Journal of the Eastern Asia Society for Transportation Studies, Vol.13, 2019

Experience of Automatic Traffic Data Collection for Development of Adjustment Factors in Colombo Suburban

R.W. AHAMED [a], T.N. LANKATHILAKE [b], N. AMARASINGHA [c*]

[a,b,c] *Sri Lanka Institute of Information Technology, New Kandy Road, Malabe, Sri Lanka*
[a] *E-mail: waajith100@gmail.com*
[b] *E-mail: nilupul.lanka@gmail.com*
[c] *E-mail: niranga.a@sliit.lk*

Abstract: Annual Average Daily Traffic (AADT) is one of the key parameters in the field of transportation. It is traditionally used for planning and designing purposes in road sector. This research was carried out for development of adjustment factors for AADT estimation two-way two-lane road of Colombo suburban. Malabe-Kaduwele roadway was selected to conduct the research. Data were collected using automatic traffic counter (Metro-Count device) at Malabe-Kaduwele road in front of SLIIT Malabe campus for the period of five and half months. From the data, hourly expansion factors (HEF) and daily expansion factors (DEF) were estimated. The data collection period was not sufficient to develop monthly expansion factors (MEF) but an attempt was made to develop factors for months fall in data collection period. The experience obtained in this study could be used for developing adjustment factors in future.

Keywords: AADT; Metro-Count Instrument; Adjustment Factor

1. INTRODUCTION

AADT estimation is one of the primary tasks in transportation engineering field. It mainly uses for pavement design, pedestrian infrastructure design, signalization, geometric design, and highway design. Vehicle counts usually collect using Automated Traffic Recording (ATR) counters or manual observation. In this study, vehicle volume was collected for long period of time. The vehicle density is very high in Colombo suburban and there are various vehicle types in Sri Lanka. A Street in Colombo suburban is shown in Figure 1. As number of vehicles at the road is very high and data for long period were needed, ATR method was selected for this study. Using ATR counters, data can be collected by type of vehicle.

AADT is defined by the sum of the entire year traffic volume at a highway location over a full year (Wang, 2012). Accurate estimation of AADT is needed for conducting studies on any traffic related infrastructure, such as roads, overheads, bridges, pedestrian crossings, traffic lights etc. Many developing countries such as Egypt, Canada, and India are using permanent traffic counters for accurate estimation of AADT (Mohamed, 2010). Those can use to collect traffic volume for a year and it is possible to identify one-year time series data and seasonal factors. But some situations, short term traffic counters are used to estimate the AADT. Since the traffic volume increase rapidly over the time in Sri Lanka it is difficult to get an accurate AADT estimation. Therefore, adjustment factors are developed to calculate accurate AADT for highways, however; as per authors' knowledge the adjustment factors for Sri Lankan roads have not been developed. The objective of this research project was to develop adjustment factors for New Kandy road.

Figure 1. Two-lane two-way highway at Colombo Suburban

1.1 Introduction of PCU Factor

Each vehicle category consists of different characteristics such as, headway, speed, density etc. The Passenger Car Unit (PCU) factor is used to compare different vehicle types with respect to single car. PCU factors developed for various vehicle types in Sri Lanka are mentioned in Table 1. These data were collected from Road Development Authority (RDA) of Sri Lanka. In this study, these PCU data were used to calculate the vehicle volume with a customized vehicle classification system.

Table 1. The PCU factors for vehicles in Sri Lanka (Source: RDA)

Class	Vehicle type	PCU Factor
1	CYCLE	0.3
2	2WHLR (2 wheeler)	0.5
3	3WHLR (3 wheeler)	1.2
4	TRCT (tractor)	5.6
5	TRCT + TRL (tractor with trailer)	5.6
6	SCV (small commercial vehicle)	1
7	LMV (light motor vehicle)	1
8	LCV (light commercial vehicle)	2.8
9	TB2 (truck or bus with 2 axles)	2.4
10	TB3 (truck or bus with 3 axles)	4.3
11	MAV (multi – axle vehicle)	12
12	OSV (oversize vehicle)	12
13	CYCRSHW (cycle rickshaw)	0.5

In the United States (US), density method is used as a common method. However, the PCU values derived from the density method are based on underlying homogeneous traffic concept such as strict lane discipline, car following and a vehicle fleet that does not vary greatly in width. In this study, these PCU factors are used to convert all vehicles to single car units for estimation of the adjustment factors.

1.2 Annual Average Daily Traffic

In the area of traffic engineering, the traffic volume is expressed in different ways; Average Annual Daily Traffic (AADT), Average Daily Traffic (ADT), and Peak Hour Volume (PHV). AADT is the average of twenty-four-hour vehicle counts collected every day in one year. This parameter mainly uses for estimation of highway user revenues, computation of accident rates in terms of accidents per 100 million vehicle-miles, establishment of traffic volume trends, improvement of freeway and major arterial street systems, and development of improvement and maintenance programs.

ADT is the average of twenty-four-hour vehicle counts collected minimum one day and less than a year. This is used for planning of highway activities, measurement of current demand and evaluation of existing traffic flow. AADT is not usually estimate in Sri Lanka by RDA other than a project needs as it takes time consuming and the cost is high. The RDA as the main responsible institute for road sector in Sri Lanka, it handles the development and maintenance of the national roadways which include the Trunk road (A class), main roads (B class) and expressways. Also, it handles the planning, design, and construction of new highways and bridges. If RDA construct a bridge or road project, before starting the project, it collects the traffic counts for three to four months and calculate the ADT and use the ADT for only the planning and construction work**.**

1.3 ADT Determination Method

Manual data collection method is used to gather data for determining vehicle classification, turning movement, direction of travel, vehicle occupancy. The manual data collection is performed in following situations where,

- small sample data at any given location,
- when automated equipment is not justified or unavailable, and
- the periods are less than a day.

The normal intervals for data collection are 5, 10 and 15 minutes. The data are collected on Tuesdays, Wednesdays, and Thursday. On Mondays and Fridays are not usually used for data collection as those days have different traffic patterns. Since, manual data collection is not a suitable for long term projects, automotive data collection methods are used in this study. The collected data set in the project consists of continuous five and half month data. ATR counts are usually taking 1-hour intervals for each 24-hour period. Permanent counters, portable counters, and videotapes can be considered as automatic counters.

2. LITERATURE REVIEW

Both short-term traffic count and long-term traffic count data can be used for estimating AADT but most of the time, data for short-term traffic counts are used because long-term or Permanent Traffic Counters (PTC) are installed in limited sites.

Jung and Ju (2014) estimated AADT using daily adjustment factors for Institute of Construction Technology in Korea. Federal Highway Administration (FHWA) Traffic Monitoring Guide in the US was proposed the adjustment factor application model to estimate the AADT. To estimate AADT, monthly and weekly adjustment factors were used in this model. But this method did not give satisfied aspect of daily pattern. Therefore, daily factor was used to estimate the AADT in this research. Daily factor was enhanced the accuracy of AADT then compared to other monthly or weekly factors. In this study there were three analyzing method; first method was to apply existing adjustment factors; and second method was to apply adjustment factors of the group using adjustment factor grouping; and then as the last method, daily factors were applied. Examination was done on 101 points in sections with more than one PTC points. Mean Absolute Percentage Error (MAPE) which is commonly consumed as error assessment index was used in this study. As AADT is one of the main factors for road designing, planning and other traffic problem, it should be very accurate. Therefore, to estimate the accuracy of AADT, adjustment factors were suggested.

Granato (1994) studied the impact of factoring traffic counts for daily and monthly variation in decreasing sample calculating error. Transportation agencies usually examine the AADT for designing and planning work in roads. Day of week and seasonal variations in traffic volume were collected at a lesser number of permanent ATR stations. In this study, the data were collected during 1991 and 1994 using daily traffic counts at 12 ATR stations. One of them is located on a local arterial street (Johnson Avenue) in a housing area at the city of Cedar Rapids. This research was conducted for main three reasons. First one is to help agencies for compare the changes of count traffic volume, second was to determine time occupied to reach wanted level of accuracy in the count, and last one was improving the standard for traffic forecasting model performance to help planning groups. Finally, through this study above mentioned three reasons were checked and analyzed. Also, reduction of sample counting error was analyzed.

Ahamed (2007) conducted on study on AADT, %k factor (the proportion of AADT occurring in a one hour), D-factor (traffic moving in the peak travel direction during the 30th highest hourly volume of the year), Design Hour Volume (DHV), and design lane factor in Kuwait. Before this study was conducted, the values had been assumed and used for pavement design and geometric design. Kuwait is a one of the quickly developed country and more than 2.5 million peoples lived in 2006. Roads in urban area of Kuwait are classified as special road network, primary road network, secondary roads, and local roads. Permanent count station which were created in every type of urban road first time in Kuwait and developed the expansion factors. The developed expansion factors would helpful to do actual designing and planning work in Kuwait.

A research on AADT estimation from Seasonal Traffic Counts (STC) was conducted by Gastaldi et al. (2012). The data were collected and tested in the province of Venice in Italy. Data were collected for period of one year in which STC stations were reserved. Correct results were calculated through this method. Analysis was done regarding traffic data from fifty ATR sites of the monitoring program. Every ATR monitored the two-lane road section, recorded hourly directional traffic volumes on a single lane and defined temporal traffic method in great detail. Traffic volume data were collected as two groups. First one was passenger vehicles and second was trucks. But this case-study was targeted for passenger vehicles only for estimating AADT. Finally, the collected data for passenger vehicle from fifty ATR stations were used for the analysis. The accuracy of AADT estimates was measured by MAPE and Standard Deviation of Absolute Percentage Error (SDAPE). The land use and socio-economic features were analyzed for accuracy of AADT estimation. Final results of estimates were evaluated by comparing the actual AADT for an ATR site with the estimated AADT from each STC for the same site. For each STC, the percent absolute estimation error was also calculated.

Sabry et al. (2007) determined AADT from certain peak hours design volumes for certain intercity road in Egypt. Traffic data of year 2002 for a selected station were used in the calculation of traffic volume. Actual and theoretical AADT were calculated from both one peak hour and the percentage of the four peak hours and compared to each other. By this way, the AADT could be estimated or forecasted for the station by using certain few peak hour traffic volumes record and this will reduce the cost of recording traffic volumes and make it cheaper. Twelve Station of daily traffic count statistics were analyzed from January to December in 2002. The average annual, monthly and weekly daily traffic volumes were calculated form the data. Final result of this study gave three models that were presented for determining the AADT. Model 1 estimates the AADT from only one peak hour traffic volume, Model 2 estimates the AADT from short period survey of traffic volumes, and Model 3 determines theoretical AADT for each month of the year in all stations.

Sakib et al. (2017) develop a statewide AADT estimation model from data of short-term counts for South Carolina. Departments of Transportation (DOT)s in US continually collect traffic count using both permanent count stations (i.e., ATRs) and temporary short-term count stations. In South Carolina, 87% of the ATRs are located on interstates and arterial highways. In the most secondary highways such as collectors and local roads, AADT is estimated based on short term counts. This paper developed AADT estimation models for different roadway functional classes with two machine learning techniques: Artificial Neural Network and Support Vector Regression (SVR). The models were to predict AADT from short-term counts. The results were first compared against each other to identify the best model. Then, the results of the best model were compared against a regression method and factor-based method. The comparison revealed the superiority of SVR for AADT estimation for different roadway functional classes over all other methods. Among all developed models for different functional roadway classes, the SVR-based model showed a minimum root mean square error of 0.22 and a MAPE of 11.3% for the interstate/expressway functional class. This model also showed a higher R-squared value compared to the traditional factor-based model or regression model.

Annual Average Daily Bicycle Traffic (AADB) was estimated with adjustment factors by Mohamed (2010) in Vancouver city, Canada. Main target to do this study was to analyze the correctness of estimation of AADB traffic measurements using daily and monthly adjustment factors. AADB was estimated in two stages. In initial stage, one day of actual bicycle counts data were factored by a DEF to estimate a MADB volume and second stage was, the estimated MADB was multiplied by a monthly–seasonal adjustment factor to estimate the AADB. Between 2005 and 2011, higher than 810,000 hours of bicycle count data were recorded by using “permanent inductive loop counters” fixed in some location in City of Vancouver. Automatically collected data from traffic count stations were used to develop adjustment factors. Completely one year of everyday bicycle volume data were recorded in 12 count stations in Vancouver and analyzed them. In this research, every factor was analyzed to estimate AADB with the lowest error. Finally, the best way was taken to estimate AADB with accuracy that is short count data collection during normal weekdays in either July or August. Finally, this research discussed the ways to compute the adjustment factors with predicted correctness. As well as, the outcomes of this paper gave some of error analyzing, when DEFs and MEFs were used to evaluate the annual averages of bicycle volumes.

Daily and monthly adjustment factors are commonly use to evaluate daily traffic volume. Esawey et al. (2010) developed and evaluated these factors for non-motorized traffic, of cycling. Some problems associated to the expansion and presentation of daily adjustment factors for bicycle traffic were discovered in this study. That included quality of the collected data and malfunctions of automatic counters. The data were collected for 500 months daily bicycle counting. It was sheltered in the city of Vancouver for 74 links, Canada. These data were collected during 2010 and 2011. Some different methods were used in this study to collect the data of average daily cycling volumes for month. MAPE was used to calculate the accuracy of the estimated MADBs. Error estimation of MADB was divided into three elements first one is a fixed component second is a spatial transferability component and last one was a temporal transferability component. Finally, the greatest valuation results of the monthly average cycling capacities were obtained through daily factors dividing by climate situations.

A method for estimating AADT on all Louisiana Roads was developed by Subasish and Xiaoduan (2015). In Louisiana, nearly 73% of the highways are non-state roadways, meaning they are not under DOT roadway network. Traffic volumes on these roads are generally fairly low, and vehicle-miles-traveled (VMT) on these roads is much less compared with that on interstate or arterial roads. Thus, regularly conducting traffic count is not economically feasible for non-state roadways. This study developed an AADT estimation methodology by using modern statistical and pattern recognition methods. By using available traffic counts on non-state roadways and four variables: population, job, distance to intersection and to major state highways at block level; a training set to estimate roadway AADT for eight parishes were obtained by a modified SVR method.

3. METHODOLOGY

3.1 Selection of Site

Malabe-Kaduwele roadway was selected to develop the daily, monthly, and hourly adjustment factors. Malabe is one of the rapidly developing area in Colombo suburban with few private universities, Nevil Fernando teaching hospital, hotels, and schools etc. A site, close to SLIIT at Malabe-Kaduwele road was selected as a suitable place to start the research, as this is a representative site and convenient for data collection. Every year population and vehicular movement are increasing in Malabe, Kaduwele, and nearby area. So, this AADT estimation is also helpful to evaluate the condition of New Kandy road, Malabe in future.

The data were collected using an automatic traffic counter. A suitable place to install an automatic traffic counter was selected considering safety and security. The place shown in Figure 2 was identified as a secure place and installed automatic traffic counter. With the permission of RDA, the instrument was installed on 02nd of April 2018.

Figure 2. Metro-Count installed location

3.2 Installation of Automatic Counter

The MC5600 Vehicle Classifier System (Metro-Count) which used for this study records the data related to vehicle axle, and speed. The configured Traffic Executive™ software provides the details of class of vehicle, speed, and gap of vehicles passing through. Based on the time-stamping approach, pioneered by Metro-Count, post-survey analysis gives an image of traffic volume, speed, class, direction, headway, etc. Automatic traffic counter roadside data collection devices have pneumatic tubes that are put across a road and secured on both sides. Then after one side of the pneumatic tubes has to put on the logger. Here, the automatic traffic counter collects the data using pulse of air. When a vehicle's axle crosses the road tube, the air is creating the pulse. It is used to determine the vehicle classes, speed, direction and total volume through this instrument.

3.3 Data Collection and Analyzing Method

Data were collected using automatic traffic counter from 03.04.2018 to 17.09.2018. Equation 1 was used to calculate the hourly expansion factor (HEF) (Garber and Hoel, 2015).

$$\frac{\text{Total volume for 24 hrs period}}{\text{Traffic volume of particular hours}} = HEF \tag{1}$$

During the period of 168 days, the total vehicle count was recorded. The average traffic volume of particular hours is defined as the particular hourly vehicle volume for 168 days. Finally, the average volume of each hour was estimated, dividing the total traffic volume by number of days. For verification purpose, vehicle counts of two hours were done by manual observation method. It was done two different days during evening peak hour. First manual data collection was done 21st August 2018 on Tuesday and second was done on 23rd August 2018. The speed tests were conducted to verify the findings. The 85th percentile speed and mean speed were calculated in this study for 24 hours, 7 days and 6 months. The hourly speeds, the 85th percentile speed, and mean speed were calculated for every particular hour. During the peak hour mean speed and 85th percentile speed were recorded. After that, the data which were collected for 168 days, were used for DEF calculation. Using the same data which is collected from 03.04.2018 to 17.09.2018 calculated DEF using Equation 2 (Garber and Hoel, 2015).

$$\frac{\text{Total volume for 24 hrs period}}{\text{Traffic volume of particular hours}} = DEF \tag{2}$$

As data for 24 weeks were completed in order to get the average weekly volume, the total vehicle volume of 24 weeks was added and divided by 24. To obtain the volume of particular day (i.e; Sunday, Monday, etc.), for 24 weeks, the total vehicle amount for that particular day was added and divided by 24. Even through six months of data were collected, an attempt was made to estimate the monthly expansion factors with collected data. The MEF is used to estimate AADT from the ADT for given month by multiplying by MEF as shown in Equation 3.

$$\frac{\text{AADT}}{\text{ADT of particular months}} = MEF \tag{3}$$

4. RESULTS AND DISCUSSION

In this study, hourly, daily, monthly expansion factors were estimated and that used to evaluate the AADT. Furthermore, vehicle volume was estimated according to the class of the vehicle.

4.1 Hourly Expansion Factors

During the period of 168 days, the total vehicle count was recorded as 8,796,638.9 pcu. And the mean average daily volume was calculated as 1,599,388.89. The hourly vehicle volumes were added separately as shown in Table 2.

Table 2. Hourly expansion factors, 85 percentile speed, and mean speed at Malabe-Kaduwala Roadway

Hrs.	No of days	Traffic Hours per day	168 days' Traffic Volume for particular hours	168 days' Traffic Volume for 24 Hrs. Period	HEF	85 percentile speed	Mean Speed
1	168	0000-0100	97,646.4	8,796,638.9	90.09	54.60	43.65
2	168	0100-0200	65,580.0	8,796,638.9	134.14	57.26	45.88
3	168	0200-0300	55,291.1	8,796,638.9	159.10	58.15	46.71
4	168	0300-0400	58,759.8	8,796,638.9	149.71	59.45	47.3
5	168	0400-0500	78,378.2	8,796,638.9	112.23	58.72	46.92
6	168	0500-0600	188,511.7	8,796,638.9	46.66	52.41	42.89
7	168	0600-0700	414,624.4	8,796,638.9	21.22	46.44	37.91
8	168	0700	559,836.1	8,796,638.9	15.71	37.73	30.17
9	168	0800	503,521.7	8,796,638.9	17.47	32.22	25.25
10	168	0900	504,795.0	8,796,638.9	17.43	33.42	26.59
11	168	1000	483,345.3	8,796,638.9	18.20	32.68	25.95
12	168	1100	488,571.8	8,796,638.9	18.00	32.54	25.81
13	168	1200	477,299.7	8,796,638.9	18.43	31.93	25.34
14	168	1300	477,034.6	8,796,638.9	18.44	33.92	26.28
15	168	1400	470,473.5	8,796,638.9	18.70	33.70	27.14
16	168	1500	469,471.6	8,796,638.9	18.74	33.38	26.63
17	168	1600	501,821.7	8,796,638.9	17.53	31.71	25.07
18	168	1700	487,124.8	8,796,638.9	18.06	28.51	22.44
19	168	1800	479,407.0	8,796,638.9	18.35	25.92	20.44
20	168	1900	472,452.7	8,796,638.9	18.62	28.57	22.56
21	168	2000	444,311.7	8,796,638.9	19.80	32.64	26.12
22	168	2100	351,175.4	8,796,638.9	25.05	38.46	31.38
23	168	2200	241,133.6	8,796,638.9	36.48	45.63	37.36
24	168	2300	148,470.0	8,796,638.9	59.25	51.10	41.06

For example, to get the total volume of hour 0:00-1:00, the volume of 0:00-1:00 hour of all 168 days were added. Then, those values were divided by 8,796,638.9 pcu to get the HEF. The 85-percentile speed and mean speed for each hour were tabulated against the respective hour in the same Table.

The histogram in Figure 2 represents the total number of vehicles from 00:00 to 23:00-hour vehicle volume. The 00:00 in the graph represent the total vehicle volume which is interval of 00:00-01:00. Significantly low number of vehicles were travelled in early morning time (00:00 – 05:00). After that there was a sudden increase in the volume of vehicle

07:00 to 09:00 range, mainly due to number of private campuses, Nevil fernando teaching hospital, and famous schools are situated in Malabe to Kaduwele road. High number of commuters use this road to go Bathramulle, Athurukiriya and Kolpitiye for working and other activities. Morning 7:00-8:00 and evening 5:00-6:00 were identified as peak hours in this roadway. But as per the Figure 2, it was noted that more traffic volume in the morning than in the evening in Malabe to Kaduwela roadway.

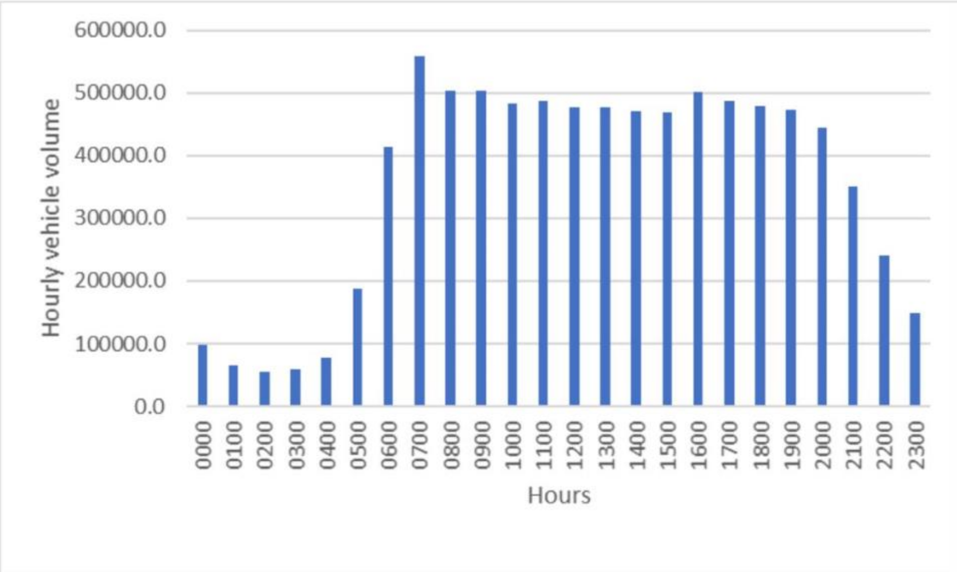

Figure 2. Hourly vehicle flow histogram at Malabe-Kaduwela Roadway

According to the Figure 2, the vehicle volume did not increase in evening hours where peak hour was expected. Therefore, a manual data counts were done during evening hours and the peak hour was found to be 5:00-6:00 pm. Total traffic volume estimated in the peak hour was 2,812 pcu through the manual data collection. At the same time 2,763 pcu were estimated through automatic data collection (from automatic traffic counter). The difference was 49 pcu and similar number of difference was observed during second manual data collection during evening peak hours on 23rd August 2018.

The Automatic traffic counter speed range is (10-160) Km/h speed. Therefore, Metro-Count instrument does not have the capability to recorded vehicle speed which is below 10 Km/h and above 160 Km/h. But, during the peak hour time the instrument had recorded the mean speed as 20.44 Km/h. As per the manual speed survey, during the peak hour, the average mean speed was around 10 Km/h. Therefore, those vehicles which had speeds less than 10 km/h were not recorded in this peak hour time. This may be the main reason for the peak hour traffic volume reduction with automatic traffic counter. Following reasons were also the identified causes for this deviation between manual data and automotive data collection.

- During the traffic congestion, vehicles were moving very slowly and 15 minutes or 20 minutes were taken to travel 500m distance. But the automatic traffic counter was recorded traffic volume in every one-hour interval. Therefore, number of vehicles which was passing through the pneumatic tubes also lower than other time.
- During the peak hour, some vehicles were stopped on the pneumatic tubes. At the same moment in other way vehicle may cross the tubes. Which may not create the pulse.
- There was a 500cm space between the edge of tube and edge of the road. During the

traffic congestion, some motorcyclists were travelling through that 500cm space as shown in the arrow at Figure 3. Therefore, these motorcycles may not be recorded in automatic traffic counter.

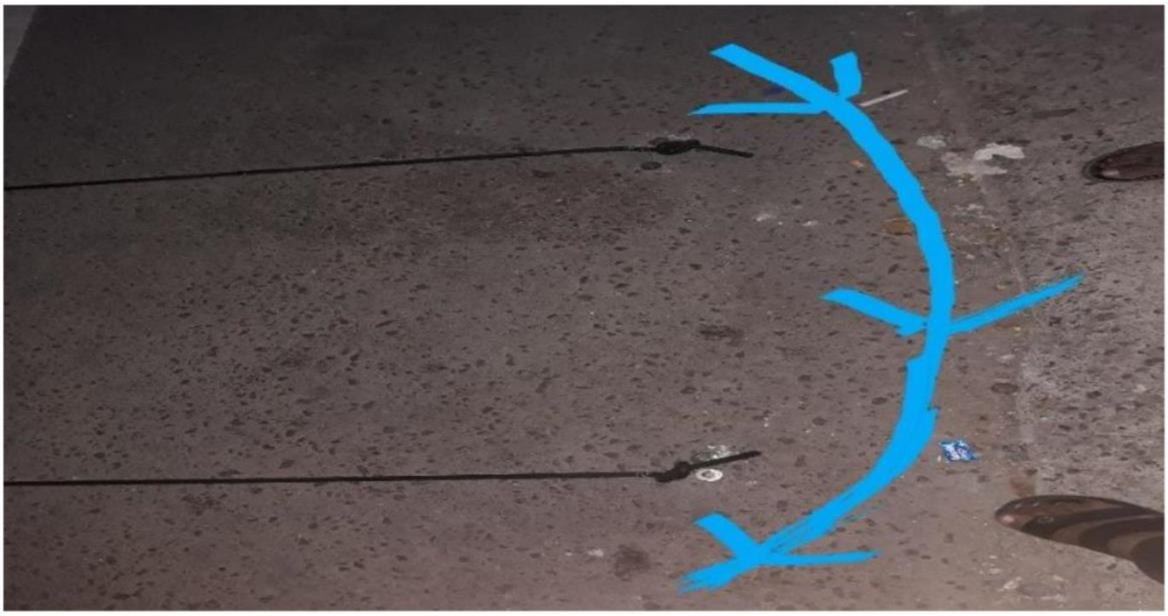

Figure 3. The path follows by some motorcycles avoid recording the counters

4.2 Daily Expansion Factors

In this study, 168 days of vehicle counts were collected and based on those data traffic volumes and DEF were calculated. In 168 days consist with 24 weeks. The 85 percentile speed and mean speed for each day of the week were tabulated against the respective day in the Table 3.

Table 3. Daily expansion factors, 85 percentile speed, and mean speed at Malabe-Kaduwala Roadway

Day of the week	Total volume of 24 week for the respected day	Total weeks	Average volume of the respected day	DEF	85 percentile speed	Mean Speed
Monday	1,260,915.5	24	52,538.1	6.31	38.2	28.9
Tuesday	1,274,242.7	24	53,093.4	6.25	38.0	28.9
Wednesday	1,302,131.9	24	54,255.5	6.12	36.9	28.5
Thursday	1,297,316.2	24	54,054.8	6.14	36.7	27.9
Friday	1,298,596.6	24	54,108.2	6.13	37.8	28.4
Saturday	1,253,385.0	24	52,224.4	6.35	38.5	29.1
Sunday	1,161,614.9	24	48,400.6	6.85	39.0	29.6

The daily vehicle flow during 24 weeks for each day of week of Malabe-Kaduwele roadway is shown in Figure 4. According to Figure 3, there was a significantly less number of vehicles in Malabe-Kaduwela road on Sunday and Saturday, this was expected as those days fall into weekends.

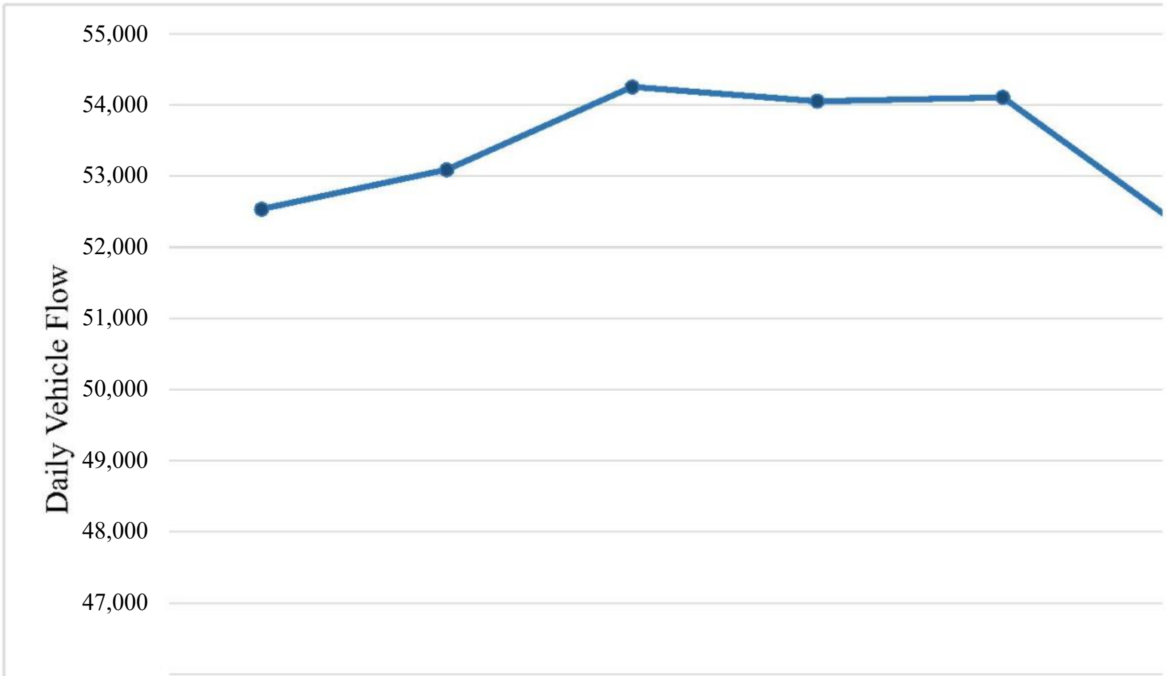

Figure 4. Hourly vehicle flow at Malabe-Kaduwela Roadway

4.3 Monthly Expansion Factors

The monthly traffic volumes were obtained for each month from April to August as shown in Table 4. Then mean average monthly volumes and total volume for six months were estimated. Accordingly, the MEFs were obtained and tabulated in Table 4.

Table 4. Monthly expansion factors, 85 percentile speed, and mean speed at Malabe-Kaduwala Roadway

Month	ADT of Month	ADT of five and half months	Monthly expansion factors	85 percentile speed	Mean Speed
April	47,690	52,361	1.10	39.33	29.96
May	51,798	52,361	1.01	37.19	28.42
June	52,990	52,361	0.99	37.99	28.91
July	48,994	52,361	1.07	37.15	28.38
August	55,492	52,361	0.94	37.81	28.84

The monthly vehicle flow for each month from April to September in Malabe-Kaduwele roadway is shown in Figure 5. It provides important information to traffic behavior in Malabe-Kaduwele roadway. The lowest vehicle flow observed in April, the reason may be because Sinhala Tamil New Year falls on this month and most of families migrate to their native places and village to celebrate the New Year and vehicle flow in whole Colombo is very few during this period.

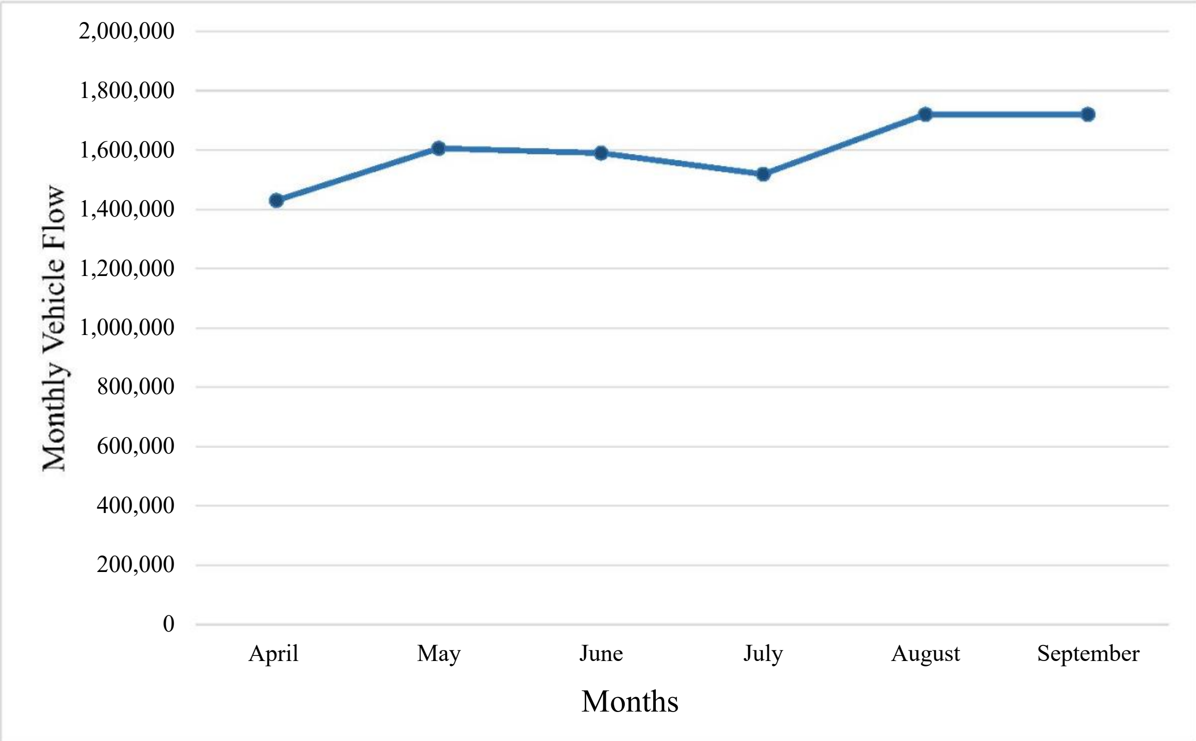

Figure 5. Monthly vehicle flow at Malabe-Kaduwela Roadway

5. CONCLUSION AND RECOMMENDATIONS

AADT estimation is one of the primary important tasks in traffic engineering and HEF, DEF and MEF are used to estimate the AADT. Main purpose of conducting this research was to find the expansion factors for estimating the AADT, as those factors are not available for local roadways. Vehicle volumes obtained by automatic traffic counter were used to calculate the expansion factors. In this study, MEF, HEF, and DEF are estimated using 168 days of traffic volumes. It was found that significantly low number of passengers travels early morning time between 00:00-05:00 hours. But there was a sudden increment of vehicles between 07:00 to 09:00 hours was observed. During the peak hour, the recorded speed was 20.44 Km/during evening peak hour. As the speed range of Automatic traffic counter is 10-160 Km/h, counts of vehicles whose speed were than 10 km/h may not be recorded. Due to that a reduction of vehicle count could be observed during the peak hour. Therefore, this automatic traffic counter is not suitable for high density traffic road for data collection during peak hours. Sudden decrement of vehicle volume was an issue in the research.

The daily moving vehicle volume for Malabe-Kaduwele road was around 52,000-55,000 in an average day. The vehicle volume decreased up to 30,000 from a particular day onwards. When looking the reasons for this problem, it was found that the pneumatic tubes were damaged and along the tube, pavement was also deformed. The use of nylon pneumatic tubes for data collection is the best suitable solution since, normal pneumatic tubes can be used only lower density traffic roads. For the high-density traffic roads like Malabe-Kaduwele road, the normal pneumatic tubes are not suitable.

The study period was six-month and it was not sufficient to develop the monthly expansion factors for all twelve months. Here only months from April to August MEFs were obtained. Therefore, minimum one-year data are needed for take expansion factors and at least five-year data is recommend for future studies. Also, more comprehensive larger sample of data collection in several sites throughout the country is required to obtain more realistic expansion factors. If so, the usefulness of introducing the automatic traffic counter for the calibration of AADT adjustment factors can be discussed and figure out any factors that can affect the accuracy of the suggested methodology of this study. More systematic technologies and sensors such as video camera also can be used for traffic volume data collection. The lessons learned in this study can be used for improving the study in future.

REFERENCES

1. Ahamed, H., Aljassar, Mohammed AhmedAli, and Omari Al-Saleh,(2007).Traffic factors for the design of road way geometrics and pavement structures in Kuwait. Kuwait j. sci.Eng.34 (2B) pp.17-33, 2007.
2. Esawey M.EI. (2010) Estimation of Annual Average Daily Bicycle Traffic with Adjustment Factors No. 2443, Transportation Research Board of the National Academies, Washington, D.C., 2014, pp. 106–114. DOI: 10.3141/2443-12
3. Gastaldi M., Rossi R., Gecchele G. and Lucia D.(2012) Annual Average Daily Traffic estimation from Seasonal Traffic Counts "Department of Civil, Architectural and Environmental Engineering, University of Padova, Via Marzolo, 9, 35131 Padova, Italy.
4. Granato S. (1994). 'The impact of factoring traffic counts for daily and monthly variation in reducing sample counting error. Journal of Transportation Engineering, 3(7):203-214, 1994.
5. Garber, J.L and Hoel, L.A, (2015). Traffic & Highway Engineering. Fifth Edition, Cengage Learning Private Limited, India, pp-139.
6. Jung-Ah H. and Ju-Sam O. (2014) Estimating Annual Average Daily Traffic Using Daily Adjustment Factor. Korea Journal of the Transportation Research Board, No. 2443, Transportation Research Board of the National Academies, Washington
7. Mohamed E., Clark L., Tarek S. and Ahmed I. (2010) Development of Daily Adjustment Factors for Bicycle Traffic, Journal of Transportation Engineering, Vol. 139, No. 8, August 1, 2013
8. Sabry, M.,Abd-El-Latif,H.,Yousif,S. and Badra,N. (2007). Determination of AADT from Short Period Traffic Volume Survey, Journal of Applied Sciences Research, 3(7): 607-612, 2007.
9. Sakib, K., Sababa, I., and Zadid, K (2017) Development of Statewide AADT Estimation Model from Short-Term Counts: A Comparative Study for South Carolina. Glenn Department of Civil Engineering 351 Fluor Daniel Engineering Innovation Building, Clemson, SC 29634
10. Subasish D and Xiaoduan S. (2015) Developing a Method for Estimating AADT on all Louisiana Roads. Civil Engineering Department University of Louisiana at Lafayette 254 Madison Hall. LTRC Project No. 14-3SA SIO No. 30001700.
11. Wang T. (2012), Improved annual average daily traffic (AADT) estimation for Local roads using parcel-level travel demand modeling, Florida International University, Miami, Florida.