
L5-V56	SCV	8.15	8.26
L5-V57	PC	8.20	8.24
L5-V58	LCV	8.25	8.33
L5-V59	TW	8.30	8.42
L5-V60	VN	8.35	8.45
L5-V61	MB	8.45	8.54
L5-V62	VN	8.50	8.56
L5-V63	VN	9.05	9.12
L5-V64	SCV	9.10	9.15
L5-V65	MCV	9.15	9.26
L5-V66	PC	9.20	9.24
L5-V67	MC	9.25	9.33
L5-V68	LB	9.45	9.57
L5-V69	TW	9.50	10.02
L5-V70	LCV	9.55	9.62
L5-V71	MCV	10.05	10.14
L5-V72	VN	10.10	10.16
L5-V73	SCV	10.20	10.25

SN	Vehicle Type	Entry Time	Exit Time
L5-V74	LCV	10.25	10.36
L5-V75	MB	10.30	10.38
L5-V76	VN	10.35	10.39
L5-V77	TW	10.50	11.01
L5-V78	LCV	10.55	11.06
L5-V79	SCV	11.10	11.17
L5-V80	VN	11.15	11.24
L5-V81	VN	11.25	11.31
L5-V82	MB	11.30	11.41
L5-V83	VN	11.35	11.40
L5-V84	LB	11.45	11.53
L5-V85	TW	11.50	11.54
L5-V86	PC	11.55	11.65
L5-V87	SCV	12.05	12.14
L5-V88	MC	12.10	12.17
L5-V89	MCV	12.15	12.21
L5-V90	MCV	12.20	12.32
L5-V91	VN	12.30	12.41
L5-V92	LCV	12.40	12.48
L5-V93	SCV	12.45	12.50
L5-V94	LCV	12.50	13.04
L5-V95	TW	13.05	13.14
L5-V96	LB	13.15	13.19
L5-V97	PC	13.20	13.27
L5-V98	PC	13.25	13.31
L5-V99	VN	13.30	13.41
L5-V100	MB	13.40	13.48
L5-V101	LB	13.50	13.62
L5-V102	VN	14.05	14.14
L5-V103	SCV	14.10	14.20
L5-V104	VN	14.20	14.25
L5-V105	MC	14.25	14.29
L5-V106	VN	14.30	14.37
L5-V107	MCV	14.40	14.46
L5-V108	LCV	14.55	14.63
L5-V109	LCV	15.00	15.11
L5-V110	LB	15.10	15.22
L5-V111	SCV	15.15	15.24

SN	Vehicle Type	Entry Time	Exit Time
L5-V112	TW	15.25	15.35
L5-V113	MCV	15.30	15.35
L5-V114	LB	15.35	15.42
L5-V115	MB	15.45	15.49
L5-V116	LCV	15.45	15.51
L5-V117	PC	15.55	16.03
L5-V118	SCV	16.00	16.11
L5-V119	LCV	16.05	16.14
L5-V120	MC	16.15	16.27
L5-V121	VN	16.25	16.35
L5-V122	VN	16.30	16.35
L5-V123	TW	16.35	16.42
L5-V124	TW	16.40	16.44
L5-V125	SCV	16.50	16.56
L5-V126	MB	16.55	17.00
L5-V127	MB	17.05	17.16
L5-V128	LB	17.10	17.19
L5-V129	PC	17.20	17.30
L5-V130	MCV	17.30	17.35
L5-V131	LB	17.35	17.42
L5-V132	SCV	17.45	17.49
L5-V133	PC	17.50	17.56
L5-V134	LCV	17.55	18.06
L5-V135	VN	18.10	18.21
L5-V136	VN	18.20	18.32
L5-V137	VN	18.25	18.34
L5-V138	TW	18.30	18.40
L5-V139	SCV	18.40	18.45
L5-V140	VN	18.45	18.52
L5-V141	MB	18.50	18.54
L5-V142	VN	19.00	19.06
L5-V143	MC	19.05	19.13
L5-V144	LCV	19.10	19.21
L5-V145	TW	19.15	19.27
L5-V146	VN	19.20	19.29
L5-V147	MCV	19.25	19.35
L5-V148	SCV	19.30	19.35

*Continued up to Serial No: L5-V703