STUDY OF ON STREET PARKING AND PEDESTRIANS INFLUENCE ON TRAFFIC FLOW PARAMETERS IN HAWASSA CITY (A CASE STUDY ON ADARE HOSPITAL TO MOBIL SEFER ROAD SECTION)

MASTERS OF SCIENCE IN CIVIL ENGINEERING (SPECIALIZATION: ROAD AND TRANSPORT ENGINEERING)

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HAWASSA UNIVERSITY, HAWASSA, ETHIOPIA

DECEMBER 2020

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A THESIS SUBMITTED TO HAWASSA UNIVERSITY, DEPARTMENT OF CIVIL ENGINEERING, INSTITUTE OF TECHNOLOGY, SCHOOL OF GRADUATE STUDIES, HAWASSA UNIVERSITY
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ADVISORS' APPROVAL SHEET

This is to certify that the thesis entitled **"STUDY OF ON STREET PARKING AND PEDESTRIANS INFLUENCE ON TRAFFIC FLOW PARAMETERS IN HAWASSA CITY (A CASE STUDY ON ADARE HOSPITAL TO MOBIL SEFER ROAD SECTION)"** submitted in partial fulfillment of the requirements for the degree of Master's with specialization in **ROAD AND TRANSPORT ENGINEERING**, the Graduate Program of the Department/School of **CIVIL ENGINEERING**, and has been carried out by **ABDULHAFIZ ARAGAW AHMED** Id. No **GpRoTrR/001/11**, under my/our supervision. Therefore, I/we recommend that the student has fulfilled the requirements and hence hereby can submit the thesis proposal to the department.

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Final approval and acceptance of the thesis is contingent upon the submission of the final copy of the thesis to the School of Graduate Studies (SGS) through the Department / School Graduate Committee (DGC/SGC) of the candidate's department.

Date _____

DECLARATION

I hereby declare that this MSc thesis entitled "**STUDY OF ON STREET PARKING AND PEDESTRIANS INFLUENCE ON TRAFFIC FLOW PARAMETERS IN HAWASSA CITY (A CASE STUDY ON ADARE HOSPITAL TO MOBIL SEFER ROAD SECTION)"** is my original work and has not been presented for a degree in any other university, and all sources of material used for this thesis / dissertation have been duly acknowledged.

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Signature: _____

Place and Date of Submission: _____ Hawassa, Ethiopia

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ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
AM	Ante Meridiem
AMT	Average Maneuvering Time
ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
ATS	Average Travel Speed
CBD	Commercial Business Districts
CCTV	Closed-circuit television
DGC	Department Graduate Committee
ERA	Ethiopian Road Authority
FHWA-HOP	Federal Highway Administration - Office of the Associate Administrator for Operations
GLM	General Linear Model
HCM	Highway Capacity Manual
HUIoT	Hawassa University Institute of Technology
IRC	Indian Road Council
KMP	K-Multimedia Player (Microsoft)
LCB	Lower Class Bound
LCL	Lower Class Limit
MANCOVA	Multivariate Analysis of Covariance
MANOVA	Multiple Analysis of Variance
MMLR	Multivariate Multiple Linear Regression
MS	Microsoft
OSPL	On Street Parking Load
PCE	Passenger Car Equivalent
PCU	Passenger Car Unit
PI	Parking Index
PM	Post Meridiem
RLW	Remaining Lane Width

SGC	School Graduate Committee
SGS	School of Graduate Studies
SNNPR	Southern Nation and Nationalities Peoples Region
SPSS	Statistical Package for Social Sciences
SS	Spot Speed
UCB	Upper Class Bound
UCL	Upper Class Limit
UN	United Nations
UNDP	United Nation Development Program

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ABSTRACT

On street parking in the city specially on active commercial areas affects the free movement of vehicles and be a contributory cause for smooth movement of traffic flow. This thesis aimed to study the influence of on street parking that affects the traffic flow by reducing the lane width of designed driveway as well as increasing the maneuvering time. Pedestrian illegal crossings have been also one of the contributory influence on traffic flow. The primary data was collected on a marked segment (120m base length for traffic flow characteristics and 54m base length for Spotspeed) where business activities were highly active at Arab Sefer. In order to clearly visible for video recording, $G^{+}4$ at Oumer Sani building was used. Field survey for road condition was conducted throughout the segment using measuring tape. Traffic count for spot speed has been conducted from 6:30AM to 7:00AM while the traffic is very less for the duration of 30min. Traffic characteristics and parameters were recorded for five working days for 12 hours from 6:30AM to 6:30PM. Data were retrieved for traffic volume, average travel speed and maneuvering time, on street parking characteristics and pedestrian crossing were studied from the video using tally marks with an interval of 15min. using Video processing software, KMPlayer 64X. Multivariate multiple linear regression analysis was used for statistical analysis. On street parking and pedestrians have significant influence on remaining lane width (R^2 = 93.7% p =0.000), average maneuvering time with (R^2 = 93.2% p =0.000), traffic flow with (R^2 = 90.1% p =0.000), average travel speed with (R^2 = 88.0% p =0.000) and followed by density with (R^2 = 86.6% p =0.000). According to the test result of MANCOVA, main effect of multivariate test results showed that On street parking has an influence on traffic flow, density and remaining lane width by 35.9%, 39.9% and 7.4% respectively. Pedestrians traffic have influenced on traffic flow, density and remaining lane width by 38.0%, 36.5% and 21.30% respectively. In respect to the covariate (interaction), on street parking and pedestrians together influence on traffic flow, average travel speed, density and average maneuvering time by 55.8%, 1.7%, 55.1% and 6.6% respectively.

Keywords: *Average Travel Speed, Density, MANCOVA, Maneuvering Time, Multivariate Multiple Linear Regression, On Street Parking, pedestrian crossing, Remaining Lane Width, Traffic volume.*

1. INTRODUCTION

Transportation is the movement of people and freights from one place to another place by means of different modes. However, vehicles need parking space at the origin and destination in every trips for loading and unloading. Parking demand in urban area is increasing as vehicular traffic increases and parking spaces are incapable of accommodating particularly at the peak hour's vehicular frequency. As the increasing of traffic and less accommodation of parking lots, vehicles are parked on road side of the driveway (AASHTO, 2011).

A roadway network should be designed and developed to provide for the safe and efficient movement of vehicle's operating on the system. The movement of the vehicles is the primary function of a roadways network, also provide on street parking. On street parking generally decrease through traffic capacity, impedes traffic flow, and increases crash potential. Since the primarily service of an arterial urban road is the movement of vehicles, it is desirable to prohibit parking on the urban areas (AASHTO, 2011).

An efficient and effective transportation system is a fundamental aspect of urban growth, which also defines the level of sustainability of urban centers, especially in rapidly growing urban areas like Hawassa city. Transportation engineering does not only consider motorized and nonnotarized vehicles roadways, but also firmly considers facilities; specially parking facility at the origin and destination of the travelers (Harriet et al., 2013; Peprah et al., 2014) describes that facilities includes roads, parking lots, vehicles and transportation terminals. Most cities require parking spaces almost everywhere in the city. Parking spaces are noticed most when absent (Manville and Shoup, 2005).

With the dramatic increase of the automobile, parking has become an integral part of the modern urban setting and important land use. Parking related concern has no longer confined to the city centers, it expands throughout the urban region. Parking contributes to the appearance of city and suburbs; affects traffic congestion and traffic operations; and is a vital component of the urban street and transit systems (Virginia, 2014).

The most frequent conditions on urban streets may vary greatly, and such factors as curb parking, transit buses, lane widths, and upstream intersections may substantially affect operations and observed volumes (HCM, 2010).

1.1. Background of the Study

As long as the human race has an existence, transportation has played a significant role by facilitating trade, commerce, and social interaction, while consuming a considerable portion of time and resources. The primary need for transportation has been economic, involving personal travel in search of food, work, education, travel for the exchange of goods and commodities, exploration, personal fulfillment, and the improvement of a society or a nation (Nicholas et al., 2009).

Over recent years, both in developed and developing countries, the problems associated with means of transport have worsened due to phenomena like congestion, longer journey times and increasing levels of pollution (Marsden, 2006).

Decision makers have tried to improve this situation in cities by introducing different management policies. Typically, parking policies currently used are those which relate to the management of parking spaces for private cars. Parking policies can affect different aspects of urban transport systems such as the efficiency and service standards of public transport and urban roads and pollution levels (Marsden, 2006).

Parking problem is most common occurrence that people have adapted to park cars on on-street parking long time which degrades the efficient of road. He also adds that concentration of parked vehicles on the busy streets is reducing the normal traffic flow, capacity of the roads, increase accident potentials and confuse vehicular and pedestrian movements in the city and this problem may worsen in the future as car the number owner ship increases (Asfaw, 2016).

In case of Hawassa city, since the city is continuously increasing its business activity through the main arterial roads, on street parking more common than off street parking. Consequently, traffic flow more increased and become influenced due to on street parking (Hawassa City Municipality, 2016).

According to Hawassa city administration, Hawassa is established in 1961 during the period of Emperor Hilesilassie, near the shore of Lake Hawassa in the Ethiopian rift valley system, located 273km south of Addis Ababa via Bishoftu, 130km east of Sodo, and 75km north of Dilla. The city serves as a capital of Sidma National Reginald State and Southern Nations, Nationalities,

and People's Region, SNNPR collectively due to the current political situation. It lies on the Trans-African Highway 4 Cairo-Cap Town, and has a latitude and longitude of 7º6'0" N 38º34'0" E and an elevation of 1760m at Tabor mountain and 2019m at Alamura mountain above sea level (Hawassa city administration, 2016).

The city is now fast growing even compared to other Ethiopian regional capitals, the city's population is increasing from time to time and based on the study of UNDP, 207,416 (51.4%) male, and 195,609 (48.6%) female a total of 410,025 (Hawassa city administration, 2016). Hawassa is remarkably growing fast, hosted so many international star hotels and restaurants. The city has a good infrastructure which are increasing yearly with quality of asphalt roads, Table 1-1. Since it is center of truism, establishment of Industrial park, newly constructed expressway, semi natural habitat, tourist attraction forest like Tkur Wuha forest and Amora Gedel, and educational institution like Hawassa university and hence traffic flow grownup unexpectedly. These facilities attract visitors from in-country and abroad continuously visiting the city. All these are the indicative of the future traffic flow escalate principally. The main transportation system includes cars, buses, minibus, tricycle, motorcycle bicycle and animal driven carts (Hawassa City Municipality, 2016).

Table 1-1. Hawassa city Infrastructure data from 2014 to 2016.

Infrastructure type	**Year**		
	2014	**2015**	**2016**
Asphalt road (km)	76.1	112	123
Cobble stone (km)	103.7	130.7	148.7
Gravel road (km)	352	342	225
Pedestrian walk ways (Asphalt)	39.6	43.8	43.8

Source: Hawassa City Municipality

A research has been done about parking demand and supply studies in the city for the last years like (Berha and Endris, 2019). But on-street-parking influence s specifically on traffic flow has not been studied. Concerning this thesis, literature review will have adopted from foreign country.

1.2. Statement of the Problem

In this digital era, researchers have studied for several reasons on traffic flow congestion like peoples are in hurry, saving time means travelling faster, people rely on their private vehicles, time valuable and trying to make the most of their needs. Accordingly, rapid increase in the number of vehicles brought lack of parking space. The reason for lack of parking space in major Indian cities is caused due to an increase in the number of cars (Manville and Shoup, 2005).

on-street parking can never exist without a challenge and does not create convenience but does trigger congestions, possible disturbance to the flow of vehicular traffic and accidents in urban areas as part of the side influence s of on street parking (Peprah et al., 2014).

On-street parking has a diverse and unpredictable history. Once widespread almost everywhere in the United States, restrictions against on-street parking began as early as 1920. When the rapid rise of the automobile in downtown Los Angeles, California, started to interrupt on the traffic flow and were forced to ban on-street parking (Manville and Shoup, 2005). It has been reported that on-street parking could be one of the major causes which lead to hazards and risk of road users in different studies (Eedan Al-Jameel and Muzhar, 2020).

In Hawassa city, infrastructure is quickly constructing without considering parking lots as it is the first question for drivers where to park. Besides, on the main arterial of the city where the city bus is serving mass transit there is no bus bays. Park and ride area are not totally considered in the city. Most of the park and ride areas are near the signalized and un-signalized intersections. Despite the fact that, international hotels in Hawassa has off street parking, most hotel use their parking lot near arterials which shares pedestrian walking and drainage coverages. Parking requirement practice in Hawassa city has been neglected. This is because on street parking is the one alternative drivers are mostly park their vehicles around business activity.

Currently, the Hawassa city administrative office has planned to introduce parking lots on newly construction asphalt roads like from Gebeya Sefer to shell through Aroge Menaharia. Otherwise, on street parking will have a negative influence on the traffic flow in the near future unless

options put. As a result, not only the city's streets serving above their capacity and become congest but also the traffic safety is in question (Hawassa city administration, 2016).

1.3. Objectives

1.3.1. General Objective

The general objective of the thesis is to study on street parking influence on traffic flow in selected road of Hawassa city.

1.3.2. Specific Objectives

- ✓ To study lane width and remaining lane width due to the presence of on street parking and pedestrians.
- ✓ To study traffic flow, speed, density influenced by on-street- parking and pedestrians.
- ✓ To measure the length of maneuvering time of vehicles to rid and park due to on street parking and pedestrian influence.
- ✓ Model the influence of on street parking and pedestrians on traffic flow, remaining lane width and maneuvering time using multivariate multiple linear regression analysis method.

1.4. Research Questions

- ✓ What are the condition of geometric elements on the selected stretch?
- ✓ What is the traffic flow condition on the selected stretch?
- ✓ Does maneuvering time of vehicles is a problem on the selected stretch?
- ✓ Does on street parking and pedestrians are a problem for traffic flow parameters on the selected stretch?

1.5. Significance of the Study

The main significance of this thesis was to study the characteristics of on street parking that creates an influence on the healthy movement of traffic flow. Whenever the study meets its objectives, the city's road will provide services nearly its capacity. The study will bring a

solution for the policy makers, designers, parking management strategies and fill the knowledge gap of on street parking influence. Generally, the smooth traffic flow become the beauty of the city.

1.6. Scope and Limitation of the Study

The scope of the study includes field survey for traffic flow parameters that are relevant to the calculation of traffic flow characteristics (traffic flow, speed and density studies on the selected segments). This survey will not include the traffic flow near the intersection. In case of on street parking studies, parking statistics which are listed on parking survey includes on street parking supply on segment of selected stretches have measured and calculated. On street parking study only includes parallel parking practices (i.e. angle parking, parking on pedestrian roads and off street parking are not included).

On street parking has been the boring practice of the metropolitan city as it creates problems like reduction of carriage width, congestion, safety problems. The city needs multi directional studies in order to solve all the problem which comes due to the accommodation of on street parking. The study limited on the study of off-street-parking and traffic safety problems came due to narrower width of the lane. To incorporate all influence of on street parking time and financial problem restricted the study. In order to incorporate and to make a full study it needs time and investment.

On the survey of road condition, since road condition survey includes several road elements and section, this thesis is limited only certain parameters like width of the road, lane width, number of lane, remaining lane width and divided or undivided road.

2. LITERATURE REVIEW

2.1. General Overview

In this section a brief explanation of related literatures was presented that deals with the influence of on street parking on traffic flow which are relevant to the analysis of the next section. On transportation system of any country, as one of the most essential part of the system, does not only include mobility of motorized vehicles, but also requires proper planning to let the vehicle stop at the desired location for loading-unloading of passengers and goods. This process of stopping the vehicle temporarily at the desired location until the purpose of the user get served is termed as parking (Das et al., 2016).

A form of parking that involves along the road sides weather It is temporary driving a vehicle or maneuvering a vehicle for different purpose like commercial purposes is termed as on street parking. On-street parking exists as a result of non-availability of space for off-street parking and it is known as nearest to destination routes (Peprah et al., 2014)

2.2. Road Conditions

On the study of (Sulistyono et al., 2018a) showed that on street parking has a direct influence on road elements on reduction of the lane width. Collection of data on the following elements has highly relevant to the influence of on street parking on traffic flow, these are measuring carriageway width, remaining lane width, Measuring total parking space available on the stretch.

Narrower lane width has a significant influence on reducing travel speed on urban arterials. (AASHTO, 2004), commonly known as the Green Book, recommends lanes 3 - 3.6 m) wide for urban and suburban arterials. It states that 3m lanes should generally be used on roadways that have little or no truck traffic, and recommends 3m lanes for urban Arterials and 3.6m lanes for higher speed, free-flowing principal arterials.

Further study found that 3m lane width is associated with higher travel speed on mid-block segments with a speed limit of 40kmph or 56kmph. For speed limits of 64kmph and 72kmph,

the 3m lane width appeared to reduce the travel speeds, which might be used for traffic calming. The midblock segments with 3.3m lane width would have higher travel speed compared to those with 3.6m lane width, but the differences in reducing lane violation in terms of encroachments on adjacent lanes are not significant. The 2.7m and 3m lanes were associated with a high rate of lane violation on midblock segments with speed limits of 40kmph and 56kmph. The influence of narrower lane width on travel speeds and vehicle lane violation have a wide viability across study data sets (Zhao et al., 2017).

2.3. Traffic Flow Characteristics

In order to understand the influence of on street parking on traffic flow, the initial focus shall be on the key parameters of traffic flow characteristics. The volume, speed, and density are three important parameters in traffic theory (Friedrich, 2016; Maerivoet and De Moor, 2008).

2.3.1. Travel time

Travel time and travel speed are close relationship once known the travel distance. Travel time can be measured in the filed by assigning pints on a road segment length as listed in *Table 2-1* and record the entrance and exit time as elapsed time. Mean travel time is the simple average of the traced vehicle travel times. Travel time used in calculation of travel speed in the system (FHWA-HOP, 2007)

2.3.2. Spot Speed Study

spot Speed (SS) depends upon various factors such as pavement characteristics, environmental factors, traffic volume, driver and vehicle characteristics. Various forms of pavement characteristics cause an impact on the traffic stream particularly Spot Speed and roadway capacity (Sekhar et al., 2016).

Counting periods as per the study of (Nuzhat et al., 2013) for Spot speed can be any duration of usually 30min periods at low volume of traffic condition and at prevailing condition such that no preceding vehicle influences the drivers' speeds. Those that affect driver’s speed are lane width, weather, horizontal alignment, vertical alignment, sight distance, lateral clearance, design

speed, behavior, and adjacent environment (HCM, 2010; Deardoff et al., 2011; Nuzhat et al., 2013; Sekhar et al., 2016).

Spot Speed (SS) is the average speed of vehicles on a given segment, measured under low-volume conditions, when drivers are free to drive at their speed and are not constrained by the presence of other vehicle or downstream traffic devices, traffic signals, roundabouts or stop signs (HCM, 2010). Theoretically, Spot speed occurs when the density and flow rate on a study segment are both zero but, in practice it is difficult to obtain such a situation. Hence, in order to overcome this difficulty for instance on Freeways, Spot Speed (SS) is considered as the prevailing speed at flow rates between 0 and 1,000 passenger cars per hour per lane (HCM, 2010).

$$\mathrm{SS} = \frac{Base\ length\ (km)}{Elapsed\ time\ (h)} \tag{2-1}$$

Base length as it is described below in *Table 2-1*

Table 2-1: Base Lengths for Spot Speed Determination

S.No	Average Speed of Traffic Stream (km/hr)	Base Length (m)
1	Less than 40	27
2	40 to 65	54
3	Greater than 65	810

Source: (Mugdha P., 1994)

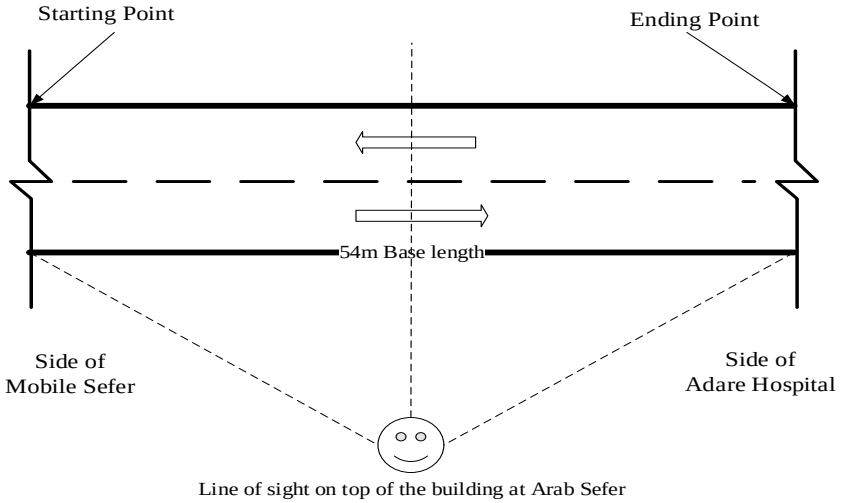


Figure 2-1. Base length for spot speed study

According to (FHWA-HOP, 2007)There are numerous speed and travel-time measuring techniques, but they can all be grouped into three large categories according to their method of sampling the travel-time universe.

a) **Spot speed measurement techniques** measure vehicle speeds only for a given point of geography or a given point of time.
b) **Vehicle tracing techniques** measure vehicle travel times only for a select portion of all trips.
c) **Trip maker tracking techniques** are similar to vehicle tracing techniques but measure traveler trip times rather than vehicle trip times.

2.3.3. Average Speed of the Flow

According to (Dar es Salaam Transport Policy and System Development Master Plan, 2007) the speed over a specified section of highway, being the distance divided by travel time and performed on normal weekdays from Monday through Thursday excluding public holidays. The speed of the vehicles may not be similar depending on the prevailing condition. Average travel speed of all vehicles passing the point on highway can be calculated as

$$\text{ATS} = \frac{Base\ length\ (km)}{Elapsed\ time\ (h)} \tag{2-2}$$

Elapsed/ Travel Time: Average travel time at 15min interval was determined for the selected road segments. Collection of data for average travel speed were taken from the recorded video by considering entry and exit time of vehicles passing the base length with an interval of 15min (Mishra et al., 2017).

At various parking demand levels, average travel speeds were recorded noticeably with an increase in parking levels. On average, there was approximately a 10km/h reduction in mean speeds between empty and full on-street parking levels (Praburam and Koorey, 2015).

On the study of (Sulistyono et al., 2018b), obtained value of R^2 of 0.8226 and obtained the value of R is 0.903. With R value of 0.903 then the relationship of parking space usage with traffic volume included in high correlation criteria with the form of relationship is negative linear.

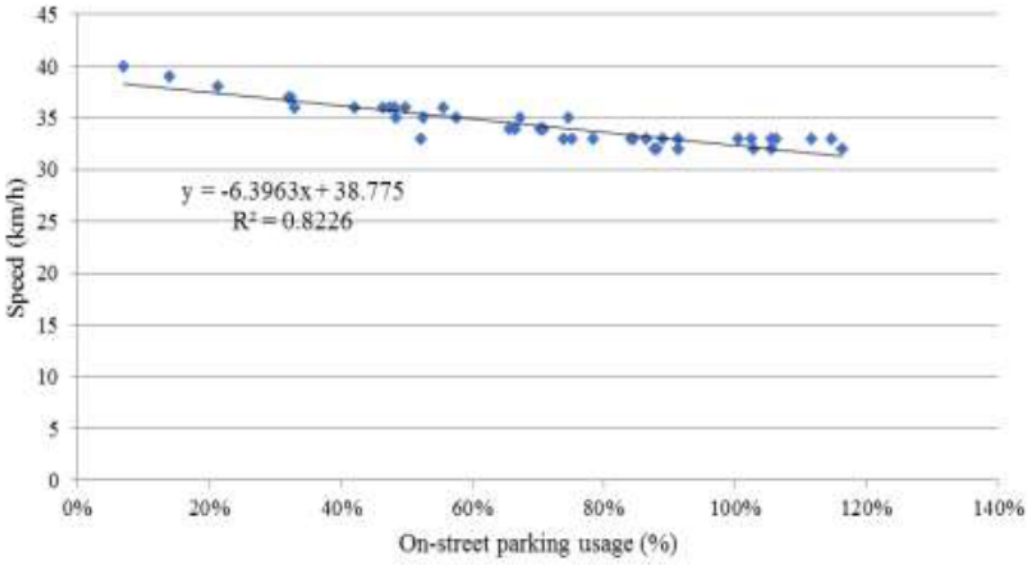


Figure 2-2: On street parking Usage Vs Speed*(Sulistyono et al., 2018b)*

2.3.4. Volume Study

Traffic Volume Count is counting of number of vehicles passing through a road point or segment over a period of time. It is usually expressed in terms of Passenger Car Unit (PCU). Volumes observed for periods of less than one hour are generally expressed as equivalent hourly rates of flow (HCM, 2010). As (Sekhar et al., 2016) showed in the study that traffic data used collected using video graphic method for 8 hours on a identified trap length (60mts) at morning and afternoon peak periods.

On the study of (Sulistyono et al., 2018b), obtained value of R^2 of 0.8949 and obtained the value of R is 0.946. With R value of 0.946 hence relation of use of parking space with traffic volume included in very strong correlation criterion.

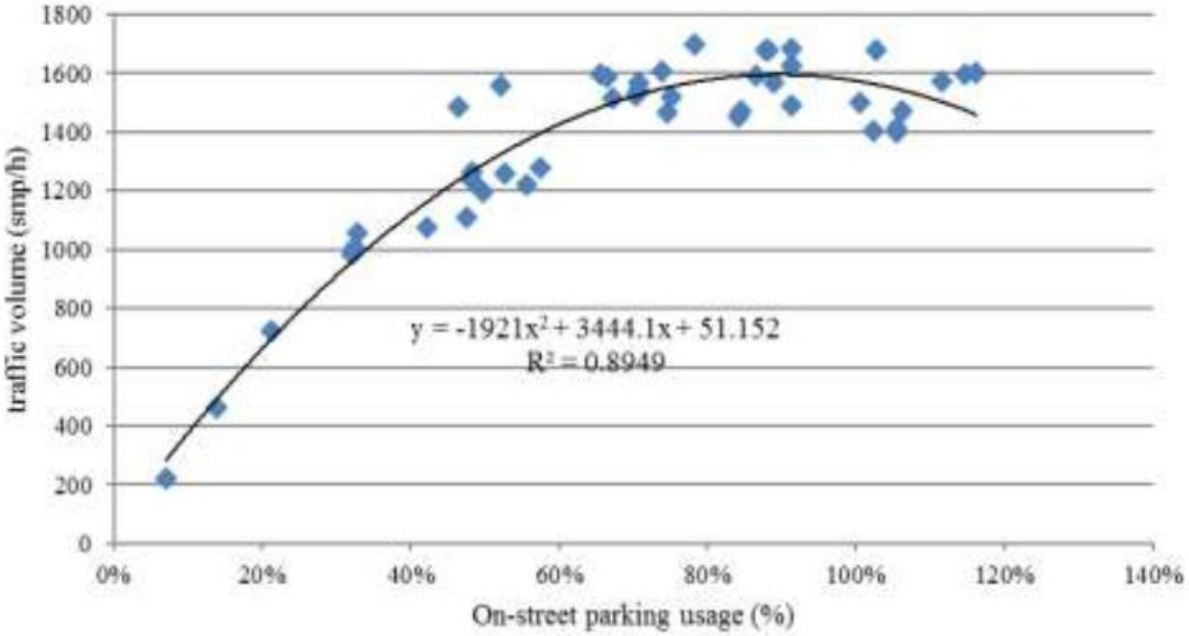


Figure 2-3: On street parking usage Vs traffic volume *(Sulistyono et al., 2018b)*

Traffic data is needed in research, planning, designing and management of vehicles on the urban highways. Traffic counts depends on the objectives of the study. For traffic control and management or operational studies short duration count at peak period is conducted (Nuzhat et al., 2013). If N cars cross line a point or road section in a time T. the flow is computed as (Maerivoet and De Moor, 2008)

$$Flow = \frac{N}{\overline{T}} \tag{2-3}$$

The counting period at a specific location depends upon the method used to obtain data and the purpose or planned use of the data. The counting period should avoid special event conditions such as holidays, sporting events, exhibitions or fairs, transit strikes, special sales, unusual weather, or temporary street closures, unless the count is for the specific purpose of studying the influence s of the special event condition. Traffic counting was made for short time count at the following periods as per (Trsns Tritia, 2018). 12 hours; from 7: 00 AM - 7: 00 PM, 8 hours; 7: 00 AM - 11: 00 AM, 2: 00 PM - 6: 00 PM and 4 hours; 7: 00 AM - 9: 00 AM, 4: 00 PM - 6: 00 PM.

The report adds that performance of a manual short-term survey is recommended during April, May, June, September, or October during the normal working day of the week (Tuesday, Wednesday, Thursday), on a short-term traffic count for 12 hours within a set time period of 15min. because the values of traffic volumes at that time are close to the annual averages of daily traffic (AADT) volumes. When determining the exact date of the survey, it is necessary to take into account the planned extraordinary events (cultural and sports events, extensive reconstruction of communications near the survey sites, etc.) that can affect the traffic volume. In such cases, another implementation date of survey should be set (Trsns Tritia, 2018; Russell and Hittle, 2015; Nicholas et al., 2009).

The actual volume for the hour was calculated by adding the consecutive 15min recorded data for one hour and proceeding by shifting 15min for the rest of hours (Roess et al., 2004) .

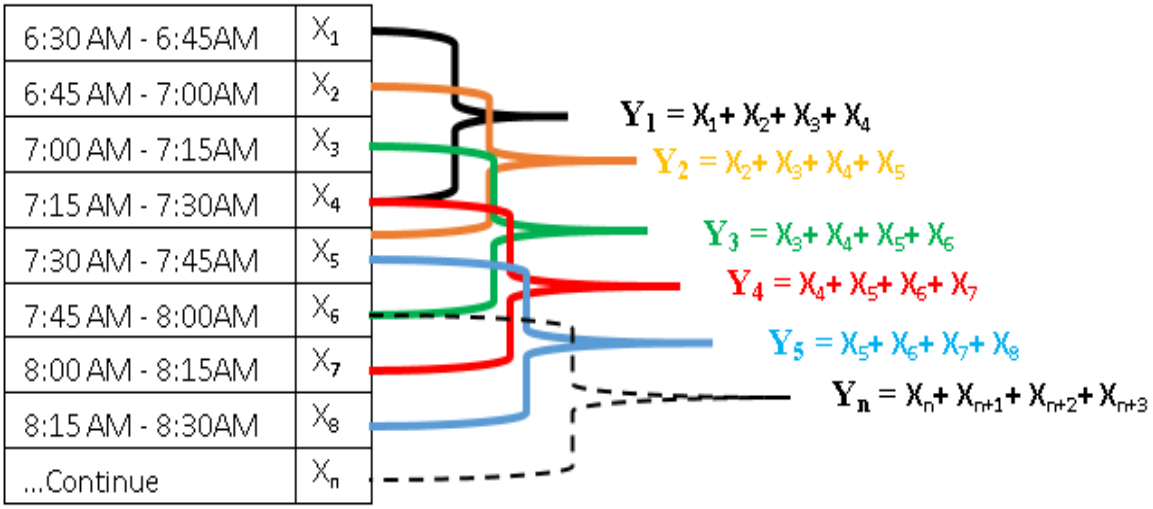


Figure 2-4: Peak Volume Calculation Steps

where X_n = volume counted in an interval of 15min, PCU
Y_n = hourly volume calculated with consecutive 15min.

2.3.5. Density

Density is the number of vehicles occupying a given length of a lane or roadway at a particular instant. Density can be computed, however, from the average travel speed and flow, which are measured more easily as (Maerivoet and De Moor, 2008). Density is a critical parameter for uninterrupted-flow facilities because it characterizes the quality of traffic operations. It

describes the proximity of vehicles to one another and reflects the freedom to maneuver within the traffic stream (HCM, 2010).

$$\text{Density} = \frac{Flow\ (\frac{PCU}{h})}{Speed\ (\frac{km}{h})} \tag{2-4}$$

(Sulistyono et al., 2018b) got the value of R^2 equal to 0.889, then R value is 0.943. With the value of R the relationship of parking space usage with density included in the criterion is very strong correlation.

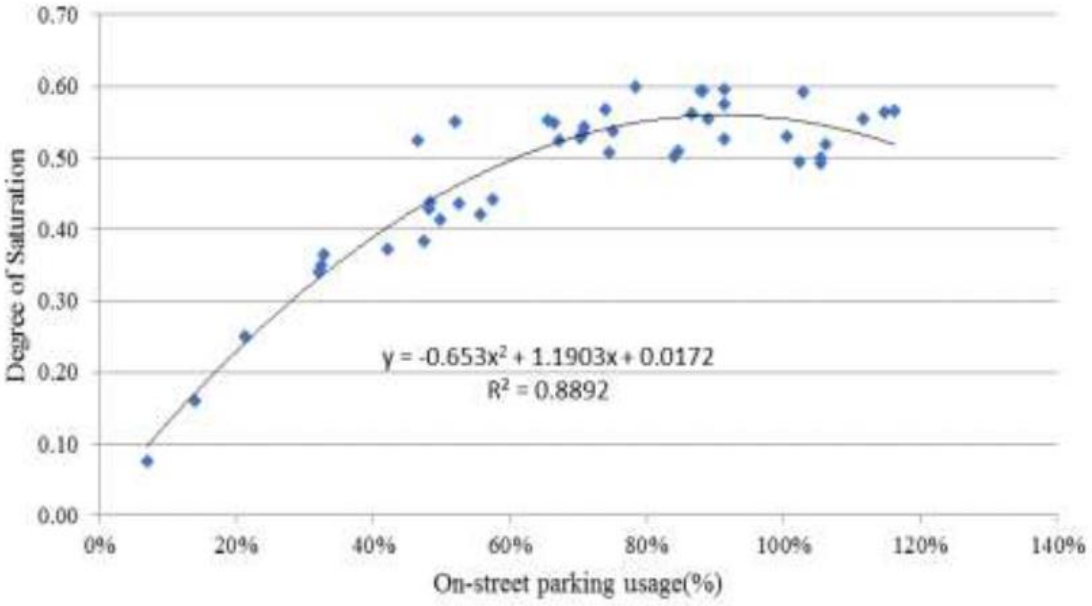


Figure 2-5: On Street parking usage Vs density *(Sulistyono et al., 2018b)*

2.3.6. Passenger Car Equivalent

Traffic volume problems occur on heterogeneity of vehicles along the road. Mixture of vehicles in the stream creates impedance due to vehicles static and dynamic characteristics. Hence simply adding number of vehicles does not give authentic speed flow relationship. Hence, the vehicles are normally presented in terms of standard type of vehicle using certain conversion factors. Generally, passenger car is adopted as standard vehicle and this factor is known as passenger car unit (PCU).

Many researchers like, (Thomas, 2018; Rao et al., 2017; Adnan, 2014; Basu et al., 2006) have developed methods to estimate PCU for a vehicle type. The interesting point to note is that each of these studies has resulted into different PCU values for the same type of vehicle. There exists large variation in PCU values being adopted in different parts of the world.

For this study, since the road services for different types of car compositions, vehicle counts did not directly take into account as traffic volume or count and hence converted to PCE.

Table 2-2 shows PCE of the Hawassa city which is studied by Tomas Bezabih) are used for this study being are studded on the same city.

Table 2-2: Passenger Car Equivalent (PCE) Values

Serial No.	Vehicle Group typical members	Vehicle Group	PCE
I	Motorcycles of different made ex. Bajaj, tvs, Lifan, etc.	Motorcycle	0.552
II	Bajaj, TVS, Piaggio Auto Rickshaws,	Bajaj	0.701
III	Toyota executive, Corolla, Vitz, Yaris, and other made but similar vehicles etc.	Passenger Car	1.00
IV	Pick-up trucks of all kind and Made, SUV, Minibus with Capacity up to 15 people etc.	Light Duty Vehicles	2.004
V	Small and Large bus; small, Medium and heavy trucks etc.	Heavy Vehicle	2.967
VI	Animal Driven Cart (Farooq and Akram, 2018)		4.0

Source: Thomas B. June 2018, pp-62

2.4. Overview of Parking

Parking is a very essential element of the transportation facility especially on urban areas. Vehicles need to park at the arrivals of its destination either on street parking or off street parking. Parking area is most frequently the cities problem unless otherwise managed by the transportation officials. Common types of parking systems are on street parking and Off street parking systems (Boro et al., 2015).

2.4.1. On Street Parking

When vehicles are parked on the street, along with the sidewalk or anywhere on the street is called On-street parking. Today, parking related concerns are no longer confined to the city center; they extend throughout the urban region. Parking contributes to the appearance of city and suburbs; affects traffic congestion and traffic operations; and is a vital component of the urban street and transit systems (Belloche, 2015; Cao et al., 2013a; Subramani, 2012; Sulistyono et al., 2018; Virginia, 2014).

On street parking is further categorized into parallel parking, 30^0 parking, 45^0 parking, 60^0 parking, 90^0 parking.

2.4.2. Off Street Parking

Off street parking is types of parking facilities on its own land, not on public rights-of-way. Several studies have been dealt with parking problems in different countries specially on on-street parking influence on traffic flow. A review of such works help to select appropriate variables. Published papers, reports, forum posts, books, parking guide lines and newspapers has been explored to get a clear concept about on street parking influence on traffic flow (Sulistyono et al., 2018a; Virginia, 2014).

2.4.3. Advantages and Disadvantages of On Street Parking

Researchers forwarded a study on street parking in two different views. The advantage and disadvantage.

2.4.3.1. Advantages of On Street Parking

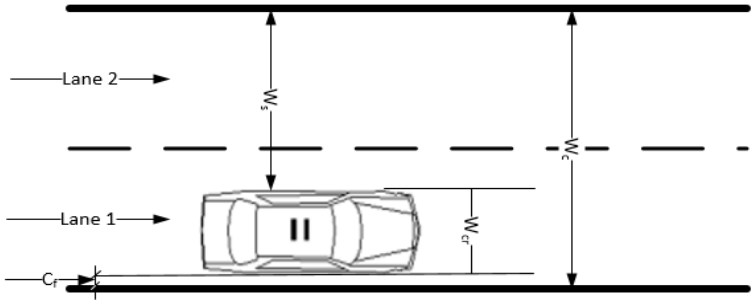
As (Peñalosa, 2017), has put the advantages of on street parking as more efficient use of land as it limits the need for off street parking and closely associable to the properties and nearby the commercial center adjacent to the arterials. Besides that, some studied showed that on street parking reduce the construction cost of off street parking.

2.4.3.2. Disadvantages of On Street Parking

Most argument exceeds on disadvantageous side, a roadway network should be designed and developed to provide for the safe and efficient movement of vehicles operating on the system. Although the movement of vehicles is the primary function of a roadway network. In the design of freeways and access-controlled facilities, as well as on most rural arterials, collectors, and local streets, stopping or parking should be permitted only in emergencies. On-street parking generally decreases through-traffic capacity, impedes traffic flow, and increases crash potential (AASHTO, 2011).

2.4.3.2.1. On Street Parking Reduce Lane Width

Generally, on street parking occupies as shown by (Cao et al., 2017) 2.1m is average car width, $W_{cr,}$ 0.15m to 0.3m/0.4m permitted clearance from the curb face plus C_f (psychological fear). Therefore, minimum width occupied by on street parking is $W_{cr} + C_f =$ 2.25m to 2.5m *Figure 2-6*.



(source: (Cao et. al., 2017)

Figure 2-6 On Street Parking lane reduction demonstration

(Wijayaratna, 2015), states that, on street parking described vehicles are parked on the sides of the street itself. In addition, on-street parking as its name suggests, a parking space on the public road although this may become somewhere parked on the road, or the side of the road, is only semi-public. On-street parking often takes place, either legally or not, on space at the side of the road that is nominally reserved for pedestrians.

As (Virginia, 2014) stated that Later study on traffic signal design by (Webster and Cobbe, 1966) reported that a single parked vehicle at or within 7.6m of the stop line caused a loss in the effective width of the roadway directly equivalent to the width of the vehicle.

2.4.3.2.2. On Street Parking Hinders Vehicular Movement

According to the Highway Research Board at the time, on-street parking would be acceptable only in situations in which the street is not required to function as part of the street network, the through movement of traffic can be prohibited, and the need for parking is so great that it hinder normal operations of vehicular movements (HCM, 2010).

On-street parking in central business district (CBD) is a significant facility for drivers. Nevertheless, the accessibility of such parking facilities may affect the traffic flow on the highway and be a contributory cause in the high number of road traffic accidents as well as having other direct or indirect influence s on other issues such as the use of public transport, business, environment and property values (Chick, 1996).

2.4.3.2.3. On Street Parking Affects Road Capacity

The influence of on-street parking on driveway capacity is frequently experienced. Substitution of a road lane by a parking lane has an important impact on capacity and a potential influence on traffic operations. Even a single vehicle parked within a curb lane can influence effectively close the lane to moving traffic (Virginia, 2014).

The American Association of State Highway and Transportation Officials (AASHTO, 2011) claims that the road capacity of four to six lane arterial roads can be increased by 50% to 80% by removing curb side on street parking. Additionally, (Wijayaratna, 2015) take a reference from (Weant and Levinson, 1990) claim that removal of on street parking on a four lane road doubles the capacity. On the other hand, (Jakle and Sculle, 2004) studied that the capacity of the road due to presence of on street parking reduces by 45%.

Basically, according to (AASHTO, 2011), on-street parking is tolerated on city driveways only when the speed is low and the traffic demand is well below capacity. At higher speeds and

during periods of heavy traffic movement, on-street parking is incompatible with arterial street service and should not be permitted.

2.4.4. On Street Parking Parameters

On-street parking slows down and impedes vehicles and disrupts the flow of traffic especially when vehicles are maneuvering in and out of the curb (Naseri, 2013). For the purpose of condition of on street parking study 120m base length has been selected at Arab Sefer in front of Commercial Bank of Ethiopia, Mobile to Arab Sefer direction Figure 3-4. Data collection was done on the base length which has a capability of 16 vehicles to park with car length of 7.5m as recommended by (Hassan, 2017). Parking characteristic is a basic trait that can provide an assessment of parking services and parking problems that occur in the study area. Parking characteristics consist of parking accumulation, parking volume, parking turn over, parking index, parking duration, and parking capacity. Parking characteristics are needed to analyze the operational conditions and design the development of parking lots (Sulistyono et al., 2018c).

According to (Hassan, 2017) , showed on his thesis, the most common Parking surveys conducted are:

A. In and Out survey
B. Fixed period sampling
C. License plate method

A. In and Out Survey

In this survey, since the data are retrieved form the recoded video, the best method of parking survey is In-and-Out Survey. The occupancy count in the selected parking lot is taken at the beginning. Then the number of vehicles that enter the parking lot for a particular time interval is counted. The number of vehicles that leave the parking lot is also taken. The final occupancy in the parking lot is also taken. Here the attendant required is very less. Only one person may be enough. In and out survey method was used to identify the accumulation profile occupied by parking lots. This survey can be used to identify the peak parking accumulation and peak hours (Sen et al., 2016). (Das *et a*l., 2016) also explained in his study that In and out survey technique

is used to determine the accumulation and the occupancy of the parking lot. Initial occupancy of the parking lot is taken. The number of vehicles entering and leaving for a particular time interval is counted. And at the end final occupancy of that lot is also taken.

B. Fixed Period Sampling

This is almost similar to In-and-Out survey. All vehicles are counted at the beginning of the survey. Then after a fixed time interval of 1 hour the count is again taken. Parking surveys are conducted to collect parking statistics. The most common purpose of this study was to determine the peak parking demand, the average parking duration and the distribution of the parking demand during the day in each of the pockets under study.

C. License Plate Method

Most accurate and realistic data. In this case of survey, every parking stall is monitored at a continuous interval of 15 minutes or so and the license plate number is noted down. This will give the data regarding the duration for which a particular vehicle was using the parking bay. This will help in calculating the fare because fare is estimated based on the duration for which the vehicle was parked. If the time interval is shorter, then there are less chances of missing short-term parkers. But this method is very labor intensive.

2.4.4.1. Accumulation

Parking accumulation refers from total number of arriving vehicles minus total number of departing vehicles, accumulated from the start of the observation The time interval should be short for greater accuracy, maximum 15 minutes. Normally this is expressed by accumulation curve. Accumulation curve is a graph obtained by plotting the numbers of bays occupied with respect to time. (Belloche, 2015; Cao et al., 2013b; Subramani, 2012; Sulistyono et al., 2018a).

2.4.4.2. Occupancy rate

Parking Occupancy Level/Rate: This is the total number of occupied parking spaces/stalls at a given time period. It is normally expressed as a percentage. (Belloche, 2015; Cao et al., 2013b; Subramani, 2012; Sulistyono et al., 2018a).

$$Parking\ Occupancy = \frac{Parking\ Accumulation}{Parking\ \text{Volume}} x100 \quad (2\text{-}5)$$

2.4.4.3. Parking Index

Parking index (IP) is calculated by dividing the number of parking vehicles with available parking lots. Parking index greater than one then the parking requirement exceeds the capacity or problems occur. Conversely, if Parking index less than one, then the parking needs are still under capacity or no problem (Sulistyono et al., 2018a).

$$Parking\ Index\ (PI) = \frac{\text{Parking Load}}{Parking\ Capacity} \quad (2\text{-}6)$$

2.4.4.4. Parking load

Parking load gives the area under the accumulation curve. It can also be obtained by simply multiplying the numbers of vehicles occupying the parking area at each time interval with the time interval. It is expressed as vehicle hour (Subramani, 2012).

2.4.5. On street Parking Restrictions

For data collection, the study concentrated on curb side parking where on street parking mostly allowed to park. Here are some rules that are allowed for the drivers to park legally and all these areas are sources of data for total area of on street parking (Green, 2018).

- ✓ In some areas, such as Parking Area sign is placed at each entry point to hospitals, universities, governmental offices, residential gates, pedestrian crossings etc. are not allowed for parking.

- ✓ It is not allowed to stop or park on a road within 20m from the nearest point of an intersecting road at an intersection with traffic lights, unless you stop or park at a place on a length of road, or in an area, to which a parking control sign permitting stopping applies. You must not stop or park on a road within 10m from the nearest point of an intersecting road at an intersection without traffic lights, unless you stop or park at a place on a length of road, or in an area, to which a parking control sign permitting stopping applies or if the intersection is a T-intersection along the continuous side of the continuing road at the intersection.
- ✓ It is not allowed to stop or park on a pedestrian crossing (that is not at an intersection), or on the road within 20m before the crossing and 10m after the crossing, unless you stop or park at a place on a length of road, or in an area, to which a parking control sign permitting stopping applies.
- ✓ It is not allowed to stop or park at a bus stop (unless you are driving a public bus which is actually engaged in taking up or setting down passengers or is stopping for the purpose of a regular passenger service), or on the road, within 20m before a sign on the road that indicates the bus stop, and 10m after the sign, unless you stop or park at a place on a length or road, or in an area, to which a parking control sign permitting stopping applies.

2.5. Standard Parking Lane Width

It has been found that most vehicles park parallel with stop clearance within 150mm to 300mm of the curb face and on the average will occupy approximately 2.1m of actual street space. Therefore, the desirable minimum width of a parking lane is 2.4m. However, to provide better clearance from the traveled way and to accommodate use of the parking lane during peak periods as a through-travel lane, a parking lane width of 3.0m to 3.6m may be desirable (AASHTO, 2011).

The number of parked vehicles on the marked section simply reflects the number of vehicles that were parked on on-street-parking along the streets at the time the measurements were made. On the selected section the individual parking spaces were delineated or marked with the division of one meter towards the center of the lane and with standard length and width of the vehicle 3.75 x 7.5 meter. Since measuring the occupied area from the tire does not represent

entire width therefore the data collection includes the edge of the vehicle body extend past the tire (Gattis et al., 2007).

2.6. Average Manoeuvre Times for Parking

Maneuvering time often ignored by traffic engineers as it contributes the cause of congestion at the time when the traffic flow is high (Purnawan and Yousif, 2004). On street parking manoeuvre times are the length of time required by vehicles to enter or leave the parking stalls. This is measured from the center of the lanes to the parking stalls in the case of entering a stall. In the case of leaving the stall, it is measured from the parking stall until the vehicle starts travelling in the traffic stream (Purnawan and Yousif, 2004). On-street parking maneuvers can often start temporary bottlenecks, potentially affecting some following vehicles which might have to endure an extra delay (Cao, 2016). Different manoeuvre patterns have been identified on entering or leaving the stalls. These patterns are influenced by many factors including type of parking, presence of other parked vehicles in the adjacent stalls, size of stalls, vehicle type, drivers' maneuvering preference to reverse when entering or leaving a stall and traffic flow levels (Purnawan and Yousif, 2004).

2.7. Pedestrian study

Even though, priority is given to the pedestrians, pedestrians crossing the road considerably influence the road traffic flow in urban area. Pedestrians decrees the speed and increase the traffic flow and density. This paper studies to which extent crossing pedestrians influence the traffic flow (Knoop and Daganzo, 2017).

2.8. Review of Statistical analysis

2.8.1. Independent and Dependent Variables

Statistics is a mathematical science that is concerned with the collection, analysis, interpretation or explanation, and presentation of data. Independent variables (Predictor(s) are variables that are manipulated or are changed by researchers and whose influences are measured and compared. Independent/explanatory variables are called as such because independent variables

predict or forecast the values of the dependent variable in the model (Dattalo, 2013; Johnson and Wichern, 2015).

Dependent/response variables refer to that type of variable that measures the influence of the independent variable(s) on the test units. It can be also said that the dependent/ predicted variables are the types of variables that are completely dependent on the independent variable(s). The dependent variables are named as such because they are the values that are predicted or assumed by the predictor / independent variables (Dattalo, 2013; Johnson and Wichern, 2015).

For this particular study the thesis showed the analysis of one or more independent and one or more dependent variables. The chosen model for this type of data fits multivariate multiple linear regression analysis (MMLR) model (Mehmet, 2011).

Regression analysis is statistical analysis which estimates the relationship between dependent and independent variables and estimating regression parameters model, show strength and direction of model (Kewan, 2015). Regression considers four types of models Simple Regression, Multiple Regression, Multivariate Linear Regression, and Multivariate Multiple Linear Regression (Mike, 2019).

Multivariate multiple linear regression analysis (MMLR) was used to investigate the relations between one or more independent and one or more dependent variables. MMLR analysis enables us to investigate the relations between two data sets (independent or predictor variables) and (dependent variables). Computationally, MMLR gives the same coefficients, standard errors, t-and p-values and confidence intervals as one would estimate with individual (Günaşdi and Topal, 2018).

Based on the study of (Mehmet, 2011), when there is one or more dependent and one or more independent variables happened, MMLR, q dependent variables (Y_1, Y_2,…,Y_q) are to be predicted by linear relationships with r independent variables (X_1, X_2,…, X_r). That is, this study interested in how the set of dependent variables relate to the independent variables. Therefore, the statistical model for the MMLR is:

$$Y_{nxq} = X_{nx(r+1)} * B_{(r+1)xm} + \varepsilon_{nxq} \quad (2\text{-}7)$$

Where: Y represents n observations of a q-dependent variable, X represents the design matrix of rank r+1 with its first column being the vector 1, β is a matrix of parameters to be estimated $\hat{\beta} = (X^T X)^{-1}((X^T Y), X^T$ is the transpose of the independent variable matrix. The first column of $\hat{\beta}$ represents the regression coefficients of dependent variables (Y_1, Y_2,…,Y_q) with the independent variables (X_1, X_2,…, X_r). and ε represents the matrix of residuals (Günaşdi and Topal, 2018; Mehmet, 2011).

In a sample where there are n observations, if the number of the dependent variable is q, and the number of the independent variable is r; then the regression models for each dependent variable may be written as (Günaşdi and Topal, 2018)

$$\begin{aligned} Y_{i1} &= \beta_{o1} + \beta_{11}X_{i1} + \beta_{21}X_{i2} + \cdots + \beta_{r1}X_{1r} + \varepsilon_{i1} \\ Y_{i2} &= \beta_{o2} + \beta_{12}X_{i1} + \beta_{22}X_{i2} + \cdots + \beta_{r2}X_{1r} + \varepsilon_{i2} \\ &\vdots \\ Y_{iq} &= \beta_{oq} + \beta_{1q}X_{i1} + \beta_{2q}X_{i2} + \cdots + \beta_{rq}X_{1r} + \varepsilon_{iq} \end{aligned} \qquad (2\text{-}8)$$

$Y_{nxq} = X_{nx(r+1)} * B_{(r+1)xm} + \varepsilon_{nxq}$, the multivariate multiple linear regression equation in matrix notation written as;

$$\begin{bmatrix} Y_{11} & Y_{12} & \cdots & Y_{1q} \\ Y_{21} & Y_{22} & & Y_{2q} \\ \vdots & \vdots & \vdots & \vdots \\ Y_{n1} & Y_{n2} & \cdots & Y_{nq} \end{bmatrix} = \begin{bmatrix} 1 & X_{11} & X_{12} & \cdots & X_{1r} \\ 1 & X_{21} & X_{22} & & X_{2r} \\ & \vdots & \vdots & \vdots & \vdots \\ 1 & X_{n1} & X_{n2} & \cdots & X_{nr} \end{bmatrix} \begin{bmatrix} \beta_{o1} & \beta_{o2} & \cdots & \beta_{oq} \\ \beta_{11} & \beta_{12} & & \beta_{1q} \\ \vdots & \vdots & \vdots & \vdots \\ \beta_{r1} & \beta_{r2} & \cdots & \beta_{rq} \end{bmatrix} + \begin{bmatrix} \varepsilon_{11} & \varepsilon_{12} & \cdots & \varepsilon_{1q} \\ \varepsilon_{21} & \varepsilon_{22} & & \varepsilon_{2q} \\ \vdots & \vdots & \vdots & \vdots \\ \varepsilon_{n1} & \varepsilon_{n2} & \cdots & \varepsilon_{nq} \end{bmatrix}$$

The validity of the variables in statistical analysis assume some certain characteristic, also known as assumptions. Violation of these assumptions changes the conclusion of the research and interpretation of the results (Günaşdi and Topal, 2018). The thesis follows these assumptions for accurate interpretation as follows.

Once it has been estimating the relationship between dependent and indecent variables the model has to be checked the goodness of fit and the power of the relationship. Most important methods of assessing the regression models are analysis of variance (ANOVA), Multivariate analysis of variance (MANOVA), Analysis of covariance (ANCOVA) and Multivariate analysis of covariance (MANCOVA) (Kewan, 2015; Ramos et al., 2012). Multivariate analysis of

covariance (MANCOVA) mostly used to comparing a continuous outcome between the levels of one or more independent variables with one or more continuous dependent variables(Landau and Everitt, 2004).

2.8.2. Assumptions of multivariate multiple linear regression analysis

Every statistical method has assumptions. Assumptions mean that your data must satisfy certain properties in order for statistical method results to be accurate. The following five points are the main assumption of MMLR.

a) Linearity
b) Multivariate normality
c) No Multicollinearity
d) Homoscedasticity

2.8.2.1. Linearity

There must be a linear relationship between the outcome variable and the independent variables. Scatterplots can show whether there is a linear or curvilinear relationship. If residuals are normally distributed and homoscedastic, you do not have to worry about linearity. Multivariate normality also implies that the relationships between variables are linear (Mike, 2019).

2.8.2.2. Multivariate Normality

Multiple regression assumes that the residuals are normally distributed in order to make valid inferences from multiple regression analysis. The residuals are simply the error terms, or the differences between the observed value of the dependent variable and the predicted value. If we examine a normal Predicted Probability (P-P) plot, we can determine if the residuals are normally distributed. On the P-P plot the diagonal line and a bunch of little circles should look like the two left most of *Figure 2-7*. If the data is not normal, the little circles will not follow the normality line, such as in the figure to the right.

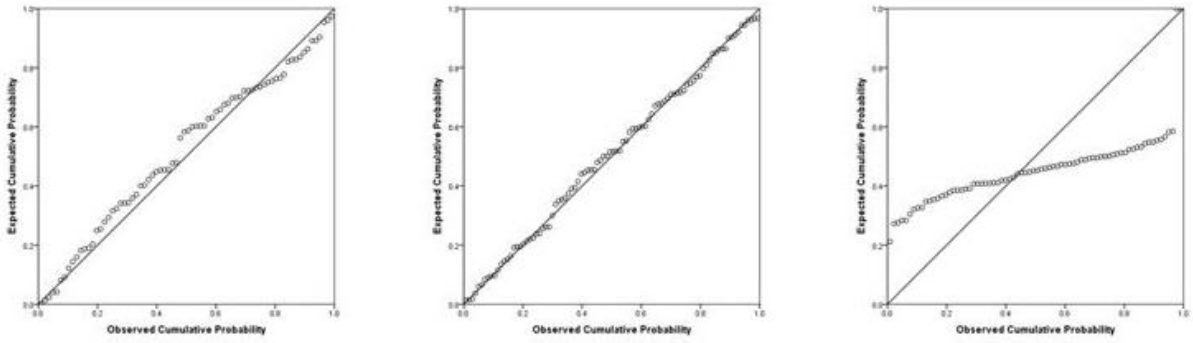


Figure 2-7: P-P plot for linearity assumption Source: https://www.statisticssolutions.com

2.8.2.3. No Multicollinearity

Multiple regression assumes that the independent variables are not highly correlated with each other. This assumption is tested using Variance Inflation Factor (VIF) values. Multicollinearity may be checked multiple ways:

a) **Correlation matrix –** When computing a matrix of Pearson's bivariate correlations among all independent variables, the magnitude of the correlation coefficients should be less than 0.80.
b) **Variance Inflation Factor (VIF) –** The VIFs of the linear regression indicate the degree that the variances in the regression estimates are increased due to multicollinearity. VIF values higher than 10 indicate that multicollinearity is a problem.

2.8.2.4. Homoscedasticity

This assumption states that the variances of error terms are similar across the values of the independent variables. The scatterplot of standardized residuals versus predicted values can show whether points are equally distributed across all values of the independent variables. There are points equally distributed above and below zero on the X axis, and to the left and right of zero on the Y axis as shown on the left side of *Figure 2-8* whereas the right side of the figure showed that the non-homoscedasticity as the small circles are not equally distributed.

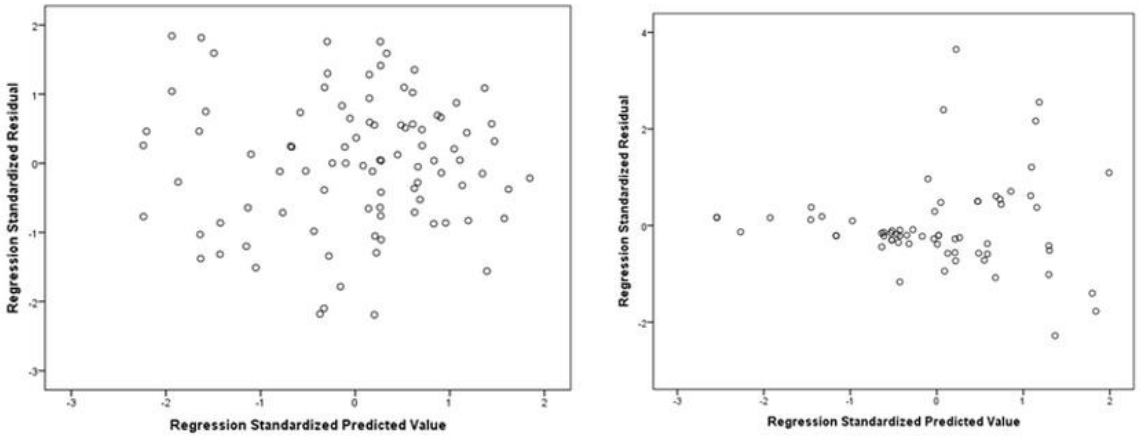


Figure 2-8: Screen Plot for homoscedasticity assumption Source: https://www.statisticssolutions.com

2.8.3. Multivariate Multiple Linear Regression Test

Multivariate analysis of covariance, MANCOVA, test was the method to check significance of MMLR model and conclude the influence of factors and covariate (Ramos et al., 2012; Mehmet, 2011). There are four multivariate measures used for assessing the multivariate multiple regression model: Wilks' lambda, Pillai's trace, Lawley–Hotelling trace, and Roy's largest root (Sekhar et al., 2016). The popular computer package called IBM SPSS statistics 20 was used for this computation.

Summary of Literature Review

On street parking influence on traffic flow has been studied by different researchers. Some argue that it is advantageous and some other said it is disadvantageous.

Advantages of on-street parking is pointed to the fact that it permits the motorists to park their vehicles nearby their destinations. Sometimes it can relieve cost of off-street parking construction, reduce land use.

On-street parking in city center is an attractive facility for drivers. However, the availability of such parking facilities may affect the capacity of the highway and be a contributory cause in high number of road traffic accidents as well as having other direct or indirect influence s on other issues such as the use of public transport, business, environment and property values.

The capacity of the road network could be reduced considerably if on-street parking facilities and their locations were not selected and controlled properly. The reduction in road width to accommodate the on-street parking facility is one of the main issues in design that could influence road capacity.

Another disadvantages that most researchers participated is the influence of on street parking on traffic flow and speed. It has been said more about the influence of on street parking on reduction of lane, congestion and reduction of travel speed.

Data collection was conducted using video for all types of parking parameters and traffic flow characteristics. Road condition survey conducted directly on the field using measuring tape.

Data were arranged using MS Excel 2016 for further analysis and IBM SPSS statistics 20 was used for Multivariate Multiple Linear Regression MMLR.

Based on dependent and independent variables, since in this study there are more than one dependent and more than one independent variable, Multivariate Multiple Linear Regression method of analysis has been used in IBM SPSS statistics 20 Software. MANCOVA test has been used for the multivariate multiple linear regression analysis.

3. MATERIALS AND METHODS

3.1. Description of the study area

As the map of the study area depicted on *Figure 3-1*, on this study, the main objective is to show in what extent on street parking influence on traffic flow. In order to investigate the influence, one site has been selected and the data has been collected on selected stretch, where the location was quite busy road serving retail and commercial activities comparing to other roads. This stretch was from Adare Hospital to Mobile Sefer.

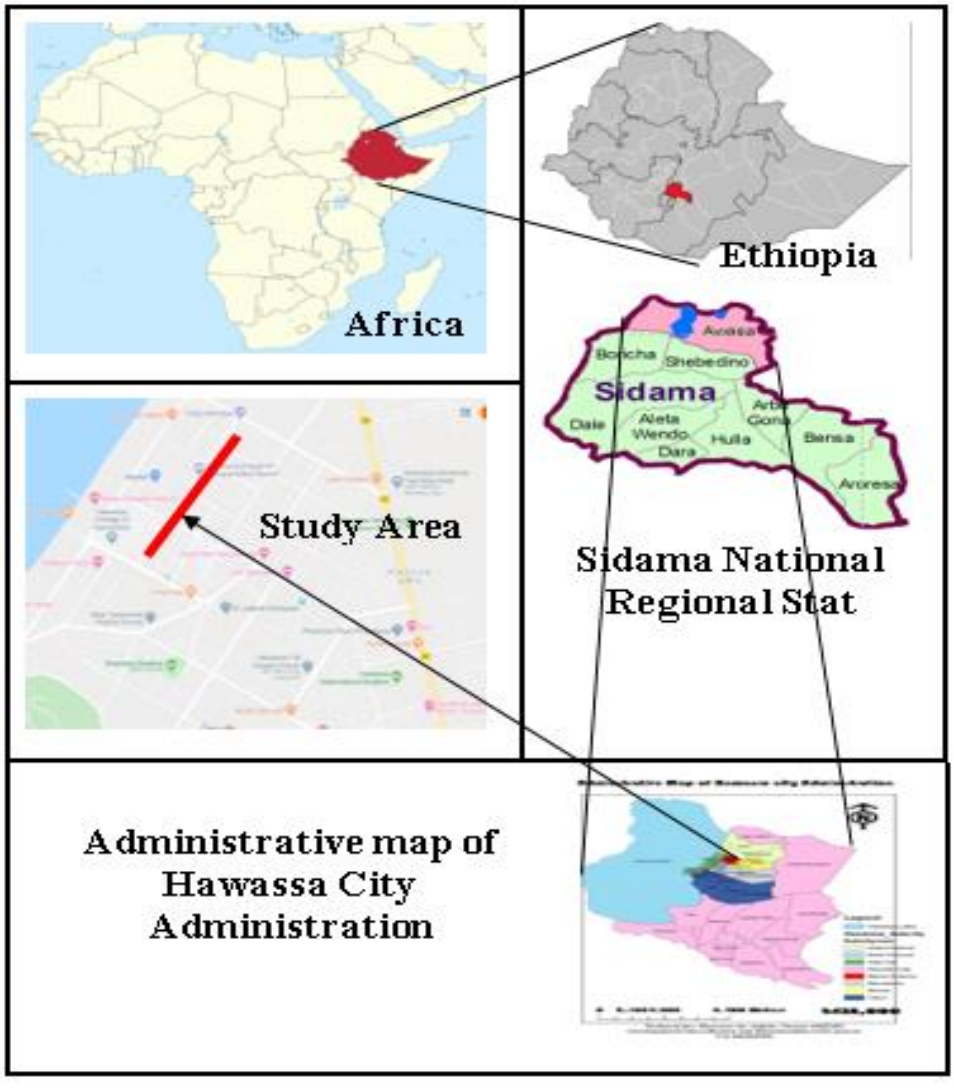


Figure 3-1: Map of Study Area (Source: Google Map and UN)

3.1.1. Adare Hospital to Mobile Sefer

This stretch is located starting from Adare hospital, locally named as Dashin Bank, through Arab Sefer ended at Mobile Sefer which is connected to the way to Selassie road covers a length of 1.67km. This stretch is an undivided two-way-two-lane asphalt road, highly business area. The road is quite congested since it is connected to the downtown, and is located near to the largest market locally named as Aroge Gebeya of Hawassa city. *Figure 3-2*

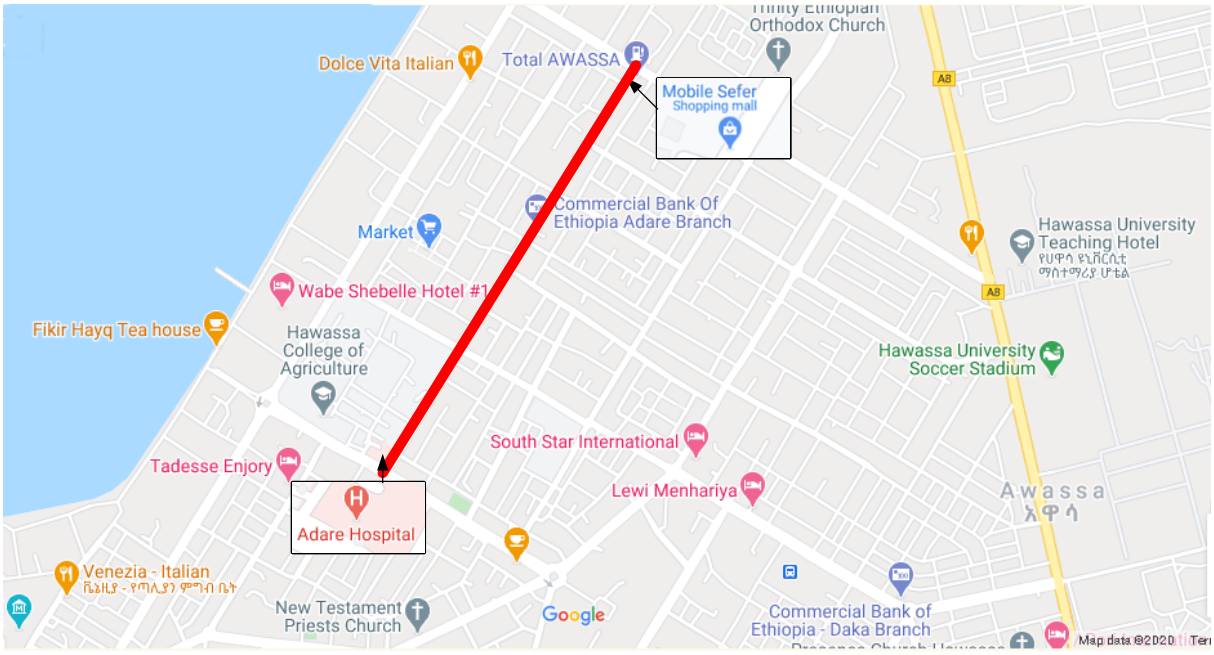


Figure 3-2. Study stretch, Adare Hospital to Mobil Sefer (Source: google map. 2020)

3.2. Study Subject

The thesis work subject matter is to study to what extent on street parking has an influence on driveways on the healthy movement of vehicles considering that the primarily function of the roadway is for vehicles.

The second subject matter of the study is to enhance by recommending the city's parking management system specially to give attention to on-street-parking. Previously several studies are done in the city, but only concentrated on parking demand and supply studies. On-street-parking is considered as part of parking type rather than considered as influence on traffic flow.

When the study conducted on the site, it incorporates all the necessary means of sources of data that are relevantly meet how on street parking has significance influence on traffic flow.

Thirdly, this thesis will be a guide to fill the gap about the concept of parking and to incorporate weather on street parking bays or off street parking for the designers.

3.3. Study design

The study design includes sample size and sampling Procedure. Sample size determined based on the length of time usually 15min interval of counting data using tally marks retrieved form video recorded. These subtopics procedures are arranged in chart type in *Figure 3-3*

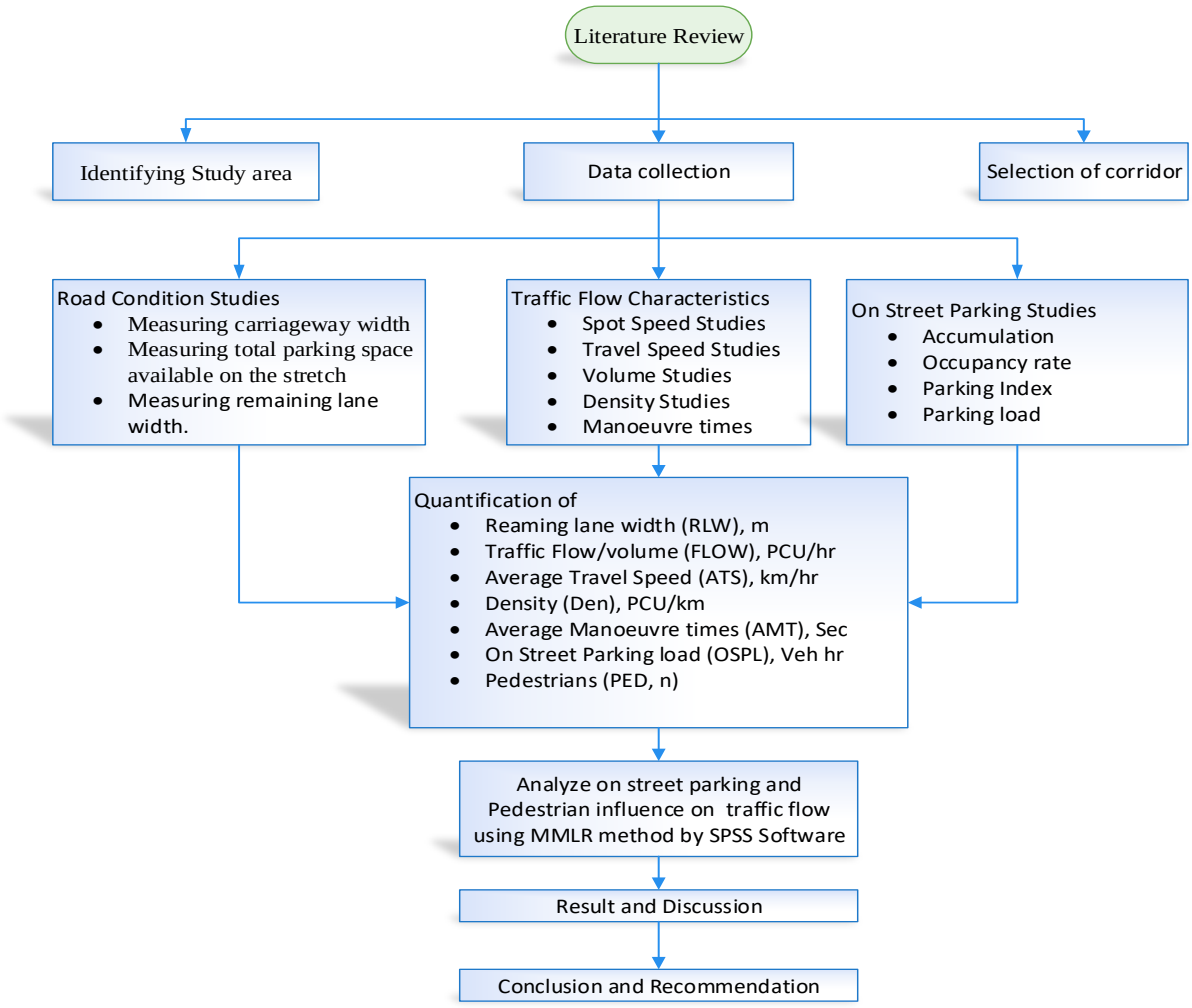


Figure 3-3. Study design chart

3.4. Study Parameters and methods

According to the study of (Nuzhat et al., 2013), There are two major methods of counting vehicle for volume survey. These are

3.4.1. Manual Counting Method

In this method, vehicles are counted manually. There are two methods of manual counting:

3.4.1.1. Direct Method

Data counted by using hand tally and manual counters/enumerators on the field.

Advantages: By this method traffic volume as well as vehicle classification and turning proportions can be obtained. Data can be used immediately after collection.

Disadvantages: This method is not practicable for long duration count and when flow is high. Error is common especially when volume is high. Count cannot be cross checked. Count cannot be done in bad weather.

3.4.1.2. Indirect Method.

In this method, data was collected using video camera. Video is captured for long time and data is collected later by rewinding.

Advantages: Besides traffic volume, several traffic parameters can be obtained from recorded film. Data can be cross checked and quality can be ensured. This method is applicable when volume is high. It is suitable for non-lane based traffic operation.

Disadvantages: A suitable elevated place is required for filming operation. Data cannot be used immediately after collection. Data must be manually written of recorded film. This process is time consuming and tedious. Because of limitation of capacity of film, it is not suitable for long duration counts. Quality of video recorded on film is dependent on intensity of light and this method is not suitable in overcast days.

3.4.2. Automatic counting method.

In this method, vehicles counted automatically without any human involvement. There are two techniques of automatic counting:

a) Contact system based on pneumatic, mechanical, magnetic or piezo-electric method, and
b) Contactless system based on electrical/optical, ultrasound/infrared radar, micro wave, CCTV/video image processing method etc.

Advantages: This method is suitable for long duration or continuous count. It is used as permanent counting station. It does not need manpower and is free from human error. Data is obtained in usable format. It is less expensive as manpower is not needed. Count is not affected by bad weather condition.

Disadvantages: It requires strict lane discipline. Non-motorized vehicles are hard to detect by this method. Detailed classification of vehicle is not possible. Accuracy is less than manual method. Installation cost is high.

Study parameters data has been collected from a total of 12hrs of video per day was recorded on the selected section for five working days. Data were retrieved from the recorded video by replaying it. Remaining lane width (RLW, m) was measured on the field while the video recorded. The traffic flow parameter which includes traffic flow (FLOW, PCU/hr), average travel speed (ATS, km/hr), Spot speed (SS, km/hr) has been studded from the recorded video. On street parking parameters has been studded and On street parking load (OSPL, veh hr) was used for analysis. Average maneuver time (AMT, seconds), and Pedestrian crossing (PED, n) were also included as the analyses parameters. All these data were collected and rearranged in the form of tables using MS Excel version 2016. For statistical analysis IBM SPSS statistics 20 was used.

3.5. Study Methodology

For this study the methodology which has been selected was indirect counting method for traffic flow characteristics studies as described in section 3.4.1.2. For geometric element which

includes measuring carriageway width, length of curb and total parking space available on the selected road were studied on direct field measurements using measuring tapes.

3.5.1. Primarily Data Sources

Primarily data was gathered from the recorded video, such as traffic volume, travel speed, on street parking and maneuver time. Direct field measurements have done for road conditions such as road length, lane width and available on street parking space. The primarily data collection have started through direct field measurements for inventory of geometric elements using measuring tapes.

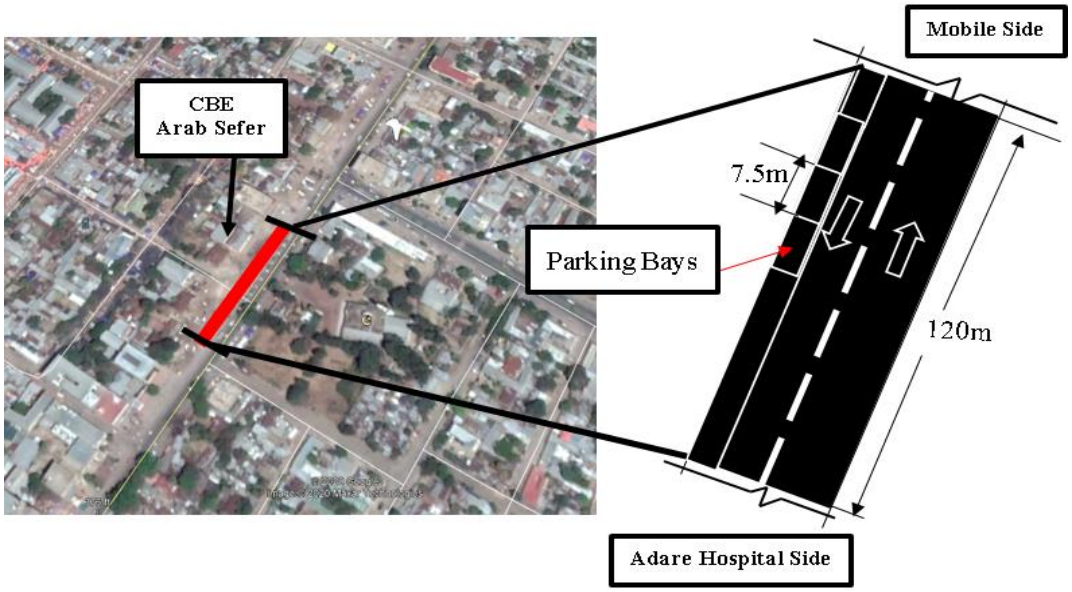


Figure 3-4:Selected Study Section for Data Collection

3.5.2. Counting Periods

Vehicles passing through a point or selected section can be counted for any duration. Duration of count depends on the objectives of data collection. For traffic control and management or operational studies short duration count at peak period is conducted. For planning and design purpose, long duration count is conducted.

For this thesis study purpose, data have been collected on selected five working days (Monday, Tuesday, Wednesday, Thursday and Friday), for a duration of 12 hours including peak and off peak periods for traffic studies (spot speed Studies, volume/flow, travel speed). On street

parking data collection, average maneuvering time and pedestrian crossing count data has been collected after having identified the peak day of the working days. In order to check the spot speed of the road data collection has been held on Sunday march 8, 2020 for a duration of 30 minutes. A video camera on selfie stick mounted on a G+4 building called Oumer Sani building at Arab Sefer. The high rise building has been selected in order not to miss any doubled moving vehicles *Figure 3-5*. For the purpose of identifying the peak day primarily data has been collected from 6:30AM to 6:30PM on five working days Monday through Friday.

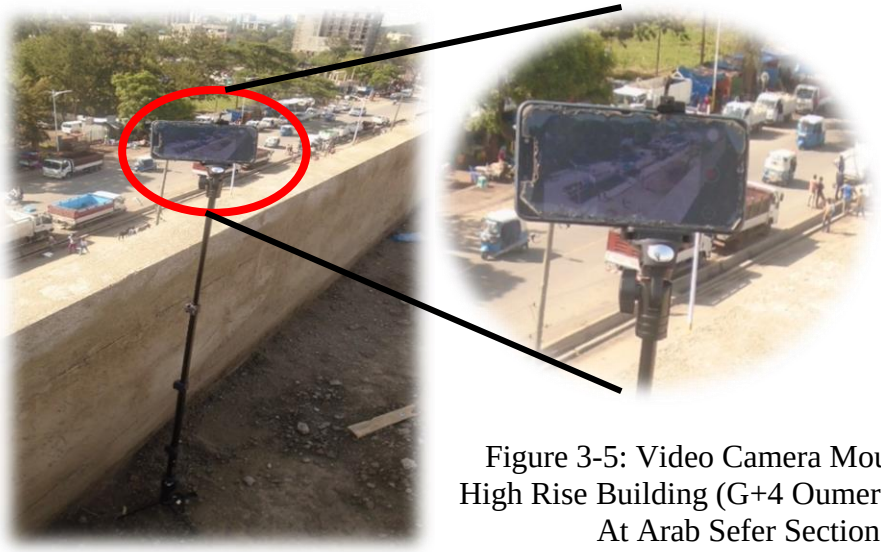


Figure 3-5: Video Camera Mounted On High Rise Building (G+4 Oumer Sani Bld.) At Arab Sefer Section

The traffic volume studies and on street parking studies has done on the selected sections at the same time using high mounted video camera. Data collection finally retrieved from the recorded video by manually counting with tally marks. For the ease of parking survey on a maximum of 120m base length (Wijayaratna, 2015) along the carriage ways are marked. Data concerning geometric elements that includes lane width, lateral clearance, number of lanes, type of medians collected from the field survey.

3.5.3. Geometric Element Studies

On street parking space conducted along each stretches that are currently functioning as parking service measured and the total parking supply from Adare Hospital to Mobile Sefer is depicted in *Table 7-18*. Measurements for parking spaces on left and right side of the road is based on

the parking restriction listed in section 2.4.5. As per IRC the standard dimensions of a car are taken as 2.5 x 5 meters and that for a truck is 3.75 x 7.5 meters.

Figure 3-6: Average Length of Right of way at Arab Sefer

Study area weather condition and information on geometric elements studies and video recording days.

Location: Arabs Sefer near Oumer Sani Building (Commercial bank of Ethiopia, CBE), $7^0$02'49" N $38^0$29'22" E	**Observations**
Date: Sunday March 8, 2020 Spotspeed and Monday March 9, 2020 through Friday March 13, 2020 Videography other parameters.	**Duration:** Saturday March 7, 2020 from 8:30 AM to 12:30PM for a period of 4hr.
Time: 6:30AM to 6:30PM	**Equipment:** Measuring tape
Weather condition: Sunny	**Number of enumerators:** 4
Method: Indirect method	**Methodology of reconnaissance survey:** road condition survey

3.5.4. Traffic Flow Characteristics Studies

It is also important to realize that the primary function of a highway is to provide mobility. This mobility must be provided with safety in mind while achieving an acceptable level of performance such as acceptable vehicle speeds (HCM, 2010).

After identified where the location of the busiest location due to retail and commercial activities, video camera was mounted on top terrace of G+4 building at the side of the selected section at Arab Sefer area to capture the traffic flow parameters. Flow direction was from Mobil Sefer to Adare Hospital as on street parking was mostly parked on this direction. Traffic data retrieved by replaying the videography and counted using tally marks.

3.5.4.1. Spot Speed

Studding Spot speed (SS) was mandatory because there was no any posted speed that limits the drivers. Since the maximum speed in town is 30kph, data collection for Spot speed (SS) and travel speed was held on marking the first reference point and second reference point with the base length of 54m *Table 2-1*. Vehicles crossing time on this section was automatically recorded with video camera. Then after, the time elapsed in seconds of vehicles crossing the base length retrieved and arranged for further calculation.

Spot speed of the road section was studied on Sunday, March 8, 2020, at 6:30AM to 7:00AM while the traffic is very less for the duration of 30min using video camera as described in section 2.3. Then after, the time at the starting point of the section is recoded and the time elapsed at the end of the section is recoded in seconds. Finally, the difference of the entering and exit time in seconds is the travel time for that section. Spot speed was computed as

$$\mathrm{SS} = \frac{Base\ length\ (km)}{Elapsed\ time\ (h)} \tag{3-1}$$

3.5.4.2. Average Travel Speed

Travel speed time data collection at peak day and peak time has been done accordingly in section 3.5.4.1. then average travel speed calculated based on the following equation.

$$\text{ATS} = \frac{Base\ length\ (km)}{Elapsed\ time\ (h)} \tag{3-2}$$

Figure 3-7:Traffic condition at Arab Sefer

3.5.4.3. Volume Study

The methodology used to count for this study was described under section 3.4.1.2. Using this method data was retrieved from the videography with a time interval of 15min by tally mark techniques.

The extracted data for the study sections were not directly used the number of vehicles as it is. The heterogeneous traffic composition was converted to passenger car unit, PCU, according to the description in section 2.3.6 and *Table 2-2*.

3.5.5. On Street Parking Studies

On street parking inventory was intended to collect relevant information of on street parking quantitative data needed to analyze the operational conditions under prevailing condition.

In and out survey method was used for data collection on the study of on street parking parameters. On street parking parameters has studied after identifying the peak day of traffic flow. Based on the study it was identified that Monday was the peak day of the week for traffic flow. On street parking parameter's data were collected on Monday, March 9, 2020 from the recorded video.

3.5.6. Parking Manoeuvre Times

Data collection for parking maneuvering time was taken from the recorded video while the vehicles were starting maneuver to park until it stops on the exact position. The elapsed was in seconds and tabulated on Table 4-10.

3.5.7. Pedestrian Crossing Count

Pedestrian crossing count has been done from the recorded video on the selected section while crossing the road illegally (without pedestrian crossing markings). Pedestrians was enumerated and has been tabulated on Table 4-10. The results in this paper can be used to optimize the influence of pedestrians on traffic flow and give recommendation to the decision makers.

3.5.8. Remaining lane width

Remaining lane width was measured from the entire width that was occupied by the parked vehicles since the edge of the vehicle body may extend apart from the tire. The offset occupied by the parked vehicle was immediately measured as one vehicle added to park on the marked one-meter length towards the center of the road. The compiled data has been presented on Table 4-10.

3.5.9. Model Development

To achieve the objective of this study data analysis was done based on the literature review described in section 2.8 using multivariate multiple linear regression analysis method. On the analysis part multivariate multiple regression analysis assumption has checked using SPSS software.

Independent and dependent variables checked using Pearson's bivariate correlation. Independent variables are on street parking load (OSPL, veh hr) and Pedestrian crossing (PED, n) which affects the traffic flow parameters which includes traffic flow (FLOW, PCU/hr), average travel speed (ATS, km/hr), and Density (Den, veh/km) which were taken as dependent variables. In addition to these parameters, remaining lane width (RLW, m) and average maneuver time (AMT, seconds) were also affected by on street parking and hence considered as dependent variables.

4. RESULTS AND DISCUSSIONS

In this section, based on the primarily data collected from the field analysis of geometric elements, data retrieved form the recorded video of current traffic flow characteristics and on street parking studies depicted as below.

4.1. Geometric Elements Studies

Based on the field data surveyed on Adare Hospital to Mobile Sefer road, it was two-way two-lane undivided road segment**.** The width of the road is 11.05m, width of the lane was 5.53m (there was no lane markings), each side has pedestrian walkway of width of 2.0m. In a direction of from Adare Hospital to Mobile Sefer on the right side there was 1m covered drainage which serves as on street parking, also there was on average 5.0m space as right of way. On the right side, 0.6m uncovered drainage has been constructed. On the same side of the road on average there was 20.0m width of right of way which serves as a store for the surrounding business owners *Figure 3-6.*

Based on road condition observation, Arab Sefer has been identified for traffic flow characteristics and on street parking parameters studies. The area was highly commercial center and active throughout the day. Oumr Sani a G+4 Building has been nominated for video recording as it was visible for the selected section.

4.2. Traffic Flow Characteristics

4.2.1. Traffic composition

It has been identified that there was heterogeneity of traffic including motorized two wheelers, cars (including jeeps and vans), buses, auto-rickshaws (three-wheeled motorized vehicles), light commercial vehicles, trucks, bicycles and Animal driven carts which share the common road space without any physical segregation. On this segment the traffic composition is listed on Table *4-1*. Even though, the higher percentage on the data collection week recorded by Bajaj, on average of 45.63%, and Motorcycle was 32.12%, on street parking is highly occupied by trucks which influences the traffic flow as it has been seen on Figure *4-1*. It should be clear that knowing the heterogeneity of vehicles along the road is used to convert number of vehicles to

passenger car equivalent, PCE for homogeneity of traffic flow. In this study traffic flow is measured in terms of PCE

Figure 4-1: Arab Sefer traffic Composition

Table 4-1 Traffic Composition in percent

Vehicle Type	Arab Sefer Traffic Composition (%)					Average
	Monday	Tuesday	Wednesday	Thursday	Friday	
Truck	6.84	4.06	2.13	3.79	3.15	3.99
Bus	4.72	4.38	2.47	4.14	3.97	3.93
Pickup	4.84	2.69	2.78	6.18	5.59	4.41
Car	2.11	1.64	1.91	3.06	2.54	2.25
Minibus	5.16	5.94	3.92	7.46	5.71	5.64
Bajaj	42.09	45.52	53.63	43.27	43.65	45.63
Motorcycle	31.21	34.14	31.49	29.98	33.76	32.12
Bicycle	0.23	0.12	0.12	0.24	0.13	0.17
Animal Driven Carts	2.81	1.50	1.56	1.89	1.51	1.86

4.2.2. Spot Speed

Spot speed has been computed under low-volume conditions. On the segment the Spot speed was 33.1km/h computed as.

Figure 4-2: Spot Speed and On Street Parking Base lengths (54m and 120m respectively)

For easily readable and understandable data are summarized into class or groups and create a frequency distribution table. From this arrangement it will be easy to plot frequency histogram, the frequency distribution, relative frequency distribution and cumulative frequency distribution.

In order to arrange the data in class and groups range R, number of class K and class width W were determined as Minimum = 22km/h Maximum = 65km/h Range R = 43, number of class K = 6 Class width W = 8. LCL/B = Lower Class Limit/Boundary, UCL/B = Upper Class Limit/Boundary.

Table 4-2: Class Limit for SS

LCL	UCL	Frequency	Relative Frequency
22.0	29.0	74.0	0.33
30.0	35.8	81.0	0.36
36.8	42.6	61.0	0.27
43.6	49.4	9.0	0.04
50.4	56.2	0.0	0.00
57.2	63.0	2.0	0.01
	Total	**227.0**	**1.00**

Table 4-3: Frequency Distribution of Spot Speed

LCB	UCB	Class Mark (x)	Frequency (f)	%f	Cum. f	x^2	fx	fx^2	$(fx)^2$
21.5	29.5	25.5	74.0	32.60	32.60	650.25	1887.0	48118.5	3560769.0
29.5	36.3	32.9	81.0	35.68	68.28	1082.69	2665.2	87697.7	7103513.3
36.3	43.1	39.7	61.0	26.87	95.15	1577.10	2422.5	96202.8	5868370.6
43.1	49.9	46.5	9.0	3.96	99.12	2164.21	418.7	19477.9	175301.2
49.9	56.7	53.3	0.0	0.00	99.12	2844.04	0.0	0.0	0.0
56.7	63.5	60.1	2.0	0.88	100.00	3616.58	120.3	7233.2	14466.3
			227.0	**100.0**		**11934.9**	**7513.7**	**258730.1**	**16722420.4**

Where

Based on the above computation Spot speed for Adare Hospital to Mobile Sefer was,

$$SS = \frac{\sum fx}{f} = \frac{\mathbf{7513.7}}{227} = 33.10\text{km/h} \quad (4\text{-}1)$$

4.2.3. Average travel speed

In as similar fashion, travel speed data collected from the recorded video of peak day and peak time (Monday from 4:00PM to 4:30PM) for about 30min. In order to arrange the data in class and groups range R, number of class K and class width W were determined as Minimum = 16.6km/h Maximum = 38.4km/h Range R = 22. number of class K = 6 Class width W = 4. LCL/B = Lower Class Limit/Boundary, UCL/B = Upper Class Limit/Boundary.

Table 4-4: LCL and UCL for Average Travel Speed on peak day of the week

LCL	UCL	Frequency	Relative Frequency
16.6	19.6	8	0.18
20.6	23.6	7	0.16
24.6	27.6	4	0.09
28.6	31.6	7	0.16
32.6	35.6	12	0.27
36.6	39.6	7	0.16
	total	**45**	

Table 4-5: Frequency Distribution of the Average Travel Speed of peak day of the week

LCB	UCB	Class Mark (x)	Frequency (f)	% f	Com f	x^2	fx	fx^2	$(fx)^2$
16.1	20.1	18.05	8	17.78	17.78	325.8025	144	2606	20851.36
20.05	24.05	22.05	7	15.56	33.33	486.2025	154	3403	23824
24.05	28.05	26.05	4	8.89	42.22	678.6025	104	2714	10858
28.05	32.05	30.05	7	15.56	57.78	903.0025	210	6321	44247
32.05	36.05	34.05	12	26.67	84.44	1159.403	409	13913	166954
36.05	40.05	38.05	7	15.56	100.00	1447.803	266	10135	70942
			45	100.00		5000.815	1288	39093	337676

$$\text{SS} = \frac{\sum fx}{f} = \frac{1288}{45} = 28.63\text{km/h} \qquad (4\text{-}2)$$

Based on the above calculation the average travel speed of the road section was reduced by (33.1 – 28.63)/33.1*100 = 13.5% due to on street parking.

4.2.4. Analysis Traffic flow, Speed and Density

On this section before the analysis of traffic flow characteristics, the peak day of the week should be identified. Hence the peak day of the week was Monday with the total traffic count was 30,784PCU/hr. *Table 4-6*.

Table 4-6: Traffic flow count of the working days

ID	Time	Monday	Tuesday	Wednesday	Thursday	Friday
1	6:30 AM - 7:30AM	583	519	390	424	420
2	6:45 AM - 7:45AM	617	546	438	486	441
3	7:00 AM - 8:00AM	692	566	477	547	460
4	7:15 AM - 8:15AM	744	578	516	615	512
5	7:30 AM - 8:30AM	795	604	535	683	566
6	7:45 AM - 8:45AM	798	633	529	696	602
7	8:00 AM - 9:00AM	737	632	535	701	633
8	8:15 AM - 9:15AM	678	633	527	704	628
9	8:30 AM - 9:30AM	634	607	501	678	599
10	8:45 AM - 9:45AM	600	574	494	659	586
11	9:00 AM - 10:00AM	597	553	464	687	587
12	9:15 AM - 10:15AM	602	534	433	718	588
13	9:30 AM - 10:30AM	593	573	435	786	622
14	9:45 AM - 10:45AM	649	600	462	837	657
15	10:00 AM - 11:00AM	696	657	495	816	668
16	10:15 AM - 11:15AM	752	690	544	795	691
17	10:30 AM - 11:30AM	795	668	588	740	676
18	10:45 AM - 11:45AM	799	670	593	703	689
19	11:00 AM - 12:00PM	817	671	614	711	716
20	11:15 AM - 12:15PM	813	681	610	684	737
21	11:30 AM - 12:30PM	772	720	591	679	740
22	11:45 AM - 12:45PM	712	744	591	687	723
23	12:00 PM - 1:00PM	645	712	572	661	698
24	12:15 PM - 1:15PM	603	681	571	665	651
25	12:30 PM - 1:30PM	602	678	574	666	637
26	12:45 PM - 1:45PM	590	640	545	661	612
27	1:00 PM - 2:00PM	572	629	548	687	552
28	1:15 PM - 2:15PM	541	622	537	693	503
29	1:30 PM - 2:30PM	529	598	525	684	461
30	1:45 PM - 2:45PM	531	582	539	667	469
31	2:00 PM - 3:00PM	547	590	521	611	504
32	2:15 PM - 3:15PM	602	606	524	600	548
33	2:30 PM - 3:30PM	650	614	524	606	585
34	2:45 PM - 3:45PM	733	643	522	609	590
35	3:00 PM - 4:00PM	775	661	531	647	599
36	3:15 PM - 4:15PM	813	666	518	670	591
37	3:30 PM - 4:30PM	826	654	523	705	595
38	3:45 PM - 4:45PM	815	623	530	731	584
39	4:00 PM - 5:00PM	804	615	518	752	601
40	4:15 PM - 5:15PM	765	612	508	773	642
41	4:30 PM - 5:30PM	759	622	480	723	609
42	4:45 PM - 5:45PM	709	665	460	681	567
43	5:00 PM - 6:00PM	675	665	449	605	495
44	5:15 PM - 6:15PM	646	639	453	506	408
45	5:30 PM - 6:30PM	579	597	469	445	375
	Total	**30,784**	**28,265**	**23,301**	**30,085**	**26,415**

Traffic flow characteristics (volume, speed and density) were computed from the recorded video on the peak day of the week which was Monday, March 9, 2020. Average travel time data were retrieved by rewinding the video while the vehicle travels the 54m base length marked on the road. Average travel speed was then calculated. Then after the density was calculated accordingly. The traffic characteristics are shown on the *Table 4-7*.

Table 4-7: Traffic flow, Average Travel Speed and Density Result

Monday Morning				**Monday Afternoon**			
Time, hr	**Flow (PCU/ hr)**	**Average Travel Speed (Km/hr)**	**Density (PCU/km)**	**Time, hr**	**Flow (PCU)**	**Average Travel Speed (Km/h)**	**Density (PCU/km)**
6:30 AM - 7:30AM	582	31.00	19	12:00 PM - 1:00PM	645	27.12	24
6:45 AM - 7:45AM	617	25.75	24	12:15 PM - 1:15PM	603	27.62	22
7:00 AM - 8:00AM	692	19.75	35	12:30 PM - 1:30PM	602	28.61	21
7:15 AM - 8:15AM	744	17.75	42	12:45 PM - 1:45PM	590	31.24	19
7:30 AM - 8:30AM	795	16.50	48	1:00 PM - 2:00PM	572	33.74	17
7:45 AM - 8:45AM	798	16.50	48	1:15 PM - 2:15PM	541	35.24	15
8:00 AM - 9:00AM	737	17.75	42	1:30 PM - 2:30PM	529	34.75	15
8:15 AM - 9:15AM	678	19.25	35	1:45 PM - 2:45PM	531	31.51	17
8:30 AM - 9:30AM	634	21.00	30	2:00 PM - 3:00PM	547	28.76	19
8:45 AM - 9:45AM	600	22.50	27	2:15 PM - 3:15PM	602	25.76	23
9:00 AM - 10:00AM	597	25.00	24	2:30 PM - 3:30PM	650	21.14	31
9:15 AM - 10:15AM	602	25.50	24	2:45 PM - 3:45PM	733	18.50	40
9:30 AM - 10:30AM	593	26.75	22	3:00 PM - 4:00PM	775	16.41	47
9:45 AM - 10:45AM	649	26.25	25	3:15 PM - 4:15PM	813	15.91	51
10:00 AM - 11:00AM	696	22.56	31	3:30 PM - 4:30PM	826	15.91	52
10:15 AM - 11:15AM	752	20.22	37	3:45 PM - 4:45PM	815	17.41	47
10:30 AM - 11:30AM	795	17.47	46	4:00 PM - 5:00PM	804	18.75	43
10:45 AM - 11:45AM	799	15.97	50	4:15 PM - 5:15PM	765	20.25	38
11:00 AM - 12:00PM	817	17.16	48	4:30 PM - 5:30PM	759	21.00	36
11:15 AM - 12:15PM	813	19.00	43	4:45 PM - 5:45PM	709	21.25	33
11:30 AM - 12:30PM	772	22.87	34	5:00 PM - 6:00PM	675	22.00	31
11:45 AM - 12:45PM	712	25.87	28	5:15 PM - 6:15PM	646	25.25	26
				5:30 PM - 6:30PM	579	30.50	19

4.3. Analysis of Maneuvering Time

Like other parameters studded on the previous sections, maneuvering time was computed from the same video recorded and arranged in an interval of 15min on peak day for 12hr. On-street parking maneuvers often block traffic, and even if for a short time, and hence extra delay triggered to the following vehicles. Based on the analysis, average maneuvering time was computed in an interval of 1hr Table 4-10. Finally, the study showed that the minimum

maneuvering time was 10 seconds and the maximum was 45 seconds. The maximum maneuvering time was recorded due to the high traffic flow recorded on the afternoon.

4.4. Analysis of On-Street-Parking

On the study of field investigation, the total amount of spaces used for on street parking service was determined. Based on the study with standard dimension of truck and car, the total space occupied by on street parking space was 7631.25m^2 for trucks and 5087.50m^2 for cars. *Table 7-18*.

In parallel with traffic flow characteristics study, analysis of on street parking parameters were computed using In-Out survey method from the same video recorded for traffic flow and average travel speed. On street Parking parameters indicated that how the traffic flow has been influenced by on-street parking.

Accumulation was calculated as initial count plus number of vehicles that entered in the parking lot minus the number of vehicles leave the parking lot within the marked base length of 120m and an interval of 15min. The initial accumulation was 5 vehicles and the first vehicles entered was 3 vehicles but there were no vehicles in the first 15min. therefore the first 15min accumulation was 5+3-0 = 8veh. Refer on Appendix C *Table 7-20*.

Occupancy or parking index was calculated on the first 15min as 8/16*100 = 50% or 0.5. in the similar fashion the next 15min intervals were calculated and tabulated on appendix C *Table 7-20*. Average occupancy of the segment was 79.95%. Parking index at 7:15AM to 9:00AM,10:45AM to 12:15AM and 3:00PM - 5:45 PM, indicated that vehicles experiences severe problem since PI value has been recorded more than one. But on off-peak times it has a meaning that parking space was moderate problem or still has seen less problem accommodation to park.

As the parking load showed it was calculated for the first 15min as multiplying accumulation of the first 15min occupying the parking area by each time interval in hour. Therefore, 8veh.*15/60 = 2 vehicle hour and more number of cars were loaded at 7:15AM to 9:00AM,10:45AM to 12:15AM and 3:00PM - 5:45 PM refer on *Table 7-20*. On *Table 4-8* the summation of parking

load was 587 vehicle hour with average of 13.04 vehicle hour. Parking duration was 48.9min and the study section was efficiently used, 81.5 %.

Table 4-8: Summary of on-street-parking parameters

Sum of parking load	587.0
Total hr	45
Average parking load, Veh hr	13.0
Parking duration, min	48.9
Parking efficiency (%)	81.5

4.5. Modeling the Relationship Between On-Street-Parking Impacts On Traffic Flow

As briefly explained on the above section 4.2.1 to 4.3, all the necessary variables/parameters were categorized as dependent and independent variables for further statistical analysis and tabulated.

Table 4-9:Category of Dependent and Independent Variables

Dependent variables	Independent variables/Factors
1. Traffic flow (Flw), PCU/hr 2. Average travel speed (ATS), km/hr 3. Density (Den) , PCU/km 4. Remaining lane width (RLW) , m 5. Average maneuvering time (AMT) , sec	1. Parking load (PL). Veh hr 2. Pedestrian count (PED, n)

Table 4-10: Arranged data for dependent and independent variables

ID	Time interval	Flow (PCU)	Average Travel Speed (Km/hr)	Density (PCU/km)	Remaining Lane Width (m)	Average Maneuvering Time, (Sec)	Parking Load (Veh hr)	Pedestrian Count (n)
1	6:30 AM - 7:30AM	582	31.00	19	3.9	23.0	10.50	91.0
2	6:45 AM - 7:45AM	617	25.75	24	3.1	26.0	12.25	98.0
3	7:00 AM - 8:00AM	692	19.75	35	2.6	30.0	14.25	108.0
4	7:15 AM - 8:15AM	744	17.75	42	2.5	35.0	16.00	112.0
5	7:30 AM - 8:30AM	795	16.50	48	2.4	36.0	17.50	119.0
6	7:45 AM - 8:45AM	798	16.50	48	2.0	38.0	17.75	121.0
7	8:00 AM - 9:00AM	737	17.75	42	2.3	36.0	16.75	120.0
8	8:15 AM - 9:15AM	678	19.25	35	2.6	35.0	14.75	115.0
9	8:30 AM - 9:30AM	634	21.00	30	3.0	29.0	12.75	116.0
10	8:45 AM - 9:45AM	600	22.50	27	3.4	22.0	10.75	114.0
11	9:00 AM - 10:00AM	597	25.00	24	3.6	20.0	9.75	112.0
12	9:15 AM - 10:15AM	602	25.50	24	3.7	19.0	10.00	114.0
13	9:30 AM - 10:30AM	593	26.75	22	2.8	29.0	10.75	119.0
14	9:45 AM - 10:45AM	649	26.25	25	2.4	32.0	12.25	121.0
15	10:00 AM - 11:00AM	696	22.56	31	2.1	36.0	13.50	123.0
16	10:15 AM - 11:15AM	752	20.22	37	1.8	38.0	14.50	124.0
17	10:30 AM - 11:30AM	795	17.47	46	1.6	40.0	15.50	126.0
18	10:45 AM - 11:45AM	799	15.97	50	1.8	39.0	16.50	127.0
19	11:00 AM - 12:00PM	817	17.16	48	2.1	39.0	16.75	128.0
20	11:15 AM - 12:15PM	813	19.00	43	1.9	37.0	16.50	129.0
21	11:30 AM - 12:30PM	772	22.87	34	2.4	33.0	15.50	115.0
22	11:45 AM - 12:45PM	712	25.87	28	2.7	29.0	14.00	108.0
23	12:00 PM - 1:00PM	645	27.12	24	3.0	25.0	12.50	102.0
24	12:15 PM - 1:15PM	603	27.62	22	3.6	20.0	10.50	95.0
25	12:30 PM - 1:30PM	602	28.61	21	4.2	15.0	8.75	92.0
26	12:45 PM - 1:45PM	590	31.24	19	4.3	14.0	7.25	96.0
27	1:00 PM - 2:00PM	572	33.74	17	4.5	16.0	6.00	97.0
28	1:15 PM - 2:15PM	541	35.24	15	4.7	12.0	5.75	91.0
29	1:30 PM - 2:30PM	529	34.75	15	4.9	11.0	5.00	91.0
30	1:45 PM - 2:45PM	531	31.51	17	4.8	10.0	5.25	90.0
31	2:00 PM - 3:00PM	547	28.76	19	4.9	12.0	6.75	85.0
32	2:15 PM - 3:15PM	602	25.76	23	4.0	20.0	9.00	93.0
33	2:30 PM - 3:30PM	650	21.14	31	3.2	29.0	12.75	105.0
34	2:45 PM - 3:45PM	733	18.50	40	2.6	36.0	15.25	110.0
35	3:00 PM - 4:00PM	775	16.41	47	2.3	40.0	16.75	117.0
36	3:15 PM - 4:15PM	813	15.91	51	2.1	44.0	17.50	125.0
37	3:30 PM - 4:30PM	826	15.91	52	1.8	45.0	17.00	129.0
38	3:45 PM - 4:45PM	815	17.41	47	1.5	41.0	16.75	127.0
39	4:00 PM - 5:00PM	804	18.75	43	1.6	36.0	17.00	118.0
40	4:15 PM - 5:15PM	765	20.25	38	2.2	41.0	16.75	117.0
41	4:30 PM - 5:30PM	759	21.00	36	2.5	39.0	16.75	114.0
42	4:45 PM - 5:45PM	709	21.25	33	2.9	31.0	16.50	108.0
43	5:00 PM - 6:00PM	675	22.00	31	3.4	25.0	14.75	100.0
44	5:15 PM - 6:15PM	646	25.25	26	3.9	20.0	13.00	93.0
45	5:30 PM - 6:30PM	579	30.50	19	4.1	22.0	10.75	87.0

Based on the compiled data on Table 4-10 multivariate multiple linear regression analysis was used for statistical analysis where there are many independent (IVs), two in this case, and possible dependent variables (DVs), five in this case, which are correlated to each other to varying degrees. The ready availability of software application programs called IBM SPSS 20 which can handle the complexity of large multivariate data sets has been used for the analysis of multivariate statistics.

4.5.1. Assumptions: Verification

4.5.1.1. Linearity

Linearity can be checked by scatterplots and p-p plot outputs. From *Figure 4-3* to *Figure 4-7* showed the p-p plot and from Figure 4-8 to Figure 4-12 showed residuals are normally distributed and homoscedastic and hence the multivariate linearity met the assumption.

4.5.1.2. Multivariate Normality

Predicted Probability (P-P) plot figured below showed that the residuals are normally distributed. On the P-P plot the diagonal line follow the normality line and hence met the second assumptions.

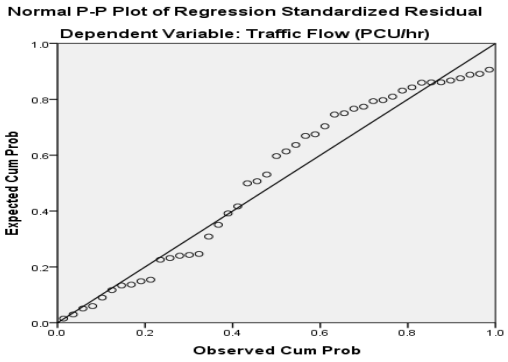


Figure 4-3: P-P Plot for dependent variable: Traffic Flow

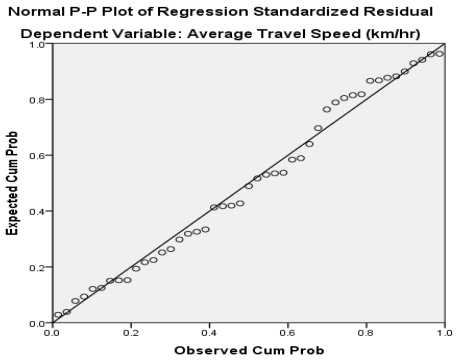


Figure 4-4: P-P Plot for dependent variable: Average Travel Speed

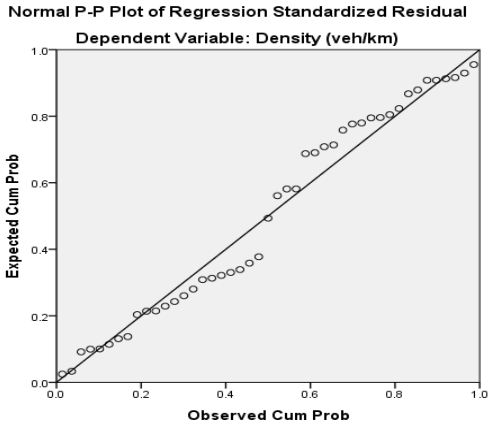


Figure 4-5: P-P Plot for dependent variable: Density

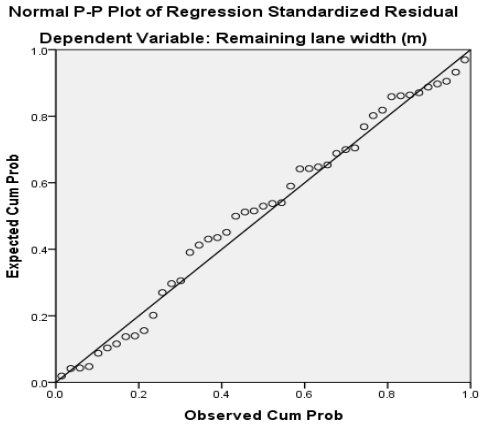


Figure 4-6: P-P Plot for dependent variable: Remaining Lane Width

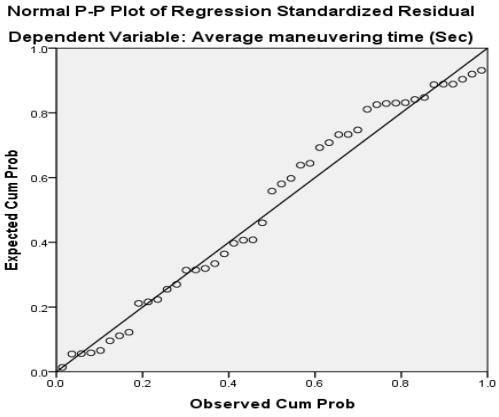


Figure 4-7: P-P Plot for dependent variable: Average Maneuvering Time

4.5.1.3. No Multicollinearity

Independent variables, On Street Parking and pedestrian counts, are not correlated (Pearson Correlation showed that the value of r = 0.770 < 0.80, p = 0.000 < 0.05) *Table 4-11* and Variance Inflation Factor (VIF<10) meet the correlation. refer on *Table 4-14*.

Table 4-11: SPSS Output of Pearson Correlation of independent variables.

Correlations

		On Street Parking Load (veh hr)	Pedestrian Count (n)
On Street Parking Load (veh hr)	Pearson Correlation	1	.770**
	Sig. (2-tailed)		.000
	N	45	45
Pedestrian Count (n)	Pearson Correlation	.770**	1
	Sig. (2-tailed)	.000	
	N	45	45

**. Correlation is significant at the 0.01 level (2-tailed).

4.5.1.4. Homoscedasticity

The scatterplot of standardized residuals versus predicted values for the independent variables displayed from *Figure 4-8* to *Figure 4-12* small circles are equally distributed across all values of the independent variables. Accordingly, variance of the residual, or error term, in a regression model is constant. That is, the error term does not vary much as the value of the predictor variable changes.

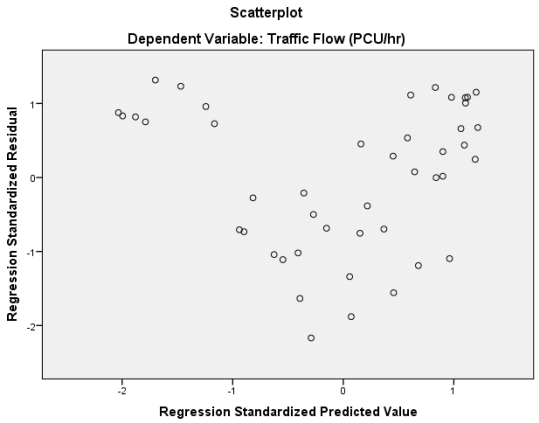


Figure 4-8: Scatterplot for dependent variable: Traffic Flow

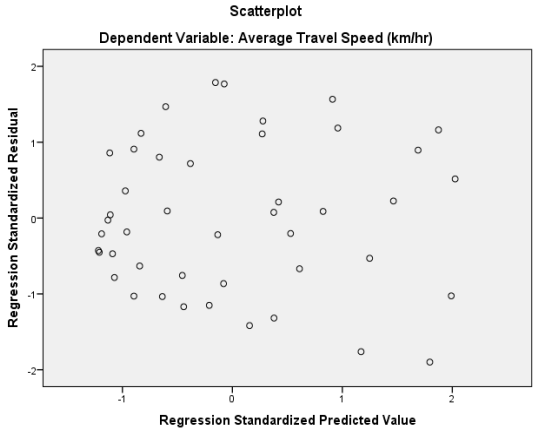


Figure 4-9: Scatterplot for dependent variable: Average Travel Speed

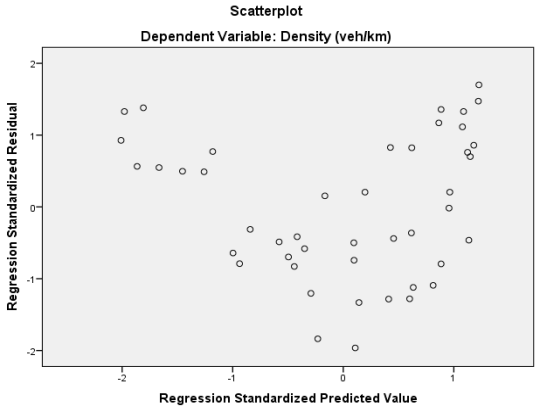


Figure 4-10: Scatterplot for dependent variable: Density

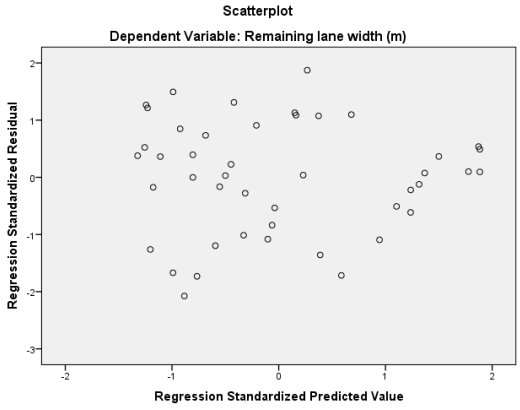


Figure 4-11: Scatterplot for dependent variable: Remaining Lane Width

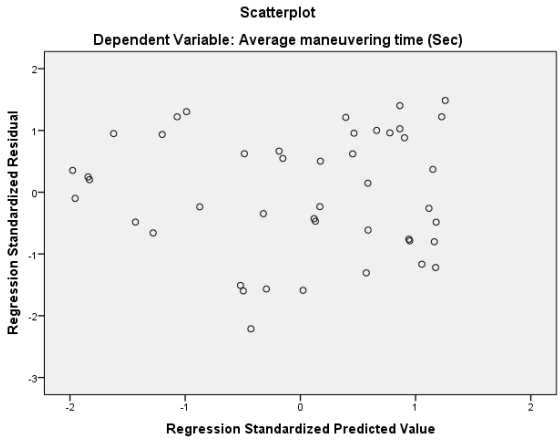


Figure 4-12: Scatterplot for dependent variable: Average Maneuvering Time

4.5.2. Multivariate Multiple Linear Regression Analysis

In this section the multivariate multiple linear regression analysis has been done based on the review in section 2.8.1 based on the category arranged on Table 4-9. Traffic flow (FLOW, PCU/hr), Average Travel Speed (ATS, km/hr), Density (DEN, PCU/km), Remaining Lane Width (RLW, m) and Average Maneuvering Time (AMT, sec) which have been taken as the dependent variables; whereas, On-Street-Parking Load (OSPL, veh hr) and Pedestrian Count (PED, n) which have been taken as the independent variables. In order to apply the multivariate multiple linear regression analysis, the dependent variable matrix which is (**Y)** and the independent variable matrix **(X)** have been formed as follows. There is the column vector which consists of the fixed value **1** which is necessary for the $\boldsymbol{\beta_o}$ term as shown on Table 4-12.

Table 4-12: Multivariate Multiple Linear Regression Analysis Data Sets

ID	Time	Dependent Variables, Y					Independent Variables, X		
		Flow (PCU/hr)	ATS (Km/hr)	Density (PCU/km)	RLW (m)	AMT (sec)	Fixed Matrix	OSPL (Veh hr)	PED (n)
1	6:30 AM - 7:30AM	582	31.00	19	3.9	23	1	10.50	91
2	6:45 AM - 7:45AM	617	25.75	24	3.1	26	1	12.25	98
3	7:00 AM - 8:00AM	692	19.75	35	2.6	30	1	14.25	108
4	7:15 AM - 8:15AM	744	17.75	42	2.5	35	1	16.00	112
5	7:30 AM - 8:30AM	795	16.50	48	2.4	36	1	17.50	119
6	7:45 AM - 8:45AM	798	16.50	48	2.0	38	1	17.75	121
7	8:00 AM - 9:00AM	737	17.75	42	2.3	36	1	16.75	120
8	8:15 AM - 9:15AM	678	19.25	35	2.6	35	1	14.75	115
9	8:30 AM - 9:30AM	634	21.00	30	3.0	29	1	12.75	116
10	8:45 AM - 9:45AM	600	22.50	27	3.4	22	1	10.75	114
11	9:00 AM - 10:00AM	597	25.00	24	3.6	20	1	9.75	112
12	9:15 AM - 10:15AM	602	25.50	24	3.7	19	1	10.00	114
13	9:30 AM - 10:30AM	593	26.75	22	2.8	29	1	10.75	119
14	9:45 AM - 10:45AM	649	26.25	25	2.4	32	1	12.25	121
15	10:00 AM - 11:00AM	696	22.56	31	2.1	36	1	13.50	123
16	10:15 AM - 11:15AM	752	20.22	37	1.8	38	1	14.50	124
17	10:30 AM - 11:30AM	795	17.47	46	1.6	40	1	15.50	126
18	10:45 AM - 11:45AM	799	15.97	50	1.8	39	1	16.50	127
19	11:00 AM - 12:00PM	817	17.16	48	2.1	39	1	16.75	128
20	11:15 AM - 12:15PM	813	19.00	43	1.9	37	1	16.50	129
21	11:30 AM - 12:30PM	772	22.87	34	2.4	33	1	15.50	115
22	11:45 AM - 12:45PM	712	25.87	28	2.7	29	1	14.00	108
23	12:00 PM - 1:00PM	645	27.12	24	3.0	25	1	12.50	102
24	12:15 PM - 1:15PM	603	27.62	22	3.6	20	1	10.50	95
25	12:30 PM - 1:30PM	602	28.61	21	4.2	15	1	8.75	92
26	12:45 PM - 1:45PM	590	31.24	19	4.3	14	1	7.25	96
27	1:00 PM - 2:00PM	572	33.74	17	4.5	16	1	6.00	97
28	1:15 PM - 2:15PM	541	35.24	15	4.7	12	1	5.75	91
29	1:30 PM - 2:30PM	529	34.75	15	4.9	11	1	5.00	91
30	1:45 PM - 2:45PM	531	31.51	17	4.8	10	1	5.25	90
31	2:00 PM - 3:00PM	547	28.76	19	4.9	12	1	6.75	85
32	2:15 PM - 3:15PM	602	25.76	23	4.0	20	1	9.00	93
33	2:30 PM - 3:30PM	650	21.14	31	3.2	29	1	12.75	105
34	2:45 PM - 3:45PM	733	18.50	40	2.6	36	1	15.25	110
35	3:00 PM - 4:00PM	775	16.41	47	2.3	40	1	16.75	117
36	3:15 PM - 4:15PM	813	15.91	51	2.1	44	1	17.50	125
37	3:30 PM - 4:30PM	826	15.91	52	1.8	45	1	17.00	129
38	3:45 PM - 4:45PM	815	17.41	47	1.5	41	1	16.75	127
39	4:00 PM - 5:00PM	804	18.75	43	1.6	36	1	17.00	118
40	4:15 PM - 5:15PM	765	20.25	38	2.2	41	1	16.75	117
41	4:30 PM - 5:30PM	759	21.00	36	2.5	39	1	16.75	114
42	4:45 PM - 5:45PM	709	21.25	33	2.9	31	1	16.50	108
43	5:00 PM - 6:00PM	675	22.00	31	3.4	25	1	14.75	100
44	5:15 PM - 6:15PM	646	25.25	26	3.9	20	1	13.00	93
45	5:30 PM - 6:30PM	579	30.50	19	4.1	22	1	10.75	87

The SPSS analysis output of the regression coefficients matrix is obtained as follows

Table 4-13: Model Summary

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.949[a]	.901	.896	30.24206	.901	191.322	2	42	.000	.425

a. Predictors: (Constant), Pedestrian Count (n), On Street Parking Load (veh hr)

b. Dependent Variable: Traffic Flow (PCU/hr)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.938[a]	.880	.874	1.98114	.880	153.332	2	42	.000	.522

a. Predictors: (Constant), Pedestrian Count (n), On Street Parking Load (veh hr)

b. Dependent Variable: Average Travel Speed (km/hr)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.931[a]	.866	.860	4.22461	.866	135.846	2	42	.000	.398

a. Predictors: (Constant), Pedestrian Count (n), On Street Parking Load (veh hr)

b. Dependent Variable: Density (veh/km)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.968[a]	.937	.934	.25328	.937	314.546	2	42	.000	.859

a. Predictors: (Constant), Pedestrian Count (n), On Street Parking Load (veh hr)

b. Dependent Variable: Remaining lane width (m)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.965[a]	.932	.928	2.65672	.932	286.161	2	42	.000	1.014

a. Predictors: (Constant), Pedestrian Count (n), On Street Parking Load (veh hr)

b. Dependent Variable: Average maneuvering time (Sec)

The model summary output on *Table 4-13* for each dependent variable compared based on R square and significance value that indicated how the independent parameters has quite significance influence on the dependent variables. Remaining lane width (R^2 = 93.7% p =0.000<0.05), Average maneuvering time (R^2 = 93.2% p =0.000<0.05), Traffic Flow (R^2 = 90.1% p =0.000<0.05), Average Travel Speed (R^2 = 88.0% p =0.000<0.05) and followed by Density (R^2 = 86.6% p =0.000<0.05).

Table 4-14: Coefficients of Multivariate Multiple Linear Regression Analysis

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	245.542	43.355		5.664	.000		
	On Street Parking Load (veh hr)	18.245	1.882	.737	9.693	.000	.408	2.454
	Pedestrian Count (n)	1.822	.538	.257	3.386	.002	.408	2.454

a. Dependent Variable: Traffic Flow (PCU/hr)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	49.231	2.840		17.334	.000
	On Street Parking Load (veh hr)	-1.053	.123	-.717	-8.541	.000
	Pedestrian Count (n)	-.112	.035	-.267	-3.185	.003

a. Dependent Variable: Average Travel Speed (km/hr)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-22.924	6.056		-3.785	.000
	On Street Parking Load (veh hr)	1.989	.263	.669	7.566	.000
	Pedestrian Count (n)	.265	.075	.312	3.525	.001

a. Dependent Variable: Density (veh/km)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	8.928	.363		24.587	.000
	On Street Parking Load (veh hr)	-.135	.016	-.517	-8.544	.000
	Pedestrian Count (n)	-.038	.005	-.513	-8.478	.000

a. Dependent Variable: Remaining lane width (m)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-23.504	3.809		-6.171	.000
	On Street Parking Load (veh hr)	1.711	.165	.654	10.347	.000
	Pedestrian Count (n)	.274	.047	.367	5.806	.000

a. Dependent Variable: Average maneuvering time (Sec)

Table 4-15: Summary of Coefficients Matrix

Variables	**Dependent variable, Y**					
	$\boldsymbol{\beta}$	**FLOW (PCU/hr)**	**ATS (Km/h)**	**Density (PCU/km)**	**RLW (m)**	**AMT (sec)**
Independent variable, X	Constants	245.542	49.231	-22.924	8.928	-23.504
	OSPL (veh hr)	18.245	-1.053	1.989	-.135	1.711
	PED(n)	1.822	-.112	.265	-.038	.274

From the results above, the estimated multivariate multiple linear regression model can be written as follows.

$$Y_{Flow} = 245.542 + 18.245 * OSPL + 1.822 * PED$$

$$Y_{ATS} = 49.231 - 1.053 * OSPL - 0.112 * PED$$

$$Y_{DEN} = -22.924 + 1.989 * OSPL + 0.265 * PED$$

$$Y_{RLW} = 8.928 - 0.135 * OSPL - 0.038 * PED$$

$$Y_{AMT} = -23.504 + 1.711 * OSPL + 0.274 * PED$$

On street parking load (OSPL) and Pedestrian crossing (PED) have statistically positive influence at a very significant level on the traffic flow (FLOW), density (DEN) and average maneuvering time (AMT). On the other hand, negative influence on average travel speed (ATS) and remaining lane width (RLW). Accordingly, an increase in the OSPL and AMT values lead to an increase in the traffic flow parameter characteristics; and a decrease in variables values lead to decrease in on traffic flow parameter characteristics. When the beta coefficients are examined, it is observed that the most significant influence was made by on street parking load with maximum coefficient of 18.245 and flowed by pedestrian count with maximum coefficient of 1.822 *Table 4-15*

4.5.3. Multivariate Analysis of Covariance (MANCOVA) test

In this section the MANCOVA model test have been chosen for the reason that the thesis tries to estimate more than one dependent continuous variable and more than one independent continuous variables. Using the data sets on *Table 4-12* the four multivariate test statistics has been displayed on *Table 4-16*. The result on multivariate test table showed that the influence of on street parking and pedestrian traffic was significant influence according to Wilks' lambda, Pillai's trace, Lawley–Hotelling trace, and Roy's largest root test results and have been found to be significant with $p = 0.000 < 0.05$. Therefore, it can conclude that Traffic Flow characteristics parameters including remaining lane width and maneuvering time were significantly dependent on On-Street-Parking load and pedestrian traffic with significant value of less than 0.05.

After obtaining a significant multivariate test for a particular main influence and for the interaction, one would examine the Multivariate F tests for each variable and combinations as it has been showed on *Table 4-17*

Table 4-16: SPSS output for Multivariate Test

Multivariate Tests[a]

Influence		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.892	61.390[b]	5.000	37.000	.000
	Wilks' Lambda	.108	61.390[b]	5.000	37.000	.000
	Hotelling's Trace	8.296	61.390[b]	5.000	37.000	.000
	Roy's Largest Root	8.296	61.390[b]	5.000	37.000	.000
OSPL	Pillai's Trace	.704	17.636[b]	5.000	37.000	.000
	Wilks' Lambda	.296	17.636[b]	5.000	37.000	.000
	Hotelling's Trace	2.383	17.636[b]	5.000	37.000	.000
	Roy's Largest Root	2.383	17.636[b]	5.000	37.000	.000
PED	Pillai's Trace	.695	16.835[b]	5.000	37.000	.000
	Wilks' Lambda	.305	16.835[b]	5.000	37.000	.000
	Hotelling's Trace	2.275	16.835[b]	5.000	37.000	.000
	Roy's Largest Root	2.275	16.835[b]	5.000	37.000	.000
OSPL * PED	Pillai's Trace	.757	23.093[b]	5.000	37.000	.000
	Wilks' Lambda	.243	23.093[b]	5.000	37.000	.000
	Hotelling's Trace	3.121	23.093[b]	5.000	37.000	.000
	Roy's Largest Root	3.121	23.093[b]	5.000	37.000	.000

a. Design: Intercept + OSPL + PED + OSPL * PED
b. Exact statistic

On the result of “Tests of Between-Subjects Effects” on *Table 4-17* showed that on street parking load has a significant influence on traffic flow and density. Besides that, the covariate has a significant influence on both dependent variables. pedestrian traffic has also significant influence on traffic flow and traffic density both on variate and covariates dependents. Partial Eta-squared provides a measure of the variance in the dependent variable accounted for independent variables (also called influence size). The study showed that on-street-parking has an influence of 35.9% on traffic flow, 39.9% on density and 7.4% on remaining lane width. The pedestrian traffic also has in influence of 38.0% on traffic flow, 36.5% on density and 21.30% on remaining lane width. In respect to the covariate result showed that 55.8% on traffic flow, 1.7% on average travel speed, 55.1% on density and 6.6% on average maneuvering time.

Table 4-17: SPSS Multivariate output for Tests of Between-Subjects Influence

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Traffic Flow (PCU/hr)	371409.693[a]	3	123803.231	299.240	.000	.956
	Average Travel Speed (km/hr)	1206.505[b]	3	402.168	101.803	.000	.882
	Density (veh/km)	5262.365[c]	3	1754.122	213.909	.000	.940
	Remaining lane width (m)	40.372[d]	3	13.457	205.804	.000	.938
	Average maneuvering time (Sec)	4059.142[e]	3	1353.047	200.373	.000	.936
Intercept	Traffic Flow (PCU/hr)	35674.649	1	35674.649	86.228	.000	.678
	Average Travel Speed (km/hr)	65.192	1	65.192	16.502	.000	.287
	Density (veh/km)	224.587	1	224.587	27.388	.000	.400
	Remaining lane width (m)	3.499	1	3.499	53.516	.000	.566
	Average maneuvering time (Sec)	.149	1	.149	.022	.883	.001
OSPL	Traffic Flow (PCU/hr)	9502.534	1	9502.534	22.968	.000	.359
	Average Travel Speed (km/hr)	1.088	1	1.088	.275	.603	.007
	Density (veh/km)	223.042	1	223.042	27.199	.000	.399
	Remaining lane width (m)	.214	1	.214	3.267	.078	.074
	Average maneuvering time (Sec)	.002	1	.002	.000	.986	.000
PED	Traffic Flow (PCU/hr)	10386.662	1	10386.662	25.105	.000	.380
	Average Travel Speed (km/hr)	.354	1	.354	.090	.766	.002
	Density (veh/km)	193.602	1	193.602	23.609	.000	.365
	Remaining lane width (m)	.727	1	.727	11.123	.002	.213
	Average maneuvering time (Sec)	1.421	1	1.421	.210	.649	.005
OSPL * PED	Traffic Flow (PCU/hr)	21449.689	1	21449.689	51.845	.000	.558
	Average Travel Speed (km/hr)	2.877	1	2.877	.728	.398	.017
	Density (veh/km)	413.375	1	413.375	50.410	.000	.551
	Remaining lane width (m)	.013	1	.013	.206	.652	.005
	Average maneuvering time (Sec)	19.585	1	19.585	2.900	.096	.066
Error	Traffic Flow (PCU/hr)	16962.751	41	413.726			
	Average Travel Speed (km/hr)	161.969	41	3.950			
	Density (veh/km)	336.213	41	8.200			
	Remaining lane width (m)	2.681	41	.065			
	Average maneuvering time (Sec)	276.858	41	6.753			
Total	Traffic Flow (PCU/hr)	21448733.000	45				
	Average Travel Speed (km/hr)	25450.274	45				
	Density (veh/km)	52192.000	45				
	Remaining lane width (m)	440.290	45				
	Average maneuvering time (Sec)	42181.000	45				
Corrected Total	Traffic Flow (PCU/hr)	388372.444	44				
	Average Travel Speed (km/hr)	1368.474	44				
	Density (veh/km)	5598.578	44				
	Remaining lane width (m)	43.052	44				
	Average maneuvering time (Sec)	4336.000	44				

a. R Squared = .956 (Adjusted R Squared = .953)

b. R Squared = .882 (Adjusted R Squared = .873)

c. R Squared = .940 (Adjusted R Squared = .936)

d. R Squared = .938 (Adjusted R Squared = .933)

e. R Squared = .936 (Adjusted R Squared = .931)

5. CONCLUSIONS AND RECCOMENDATIONS

5.1. Conclusions

The study of this thesis has been dealt the influence of on street parking on traffic flow in the city of Hawassa from Adare Hospital to Mobile Sefer stretch, which covers a total of 1.67km. In order to meet the objectives of the study.

First, road condition survey dealt throughout the section. The road was undivided two-way two-lane highway with no road markings, a total capacity of on-street-parking space of 7631.25m^2 for trucks and 5087.5m^2 for cars. On average there was 2m width of shoulder, uncovered drainage and 20m width of right of way which serves as temporarily open air storage for local wholesalers and retailers. Quantitative data has been collected on the field for remaining lane width together with the data collection of traffic flow and on street parking.

Second, traffic flow parameters characteristics parameters have been studded. Video graphing survey method was used on G+4 building on the study area with the base length of 120m for collecting the traffic flow parameters characteristics study. This includes traffic flow, average travel speed and density. Since there was no posted speed, study of Spot speed was mandatory. Spot speed was studded under the condition of low traffic volume on a 54m base length and the result showed that 33.1km/hr considered as spot speed.

Multivariate multiple linear regression analysis was used for statistical analysis. As a result, remaining lane width (R^2 = 93.7% p =0.000<0.05), average maneuvering time (R^2 = 93.2% p =0.000<0.05), traffic flow (R^2 = 90.1% p =0.000<0.05), average travel speed (r^2 = 88.0% p =0.000<0.05) and followed by density (r^2 = 86.6% p =0.000<0.05). in conclusion, study confirms that the influence of on street parking on traffic flow, average travel speed and density met the results of others' work like (Sulistyono et al., 2018c).

According to the test result of multivariate multiple linear regression analysis, MANCOVA test has been conducted for the test of the goodness of fit. Accordingly, multivariate test results showed that on-street-parking has a significant influence on the traffic flow (p = 0.000 <0.05. The test between-subjects Effects indicated that individual influence. Independent variable

interaction confirms that on-street-parking has an influence of 35.9% on traffic flow, 39.9% on density and 7.4% on remaining lane width. The pedestrian traffic also has in influence of 38.0% on traffic flow, 36.5% on density and 21.30% on remaining lane width. In respect to the covariate result showed that 55.8% on traffic flow, 1.7% on average travel speed 55.1% on density and 6.6% on average maneuvering time.

5.2. Recommendations

In practical sense, the primary service role of the main roads in urban area are for the free movement vehicles not for storage of vehicles. Since the study area has enough right-of-way the following recommendation are forwarded to the principals of the city.

- ✓ Automatically restrict on-street-parking on highly commercially active arterials and use the right-of-way until parking loading unloading zone is constructed.
- ✓ Medium truck like Isuzu in the area are the main factors that creates the traffic flow to be influenced. Therefore, the transport officials should automatically restrict such vehicles to park on the side of the main arterials. (currently it has been done by the city administration).
- ✓ On street parking restriction should be made on peak periods.
- ✓ Road marking signs like center line, U-turn restrictions and parking lane markings that are used to guide the drivers should incorporate so that it restricts to share the lane in the opposite direction while the remaining lane width reduced significantly.

Finally, there are some parameters which have not been included in this study. Therefore, it is highly recommended that more development on the subject is necessary to clarify and justify those influences on safety, road capacity and LOS for further study.

6. REFERENCES

AASHTO, 2011. A policy on geometric design of highways and streets, 4th ed. ed. American Association of State Highway and Transportation Officials, Washington, D.C.

AASHTO, 2004. AASHTO Geometric Design of Highways and Streets 2004.

Adnan, M., 2014. Passenger Car Equivalent Factors in Heterogeneous Traffic Environment-are We Using the Right Numbers? Procedia Eng. 77, 106–113. https://doi.org/10.1016/j.proeng.2014.07.004

Asfaw, D., 2016. Parking Demand Analysis and Modeling for Major Shopping Centers in Addis Ababa City. Ethiopia.

Basu, D., Maitra, S.R., Maitra, B., 2006. Modelling passenger car equivalency at an urban mid-block using stream speed as measure of equivalence 13.

Belloche, S., 2015. On-street Parking Search Time Modelling and Validation with Survey-based Data. Transp. Res. Procedia 6, 313–324. https://doi.org/10.1016/j.trpro.2015.03.024

Boro, D., Ahmed, M.A., Goswami, A., 2015. Impact of On-Street Parking on Traffic Flow Characteristics 2, 5.

Cao, J., 2016. Effects of parking on urban traffic performance. ETH Zurich. https://doi.org/10.3929/ETHZ-A-010792905

Cao, J., Vasileios, N., Menendez, M., 2013a. On-street parking near the intersections: effects on traffic 3.

Cao, J., Vasileios, N., Menendez, M., 2013b. On-street parking near the intersections: effects on traffic 3.

Cao, Y.., Yang, Z.Z., Zuo, Z.Y., 2017. The effect of curb parking on road capacity and traffic safety. Eur. Transp. Res. Rev. 9, 4. https://doi.org/10.1007/s12544-016-0219-3

Chick, C., 1996. On Street Parking: A guide to Practice. Landor Publishing, London.

Dar es Salaam Transport Policy and System Development Master Plan, 2007. Traffic Surveys and Analysis.

Das, D., Ahmed, D.M.A., Sen, S., 2016. On-street parking demand estimation model: A case study of Kolkata 9.

Dattalo, P., 2013. Multivariate Multiple Regression, Analysis of Multiple Dependent Variables. Oxford University Press.

Deardoff, M.D., Wiesner, B.N., Fazio, J., 2011. Estimating Free-flow Speed from Posted Speed Limit Signs. Procedia - Soc. Behav. Sci. 16, 306–316. https://doi.org/10.1016/j.sbspro.2011.04.452

Eedan Al-Jameel, H.A., Muzhar, R.R., 2020. Characteristics of On-street Parking On-street Parking in Al-Najaf City Urban Streets. Transp. Res. Procedia 45, 612–620. https://doi.org/10.1016/j.trpro.2020.03.050

Farooq, D., Akram, T., 2018. Traffic Flow Analysis and Solutions to Ease Traffic Flow at Unsignalized Taxila Intersection. Period. Polytech. Transp. Eng. https://doi.org/10.3311/PPtr.10415

FHWA-HOP, 2007. Definitions, interpretation, and Calculation of Traffic Analysis Tools Measures of Effectiveness. FHWA-HOP-08-054 VI.

Friedrich, B., 2016. The Effect of Autonomous Vehicles on Traffic, in: Maurer, M., Gerdes, J.C., Lenz, B., Winner, H. (Eds.), Autonomous Driving: Technical, Legal and Social Aspects. Springer, Berlin, Heidelberg, pp. 317–334. https://doi.org/10.1007/978-3-662-48847-8_16

Gattis, J.L., Dammalapati, S., Cotton, Joshua, Cotton, Joseph, 2007. CROSS SECTION WIDTH FOR PARALLEL PARKING 14.

Green, B., 2018. ON-STREET PARKING GUIDELINE 15.

Günaşdi, N.E., Topal, M., 2018. EXAMINATION OF MULTIVARIATE MULTIPLE LINEAR REGRESSION ANALYSIS 9.

Harriet, T., Emmanuel, A.K., Poku, K., 2013. Assessment of Traffic Congestion and Its Effects on Productivity in Urban Ghana. International Journal of Business and Social Science Vol. 4 No. 3, 225-235.

Hassan, H.U., 2017. Study on Urban Vehicles Parking Characteristics and Analysis. Int. J. Res. Appl. Sci. Eng. Technol. V, 1553–1557. https://doi.org/10.22214/ijraset.2017.9227

Hawassa city administration, 2016.

Hawassa City Municipality, 2016. (7th Ethiopian Urban Forum).

HCM, 2010. Highway capacity manual. Transportation Research Board, National Research Council, Washington, D.C.

Jakle, J., Sculle, K., 2004. Lots of parking. Univ. Va. Press Charlottesv.

Johnson, R.A., Wichern, D., 2015. Multivariate Analysis, in: Wiley StatsRef: Statistics Reference Online. American Cancer Society, pp. 1–20. https://doi.org/10.1002/9781118445112.stat02623.pub2

Kewan, J.N.S., 2015. Estimation of Multivariate Multiple Linear Regression Models and Applications 168.

Knoop, V.L., Daganzo, C.F., 2017. The Effect of Pedestrian Crossings on Traffic Flow. Presented at the Transportation Research Board 96th Annual MeetingTransportation Research Board.

Landau, S., Everitt, B., 2004. A handbook of statistical analyses using SPSS. Chapman & Hall/CRC, Boca Raton.

Maerivoet, S., De Moor, B., 2008. Traffic Flow Theory. arXiv:physics/0507126.

Manville, M., Shoup, D., 2005. Parking, People and Cities. Journal of Urban Planning and Development, 233-245.

Marsden, G., 2006. The evidence base for parking policies--a review. Transport Policy 13, 447-457.

Mehmet, M., 2011. Multivariate multiple regression analysis based on principal component scores to study relationships between some pre- and post-slaughter traits of broilers. Tarım Bilim. Derg. 17, 77–83. https://doi.org/10.1501/Tarimbil_0000001158

Mike, W., 2019. A Practical Guide to the Use of Selected Multivariate Statistics 57.

Mishra, R.R., Gautam, V., Dhamaniya, A., 2017. Evaluating Effect of on-Street Parking for Urban Arterials by Stream Equivalency Factor 3, 8.

Mugdha P., 1994. Spot Speed of Traffic on Roads | Engineering Notes India [WWW Document]. URL https://www.engineeringenotes.com/tag/spot-speed-of-traffic-on-roads (accessed 10.1.20).

Naseri, A., 2013. A Method for Estimating Average Delay Time due on-Street Parking 8.

Nicholas, J., Garber, Lester, A.H., 2009. Traffic and Highway Engineering, Fourth Edition. ed. United States of America, University of Virginia.

Nuzhat, N.H., Sanchari, H., Mohammed, A.I., Nag, R., Md. Ridwan Bin Alam, Md. Mehedi Hassan, 2013. Traffic Volume Study. https://doi.org/10.13140/RG.2.1.3063.7521

Peñalosa, E., 2017. A city can be friendly to people or it can be friendly to cars, but it can't be both. 13.

Peprah, C., Oduro, C.Y., Ocloo, K.A., 2014. On-Street Parking and Pedestrian Safety in the Kumasi Metropolis: Issues of Culture and Attitude 11.

Praburam, G., Koorey, G., 2015. EFFECT OF ON-STREET PARKING ON TRAFFIC SPEEDS 10.

Purnawan, Yousif, S., 2004. A STUDY INTO ON-STREET PARKING: EFFECTS ON TRAFFIC CONGESTION. p. 8.

Ramos, M.R., Carolino, E., Oliveira, T., Bicho, M., 2012. Two-way MANCOVA: An application to public health. Presented at the NUMERICAL ANALYSIS AND APPLIED MATHEMATICS ICNAAM 2012: International Conference of Numerical Analysis and Applied Mathematics, Kos, Greece, pp. 1716–1719. https://doi.org/10.1063/1.4756503

Rao, A.M., Velmurugan, S., Lakshmi, K.M.V.N., 2017. Evaluation of Influence of Roadside Frictions on the Capacity of Roads in Delhi, India. Transp. Res. Procedia 25, 4771–4782. https://doi.org/10.1016/j.trpro.2017.05.489

Roess, R.P., Prassas, E.S., McShane, W.R., 2004. Traffic engineering. Prentice-Hall : Pearson, Upper Saddle River, New Jersey.

Russell, E.R., Hittle, J.E., 2015. Guidelines for Traffic Counts on County Roads 35.

Sekhar, Ch.R., Nataraju, J., Velmurugan, S., Kumar, P., Sitaramanjaneyulu, K., 2016. Free Flow Speed Analysis of Two Lane Inter Urban Highways. Transp. Res. Procedia 17, 664–673. https://doi.org/10.1016/j.trpro.2016.11.121

Sen, S., Ahmed, M.A., Das, D., 2016. A Case Study on On-Street Parking Demand Estimation for 4-Wheelers in Urban CBD 3, 6.

Subramani, T., 2012. Parking Study on Main Corridors in Major Urban Centre 7.

Sulistyono, S., Sulistio, H., Djakfar, L., Wicaksono, A., Endah Badriani, R., 2018a. On street parking and its impact on road performance. MATEC Web Conf. 181, 06008. https://doi.org/10.1051/matecconf/201818106008

Sulistyono, S., Sulistio, H., Djakfar, L., Wicaksono, A., Endah Badriani, R., 2018b. On street parking and its impact on road performance. MATEC Web Conf. 181, 06008. https://doi.org/10.1051/matecconf/201818106008

Sulistyono, S., Sulistio, H., Djakfar, L., Wicaksono, A., Endah Badriani, R., 2018c. On street parking and its impact on road performance. MATEC Web Conf. 181, 06008. https://doi.org/10.1051/matecconf/201818106008

Sun, D., 2008. Calibrating Passenger Car Equivalent (PCE) for Highway Work Zones using Speed and Percentage of Trucks 18.

Tamene, G., 2016. PASSENGER CAR EQUIVALENTS FOR BASIC FREEWAY SEGMENTS ON ADDIS ABABA – ADAMA EXPRESSWAY 111.

Thomas, B., 2018. Development of Passenger Car Equvalent for Signilized Intersection based on a study conducted at selected four signalised intersection of Hawassa city.

Trsns Tritia, 2018. Methodology of development of traffic surveys (No. D.T3.1.1 Report). Transport Research Institute, JSC. Contribution partners:, University of Žilina.

Virginia, P.S., 2014. On-Street Parking On State Roads.

Weant, R.A., Levinson, H.S., 1990. Parking (Eno Foundation for Transportation). Washington DC.

Webster, F.V., Cobbe, B.M., 1966. Traffic Signals, Road Research Technical Paper no. 56.

Wijayaratna, S., 2015. Impacts of On-street Parking on Road Capacity 15.

Zhao, M., Liu, C., Li, W., Sharma, A., 2017. Effect of Narrower Lane Width on Traffic Operations for Urban Midblock Segments 13.

7. APPENDICES

7.1. Appendix A: Road condition survey data

Table 7-1: Average Carriageway width and right of way width

Section	Selected Station	Carriageway Width, (m)	Number of Lanes, (m)	Lane Width, (m)	Right of way, right side from Mobile to Piazza direction, (m)
A	Adare Hospital	11.10	2	5.55	-
	Lewi Hotel (Piazza)	11.00	2	5.50	-
	Midre Genet Hotel	11.20	2	5.60	-
Average		**11.10**	**2**	**5.55**	**-**
B	Midre Genet Hotel	11.10	2	5.55	15.5
	Arab Sefer	10.90	2	5.45	23.5
	G/kristos	10.80	2	5.40	22.5
	Mobil Sefer	11.20	2	5.60	18.5
Average		**11.00**	**2**	**5.50**	
Total Average		**11.05**		**5.53**	**20.00**

7.2. Appendix B: Traffic composition

Table 7-2: Traffic Composition (%)

Vehicle Type	Arab Sefer Traffic Composition (%)				
	Monday	Tuesday	Wednesday	Thursday	Friday
Truck	6.84	4.06	2.13	3.79	3.15
Bus	4.72	4.38	2.47	4.14	3.97
Pickup	4.84	2.69	2.78	6.18	5.59
Car	2.11	1.64	1.91	3.06	2.54
Minibus	5.16	5.94	3.92	7.46	5.71
Bajaj	42.09	45.52	53.63	43.27	43.65
Motorcycle	31.21	34.14	31.49	29.98	33.76
Bicycle	0.23	0.12	0.12	0.24	0.13
Animal Driven Carts	2.81	1.50	1.56	1.89	1.51

Appendix C: Traffic Flow data

Table 7-3: Monday Volume Count

Time	Vehicle Type								
	Truck	Bus	Pickup	Car	Minibus	Bajaj	Motorcycle	Bicycle	Animal Driven Carts
6:30 AM - 6:45AM	3	1	1	2	7	92	87	0	0
6:45 AM - 7:00AM	2	2	2	1	2	96	89	1	0
7:00 AM - 7:15AM	3	4	1	1	4	98	84	1	1
7:15 AM - 7:30AM	4	2	2	2	2	96	95	1	1
7:30 AM - 7:45AM	5	3	4	5	6	98	99	3	1
7:45 AM - 8:00AM	6	7	8	5	8	101	97	4	3
8:00 AM - 8:15AM	7	6	5	7	5	104	101	4	2
8:15 AM - 8:30AM	8	5	7	5	4	100	105	2	2
8:30 AM - 8:45AM	4	2	2	2	3	112	107	3	3
8:45 AM - 9:00AM	3	2	1	1	1	103	101	1	1
9:00 AM - 9:15AM	1	1	1	1	2	101	102	1	1
9:15 AM - 9:30AM	2	3	3	3	2	98	89	2	3
9:30 AM - 9:45AM	2	2	2	2	1	97	90	1	2
9:45 AM - 10:00AM	1	2	1	3	3	95	91	2	3
10:00 AM - 10:15AM	2	2	2	2	2	98	83	1	3
10:15 AM - 10:30AM	1	2	3	1	3	99	97	1	1
10:30 AM - 10:45AM	6	4	6	6	7	114	102	0	1
10:45 AM - 11:00AM	5	3	9	6	7	107	101	1	1
11:00 AM - 11:15AM	4	5	9	7	6	115	100	1	1
11:15 AM - 11:30AM	3	4	7	5	6	109	102	1	2
11:30 AM - 11:45AM	7	3	8	5	7	106	105	2	2
11:45 AM - 12:00PM	9	6	7	7	5	112	103	2	1
12:00 PM - 12:15PM	7	3	5	8	8	107	101	3	1
12:15 PM - 12:30PM	1	2	2	1	3	105	106	0	0
12:30 PM - 12:45PM	2	2	1	2	5	97	78	1	2
12:45 PM - 1:00PM	1	3	2	5	8	96	81	1	0
1:00 PM - 1:15PM	2	3	3	2	6	95	98	4	0
1:15 PM- 1:30PM	1	2	2	3	8	93	91	2	1
1:30 PM - 1:45PM	2	1	2	2	2	92	89	0	0
1:45 PM - 2:00PM	1	1	2	1	2	94	85	0	1
2:00 PM - 2:15PM	1	2	1	1	1	87	83	1	1
2:15 PM - 2:30PM	2	3	2	1	2	86	86	2	2
2:30 PM - 2:45PM	1	2	3	2	2	91	81	2	1
2:45 PM - 3:00PM	2	1	5	3	3	90	89	2	2
3:00 PM - 3:15PM	6	4	7	3	5	97	91	1	1
3:15 PM - 3:30PM	7	2	4	4	3	120	93	2	2
3:30 PM - 3:45PM	6	5	9	9	8	122	98	5	0
3:45 PM - 4:00PM	5	1	5	3	2	125	115	6	1
4:00 PM - 4:15PM	7	5	7	5	7	123	102	7	1
4:15 PM - 4:30PM	6	2	6	5	5	119	114	2	1
4:30 PM - 4:45PM	7	2	7	5	7	115	110	4	1
4:45 PM - 5:00PM	5	1	5	4	3	110	109	3	1
5:00 PM - 5:15PM	4	3	6	2	4	106	110	2	0

5:15 PM - 5:30PM	7	2	6	4	4	109	115	3	1
5:30 PM - 5:45PM	7	3	4	3	5	81	87	4	0
5:45 PM - 6:00PM	4	0	2	6	4	89	88	0	1
6:00 PM - 6:15PM	3	3	4	4	5	88	79	0	1
6:15 PM - 6:30PM	2	0	3	4	4	86	81	0	0
Total vehicles	187	129	196	171	209	4874	4590	92	57

Table 7-4: Monday Volume Count in PCU

Time	Vehicle Type									
	Truck	Bus	Pickup	Car	Minibus	Bajaj	Motorcycle	Bicycle	Animal Driven Carts	Total Vehicle (PCU)
6:30 AM - 6:45AM	9	3	2	2	14	64	48	0	0	142
6:45 AM - 7:00AM	6	6	4	1	4	67	49	0	0	138
7:00 AM - 7:15AM	9	12	2	1	8	69	46	0	4	151
7:15 AM - 7:30AM	12	6	4	2	4	67	52	0	4	152
7:30 AM - 7:45AM	15	9	8	5	12	69	55	1	4	177
7:45 AM - 8:00AM	18	21	16	5	16	71	54	1	12	213
8:00 AM - 8:15AM	21	18	10	7	10	73	56	1	8	203
8:15 AM - 8:30AM	24	15	14	5	8	70	58	0	8	202
8:30 AM - 8:45AM	12	6	4	2	6	79	59	1	12	180
8:45 AM - 9:00AM	9	6	2	1	2	72	56	0	4	152
9:00 AM - 9:15AM	3	3	2	1	4	71	56	0	4	144
9:15 AM - 9:30AM	6	9	6	3	4	69	49	0	12	158
9:30 AM - 9:45AM	6	6	4	2	2	68	50	0	8	146
9:45 AM - 10:00AM	3	6	2	3	6	67	50	0	12	149
10:00 AM - 10:15AM	6	6	4	2	4	69	46	0	12	149
10:15 AM - 10:30AM	3	6	6	1	6	69	54	0	4	149
10:30 AM - 10:45AM	18	12	12	6	14	80	56	0	4	202
10:45 AM - 11:00AM	15	9	18	6	14	75	56	0	4	197
11:00 AM - 11:15AM	12	15	18	7	12	81	55	0	4	204
11:15 AM - 11:30AM	9	12	14	5	12	76	56	0	8	193
11:30 AM - 11:45AM	21	9	16	5	14	74	58	0	8	205
11:45 AM - 12:00PM	27	18	14	7	10	79	57	0	4	215
12:00 AM - 12:15AM	21	9	10	8	16	75	56	1	4	199
12:15 AM - 12:30AM	3	6	4	1	6	74	59	0	0	152
12:30 AM - 12:45AM	6	6	2	2	10	68	43	0	8	145
12:45 AM - 1:00PM	3	9	4	5	16	67	45	0	0	149
1:00 PM - 1:15PM	6	9	6	2	12	67	54	1	0	156
1:15 PM- 1:30PM	3	6	4	3	16	65	50	0	4	152
1:30 PM - 1:45PM	6	3	4	2	4	64	49	0	0	133
1:45 PM - 2:00PM	3	3	4	1	4	66	47	0	4	132
2:00 PM - 2:15PM	3	6	2	1	2	61	46	0	4	125
2:15 PM - 2:30PM	6	9	4	1	4	60	47	0	8	140
2:30 PM - 2:45PM	3	6	6	2	4	64	45	0	4	134
2:45 PM - 3:00PM	6	3	10	3	6	63	49	0	8	149
3:00 PM - 3:15PM	18	12	14	3	10	68	50	0	4	179
3:15 PM - 3:30PM	21	6	8	4	6	84	51	0	8	189
3:30 PM - 3:45PM	18	15	18	9	16	86	54	1	0	216
3:45 PM - 4:00PM	15	3	10	3	4	88	63	1	4	191

4:00 PM - 4:15PM	21	15	14	5	14	86	56	1	4	217
4:15 PM - 4:30PM	18	6	12	5	10	83	63	0	4	202
4:30 PM - 4:45PM	21	6	14	5	14	81	61	1	4	206
4:45 PM - 5:00PM	15	3	10	4	6	77	60	1	4	180
5:00 PM - 5:15PM	12	9	12	2	8	74	61	0	0	178
5:15 PM - 5:30PM	21	6	12	4	8	76	63	1	4	195
5:30 PM - 5:45PM	21	9	8	3	10	57	48	1	0	156
5:45 PM - 6:00PM	12	0	4	6	8	62	49	0	4	145
6:00 PM - 6:15PM	9	9	8	4	10	62	44	0	4	149
6:15 PM - 6:30PM	6	0	6	4	8	60	45	0	0	129
Total vehicles	555	383	393	171	419	3417	2534	18	228	8117

Table 7-5: Monday traffic Volume computed from consecutive 15min interval

Time (min)	Volume PCU/min	Volume PCU/hr	Time (min)	Volume PCU/min	Volume PCU/hr
6:30 AM - 6:45AM	142	583	12:15 PM - 12:30PM	152	603
6:45 AM - 7:00AM	138		12:30 PM - 12:45PM	145	
7:00 AM - 7:15AM	151		12:45 PM - 1:00PM	149	
7:15 AM - 7:30AM	152		1:00 PM - 1:15PM	156	
6:45 AM - 7:00AM	138	617	12:30 PM - 12:45PM	145	602
7:00 AM - 7:15AM	151		12:45 PM - 1:00PM	149	
7:15 AM - 7:30AM	152		1:00 PM - 1:15PM	156	
7:30 AM - 7:45AM	177		1:15 PM- 1:30PM	152	
7:00 AM - 7:15AM	151	692	12:45 PM - 1:00PM	149	590
7:15 AM - 7:30AM	152		1:00 PM - 1:15PM	156	
7:30 AM - 7:45AM	177		1:15 PM- 1:30PM	152	
7:45 AM - 8:00AM	213		1:30 PM - 1:45PM	133	
7:15 AM - 7:30AM	152	744	1:00 PM - 1:15PM	156	572
7:30 AM - 7:45AM	177		1:15 PM- 1:30PM	152	
7:45 AM - 8:00AM	213		1:30 PM - 1:45PM	133	
8:00 AM - 8:15AM	203		1:45 PM - 2:00PM	132	
7:30 AM - 7:45AM	177	795	1:15 PM- 1:30PM	152	541
7:45 AM - 8:00AM	213		1:30 PM - 1:45PM	133	
8:00 AM - 8:15AM	203		1:45 PM - 2:00PM	132	
8:15 AM - 8:30AM	202		2:00 PM - 2:15PM	125	
7:45 AM - 8:00AM	213	798	1:30 PM - 1:45PM	133	529
8:00 AM - 8:15AM	203		1:45 PM - 2:00PM	132	
8:15 AM - 8:30AM	202		2:00 PM - 2:15PM	125	
8:30 AM - 8:45AM	180		2:15 PM - 2:30PM	140	
8:00 AM - 8:15AM	203	737	1:45 PM - 2:00PM	132	531
8:15 AM - 8:30AM	202		2:00 PM - 2:15PM	125	
8:30 AM - 8:45AM	180		2:15 PM - 2:30PM	140	
8:45 AM - 9:00AM	152		2:30 PM - 2:45PM	134	
8:15 AM - 8:30AM	202	678	2:00 PM - 2:15PM	125	547
8:30 AM - 8:45AM	180		2:15 PM - 2:30PM	140	
8:45 AM - 9:00AM	152		2:30 PM - 2:45PM	134	
9:00 AM - 9:15AM	144		2:45 PM - 3:00PM	149	
8:30 AM - 8:45AM	180	634	2:15 PM - 2:30PM	140	602
8:45 AM - 9:00AM	152		2:30 PM - 2:45PM	134	

9:00 AM - 9:15AM	144		2:45 PM - 3:00PM	149	
9:15 AM - 9:30AM	158		3:00 PM - 3:15PM	179	
8:45 AM - 9:00AM	152	600	2:30 PM - 2:45PM	134	650
9:00 AM - 9:15AM	144		2:45 PM - 3:00PM	149	
9:15 AM - 9:30AM	158		3:00 PM - 3:15PM	179	
9:30 AM - 9:45AM	146		3:15 PM - 3:30PM	189	
9:00 AM - 9:15AM	144	597	2:45 PM - 3:00PM	149	733
9:15 AM - 9:30AM	158		3:00 PM - 3:15PM	179	
9:30 AM - 9:45AM	146		3:15 PM - 3:30PM	189	
9:45 AM - 10:00AM	149		3:30 PM - 3:45PM	216	
9:15 AM - 9:30AM	158	602	3:00 PM - 3:15PM	179	775
9:30 AM - 9:45AM	146		3:15 PM - 3:30PM	189	
9:45 AM - 10:00AM	149		3:30 PM - 3:45PM	216	
10:00 AM - 10:15AM	149		3:45 PM - 4:00PM	191	
9:30 AM - 9:45AM	146	593	3:15 PM - 3:30PM	189	813
9:45 AM - 10:00AM	149		3:30 PM - 3:45PM	216	
10:00 AM - 10:15AM	149		3:45 PM - 4:00PM	191	
10:15 AM - 10:30AM	149		4:00 PM - 4:15PM	217	
9:45 AM - 10:00AM	149	649	3:30 PM - 3:45PM	216	826
10:00 AM - 10:15AM	149		3:45 PM - 4:00PM	191	
10:15 AM - 10:30AM	149		4:00 PM - 4:15PM	217	
10:30 AM - 10:45AM	202		4:15 PM - 4:30PM	202	
10:00 AM - 10:15AM	149	696	3:45 PM - 4:00PM	191	815
10:15 AM - 10:30AM	149		4:00 PM - 4:15PM	217	
10:30 AM - 10:45AM	202		4:15 PM - 4:30PM	202	
10:45 AM - 11:00AM	197		4:30 PM - 4:45PM	206	
10:15 AM - 10:30AM	149	752	4:00 PM - 4:15PM	217	804
10:30 AM - 10:45AM	202		4:15 PM - 4:30PM	202	
10:45 AM - 11:00AM	197		4:30 PM - 4:45PM	206	
11:00 AM - 11:15AM	204		4:45 PM - 5:00PM	180	
10:30 AM - 10:45AM	202	795	4:15 PM - 4:30PM	202	765
10:45 AM - 11:00AM	197		4:30 PM - 4:45PM	206	
11:00 AM - 11:15AM	204		4:45 PM - 5:00PM	180	
11:15 AM - 11:30AM	193		5:00 PM - 5:15PM	178	
10:45 AM - 11:00AM	197	799	4:30 PM - 4:45PM	206	759
11:00 AM - 11:15AM	204		4:45 PM - 5:00PM	180	
11:15 AM - 11:30AM	193		5:00 PM - 5:15PM	178	
11:30 AM - 11:45AM	205		5:15 PM - 5:30PM	195	
11:00 AM - 11:15AM	204	817	4:45 PM - 5:00PM	180	709
11:15 AM - 11:30AM	193		5:00 PM - 5:15PM	178	
11:30 AM - 11:45AM	205		5:15 PM - 5:30PM	195	
11:45 AM - 12:00PM	215		5:30 PM - 5:45PM	156	
11:15 AM - 11:30AM	193	813	5:00 PM - 5:15PM	178	675
11:30 AM - 11:45AM	205		5:15 PM - 5:30PM	195	
11:45 AM - 12:00PM	215		5:30 PM - 5:45PM	156	
12:00 PM - 12:15PM	199		5:45 PM - 6:00PM	145	
11:30 AM - 11:45AM	205	772	5:15 PM - 5:30PM	195	646
11:45 AM - 12:00PM	215		5:30 PM - 5:45PM	156	
12:00 PM - 12:15PM	199		5:45 PM - 6:00PM	145	

12:15 PM - 12:30PM	152		6:00 PM - 6:15PM	149	
11:45 PM - 12:00PM	215	712	5:30 PM - 5:45PM	156	579
12:00 PM - 12:15PM	199		5:45 PM - 6:00PM	145	
12:15 PM - 12:30PM	152		6:00 PM - 6:15PM	149	
12:30 PM - 12:45PM	145		6:15 PM - 6:30PM	129	
12:00 PM - 12:15PM	199	645			
12:15 PM - 12:30PM	152				
12:30 PM - 12:45PM	145				
12:45 PM - 1:00PM	149				

Table 7-6: Tuesday Volume, veh.

Time	Vehicle Type								
	Truck	Bus	Pickup	Car	Minibus	Bajaj	Motorcycle	Bicycle	Animal Driven Carts
6:30 AM - 6:45AM	0	0	0	1	2	99	69	0	0
6:45 AM - 7:00AM	0	2	0	1	2	114	71	0	0
7:00 AM - 7:15AM	1	5	1	0	3	114	65	0	1
7:15 AM - 7:30AM	3	3	1	2	3	95	66	1	0
7:30 AM - 7:45AM	2	1	5	2	3	99	71	1	1
7:45 AM - 8:00AM	0	0	3	2	6	118	84	2	0
8:00 AM - 8:15AM	2	1	4	1	5	114	82	1	1
8:15 AM - 8:30AM	2	4	2	2	6	107	76	1	1
8:30 AM - 8:45AM	3	5	3	3	6	114	81	1	0
8:45 AM - 9:00AM	1	3	2	2	1	118	74	1	1
9:00 AM - 9:15AM	2	4	1	3	5	112	78	1	1
9:15 AM - 9:30AM	2	1	2	2	3	95	79	0	0
9:30 AM - 9:45AM	2	0	1	2	2	99	82	1	2
9:45 AM - 10:00AM	1	1	2	3	2	81	95	2	0
10:00 AM - 10:15AM	1	2	2	6	3	85	99	1	0
10:15 AM - 10:30AM	3	2	2	2	8	108	97	2	1
10:30 AM - 10:45AM	4	2	1	4	6	96	101	3	1
10:45 AM - 11:00AM	5	3	2	3	7	107	100	1	2
11:00 AM - 11:15AM	3	3	4	4	6	89	117	2	1
11:15 AM - 11:30AM	2	2	2	3	6	74	118	1	0
11:30 AM - 11:45AM	3	5	3	3	7	85	99	2	1
11:45 AM - 12:00PM	3	6	4	3	6	89	117	0	2
12:00 PM - 12:15PM	2	4	3	3	5	118	107	0	1
12:15 PM - 12:30PM	2	5	2	4	4	119	113	1	1
12:30 PM - 12:45PM	3	2	2	4	6	118	117	1	2
12:45 PM - 1:00PM	0	5	1	3	7	91	98	0	0
1:00 PM - 1:15PM	4	3	1	2	4	95	96	0	0
1:15 PM- 1:30PM	6	2	2	3	6	107	111	2	1
1:30 PM - 1:45PM	2	3	1	1	2	98	112	1	0
1:45 PM - 2:00PM	2	2	0	2	6	85	93	0	1
2:00 PM - 2:15PM	3	2	2	2	4	88	91	1	1
2:15 PM - 2:30PM	3	2	1	1	3	119	94	0	0

2:30 PM - 2:45PM	4	1	2	3	1	89	84	1	1
2:45 PM - 3:00PM	1	0	2	2	2	104	114	1	0
3:00 PM - 3:15PM	0	2	2	1	2	109	126	0	0
3:15 PM - 3:30PM	1	3	1	0	4	114	118	1	0
3:30 PM - 3:45PM	0	4	3	2	3	112	110	2	0
3:45 PM - 4:00PM	1	2	2	1	4	110	117	1	1
4:00 PM - 4:15PM	2	3	3	0	6	114	95	1	0
4:15 PM - 4:30PM	0	2	2	3	4	108	98	0	1
4:30 PM - 4:45PM	0	1	2	1	8	84	95	0	0
4:45 PM - 5:00PM	5	1	3	5	8	91	85	1	1
5:00 PM - 5:15PM	6	2	2	5	7	89	96	0	0
5:15 PM - 5:30PM	2	2	3	5	6	87	117	0	1
5:30 PM - 5:45PM	6	1	4	7	7	92	116	0	0
5:45 PM - 6:00PM	2	0	3	3	8	96	111	3	0
6:00 PM - 6:15PM	0	1	3	3	4	98	85	3	0
6:15 PM - 6:30PM	0	0	1	2	2	92	89	1	0
Total vehicles	102	110	100	122	221	4839	4609	45	28

Table 7-7: Tuesday Volume Count in PCU

Time	Vehicle Type									Total Vehicle (PCU)
	Truck	Bus	Pickup	Car	Minibus	Bajaj	Motorcycle	Bicycle	Animal Driven Carts	
6:30 AM - 6:45AM	0	0	0	1	4	69	38	0	0	112
6:45 AM - 7:00AM	0	6	0	1	4	80	39	0	0	130
7:00 AM - 7:15AM	3	15	2	0	6	80	36	0	4	146
7:15 AM - 7:30AM	9	9	2	2	6	67	36	0	0	131
7:30 AM - 7:45AM	6	3	10	2	6	69	39	0	4	140
7:45 AM - 8:00AM	0	0	6	2	12	83	46	0	0	150
8:00 AM - 8:15AM	6	3	8	1	10	80	45	0	4	157
8:15 AM - 8:30AM	6	12	4	2	12	75	42	0	4	157
8:30 AM - 8:45AM	9	15	6	3	12	80	45	0	0	170
8:45 AM - 9:00AM	3	9	4	2	2	83	41	0	4	148
9:00 AM - 9:15AM	6	12	2	3	10	79	43	0	4	159
9:15 AM - 9:30AM	6	3	4	2	6	67	44	0	0	131
9:30 AM - 9:45AM	6	0	2	2	4	69	45	0	8	137
9:45 AM - 10:00AM	3	3	4	3	4	57	52	0	0	127
10:00 AM - 10:15AM	3	6	4	6	6	60	55	0	0	139
10:15 AM - 10:30AM	9	6	4	2	16	76	54	0	4	171
10:30 AM - 10:45AM	12	6	2	4	12	67	56	1	4	163
10:45 AM - 11:00AM	15	9	4	3	14	75	55	0	8	183
11:00 AM - 11:15AM	9	9	8	4	12	62	65	0	4	173
11:15 AM - 11:30AM	6	6	4	3	12	52	65	0	0	148
11:30 AM - 11:45AM	9	15	6	3	14	60	55	0	4	165
11:45 AM - 12:00PM	9	18	8	3	12	62	65	0	8	185
12:00 AM - 12:15AM	6	12	6	3	10	83	59	0	4	183
12:15 AM - 12:30AM	6	15	4	4	8	83	62	0	4	187
12:30 AM - 12:45AM	9	6	4	4	12	83	65	0	8	190

12:45 AM - 1:00PM	0	15	2	3	14	64	54	0	0	152
1:00 PM - 1:15PM	12	9	2	2	8	67	53	0	0	152
1:15 PM- 1:30PM	18	6	4	3	12	75	61	0	4	183
1:30 PM - 1:45PM	6	9	2	1	4	69	62	0	0	153
1:45 PM - 2:00PM	6	6	0	2	12	60	51	0	4	141
2:00 PM - 2:15PM	9	6	4	2	8	62	50	0	4	145
2:15 PM - 2:30PM	9	6	2	1	6	83	52	0	0	159
2:30 PM - 2:45PM	12	3	4	3	2	62	46	0	4	137
2:45 PM - 3:00PM	3	0	4	2	4	73	63	0	0	149
3:00 PM - 3:15PM	0	6	4	1	4	76	70	0	0	161
3:15 PM - 3:30PM	3	9	2	0	8	80	65	0	0	167
3:30 PM - 3:45PM	0	12	6	2	6	79	61	0	0	166
3:45 PM - 4:00PM	3	6	4	1	8	77	65	0	4	168
4:00 PM - 4:15PM	6	9	6	0	12	80	52	0	0	165
4:15 PM - 4:30PM	0	6	4	3	8	76	54	0	4	155
4:30 PM - 4:45PM	0	3	4	1	16	59	52	0	0	135
4:45 PM - 5:00PM	15	3	6	5	16	64	47	0	4	160
5:00 PM - 5:15PM	18	6	4	5	14	62	53	0	0	162
5:15 PM - 5:30PM	6	6	6	5	12	61	65	0	4	164
5:30 PM - 5:45PM	18	3	8	7	14	64	64	0	0	178
5:45 PM - 6:00PM	6	0	6	3	16	67	61	1	0	160
6:00 PM - 6:15PM	0	3	6	3	8	69	47	1	0	136
6:15 PM - 6:30PM	0	0	2	2	4	64	49	0	0	122
Total vehicles	303	326	200	122	443	3392	2544	9	112	7452

Table 7-8: Tuesday traffic Volume computed from consecutive 15min interval

Time (min)	Volume PCU/min	Volume PCU/hr	Time (min)	Volume PCU/min	Volume PCU/hr
6:30 AM - 6:45AM	112		12:15 PM - 12:30PM	187	
6:45 AM - 7:00AM	130	519	12:30 PM - 12:45PM	**190**	681
7:00 AM - 7:15AM	146		12:45 PM - 1:00PM	152	
7:15 AM - 7:30AM	131		1:00 PM - 1:15PM	152	
6:45 AM - 7:00AM	130		12:30 PM - 12:45PM	190	
7:00 AM - 7:15AM	146	546	12:45 PM - 1:00PM	152	678
7:15 AM - 7:30AM	131		1:00 PM - 1:15PM	152	
7:30 AM - 7:45AM	140		1:15 PM- 1:30PM	183	
7:00 AM - 7:15AM	146		12:45 PM - 1:00PM	152	
7:15 AM - 7:30AM	131	566	1:00 PM - 1:15PM	152	640
7:30 AM - 7:45AM	140		1:15 PM- 1:30PM	183	
7:45 AM - 8:00AM	150		1:30 PM - 1:45PM	153	
7:15 AM - 7:30AM	131		1:00 PM - 1:15PM	152	
7:30 AM - 7:45AM	140	578	1:15 PM- 1:30PM	183	629
7:45 AM - 8:00AM	150		1:30 PM - 1:45PM	153	
8:00 AM - 8:15AM	157		1:45 PM - 2:00PM	141	
7:30 AM - 7:45AM	140		1:15 PM- 1:30PM	183	
7:45 AM - 8:00AM	150	604	1:30 PM - 1:45PM	153	622
8:00 AM - 8:15AM	157		1:45 PM - 2:00PM	141	
8:15 AM - 8:30AM	157		2:00 PM - 2:15PM	145	
7:45 AM - 8:00AM	150	633	1:30 PM - 1:45PM	153	598

8:00 AM - 8:15AM	157		1:45 PM - 2:00PM	141	
8:15 AM - 8:30AM	157		2:00 PM - 2:15PM	145	
8:30 AM - 8:45AM	170		2:15 PM - 2:30PM	159	
8:00 AM - 8:15AM	157	632	1:45 PM - 2:00PM	141	582
8:15 AM - 8:30AM	157		2:00 PM - 2:15PM	145	
8:30 AM - 8:45AM	170		2:15 PM - 2:30PM	159	
8:45 AM - 9:00AM	148		2:30 PM - 2:45PM	137	
8:15 AM - 8:30AM	157	633	2:00 PM - 2:15PM	145	590
8:30 AM - 8:45AM	170		2:15 PM - 2:30PM	159	
8:45 AM - 9:00AM	148		2:30 PM - 2:45PM	137	
9:00 AM - 9:15AM	159		2:45 PM - 3:00PM	149	
8:30 AM - 8:45AM	170	607	2:15 PM - 2:30PM	159	606
8:45 AM - 9:00AM	148		2:30 PM - 2:45PM	137	
9:00 AM - 9:15AM	159		2:45 PM - 3:00PM	149	
9:15 AM - 9:30AM	131		3:00 PM - 3:15PM	161	
8:45 AM - 9:00AM	148	574	2:30 PM - 2:45PM	137	614
9:00 AM - 9:15AM	159		2:45 PM - 3:00PM	149	
9:15 AM - 9:30AM	131		3:00 PM - 3:15PM	161	
9:30 AM - 9:45AM	137		3:15 PM - 3:30PM	167	
9:00 AM - 9:15AM	159	553	2:45 PM - 3:00PM	149	643
9:15 AM - 9:30AM	131		3:00 PM - 3:15PM	161	
9:30 AM - 9:45AM	137		3:15 PM - 3:30PM	167	
9:45 AM - 10:00AM	127		3:30 PM - 3:45PM	166	
9:15 AM - 9:30AM	131	534	3:00 PM - 3:15PM	161	661
9:30 AM - 9:45AM	137		3:15 PM - 3:30PM	167	
9:45 AM - 10:00AM	127		3:30 PM - 3:45PM	166	
10:00 AM - 10:15AM	139		3:45 PM - 4:00PM	168	
9:30 AM - 9:45AM	137	573	3:15 PM - 3:30PM	167	666
9:45 AM - 10:00AM	127		3:30 PM - 3:45PM	166	
10:00 AM - 10:15AM	139		3:45 PM - 4:00PM	168	
10:15 AM - 10:30AM	171		4:00 PM - 4:15PM	165	
9:45 AM - 10:00AM	127	600	3:30 PM - 3:45PM	166	654
10:00 AM - 10:15AM	139		3:45 PM - 4:00PM	168	
10:15 AM - 10:30AM	171		4:00 PM - 4:15PM	165	
10:30 AM - 10:45AM	163		4:15 PM - 4:30PM	155	
10:00 AM - 10:15AM	139	657	3:45 PM - 4:00PM	168	623
10:15 AM - 10:30AM	171		4:00 PM - 4:15PM	165	
10:30 AM - 10:45AM	163		4:15 PM - 4:30PM	155	
10:45 AM - 11:00AM	183		4:30 PM - 4:45PM	135	
10:15 AM - 10:30AM	171	690	4:00 PM - 4:15PM	165	615
10:30 AM - 10:45AM	163		4:15 PM - 4:30PM	155	
10:45 AM - 11:00AM	183		4:30 PM - 4:45PM	135	
11:00 AM - 11:15AM	173		4:45 PM - 5:00PM	160	
10:30 AM - 10:45AM	163	668	4:15 PM - 4:30PM	155	612
10:45 AM - 11:00AM	183		4:30 PM - 4:45PM	135	623
11:00 AM - 11:15AM	173		4:45 PM - 5:00PM	160	
11:15 AM - 11:30AM	148		5:00 PM - 5:15PM	162	
10:45 AM - 11:00AM	183	670	4:30 PM - 4:45PM	135	622
11:00 AM - 11:15AM	173		4:45 PM - 5:00PM	160	

11:15 AM - 11:30AM	148		5:00 PM - 5:15PM	162	
11:30 AM - 11:45AM	165		5:15 PM - 5:30PM	164	
11:00 AM - 11:15AM	173	671	4:45 PM - 5:00PM	160	665
11:15 AM - 11:30AM	148		5:00 PM - 5:15PM	162	
11:30 AM - 11:45AM	165		5:15 PM - 5:30PM	164	
11:45 AM - 12:00PM	185		5:30 PM - 5:45PM	178	
11:15 AM - 11:30AM	148	681	5:00 PM - 5:15PM	162	665
11:30 AM - 11:45AM	165		5:15 PM - 5:30PM	164	
11:45 AM - 12:00PM	185		5:30 PM - 5:45PM	178	
12:00 PM - 12:15PM	183		5:45 PM - 6:00PM	160	
11:30 AM - 11:45AM	165	720	5:15 PM - 5:30PM	164	639
11:45 AM - 12:00PM	185		5:30 PM - 5:45PM	178	
12:00 PM - 12:15PM	183		5:45 PM - 6:00PM	160	
12:15 PM - 12:30PM	187		6:00 PM - 6:15PM	136	
11:45 PM - 12:00PM	185	744	5:30 PM - 5:45PM	178	597
12:00 PM - 12:15PM	183		5:45 PM - 6:00PM	160	
12:15 PM - 12:30PM	187		6:00 PM - 6:15PM	136	
12:30 PM - 12:45PM	190		6:15 PM - 6:30PM	122	
12:00 PM - 12:15PM	183	712			
12:15 PM - 12:30PM	187				
12:30 PM - 12:45PM	190				
12:45 PM - 1:00PM	152				

Table 7-9: Wednesday Volume, veh

	Vehicle Type								
Time	**Truck**	**Bus**	**Pickup**	**Car**	**Minibus**	**Bajaj**	**Motorcycle**	**Bicycle**	**Animal Driven Carts**
6:30 AM - 6:45AM	0	0	0	0	2	85	31	0	0
6:45 AM - 7:00AM	0	0	0	1	1	95	35	0	0
7:00 AM - 7:15AM	2	0	0	2	2	91	45	0	1
7:15 AM - 7:30AM	0	0	0	1	3	102	67	0	0
7:30 AM - 7:45AM	1	0	1	1	3	109	66	0	1
7:45 AM - 8:00AM	0	1	1	1	2	115	68	0	0
8:00 AM - 8:15AM	2	1	1	1	3	117	64	0	2
8:15 AM - 8:30AM	1	1	3	2	2	105	71	0	1
8:30 AM - 8:45AM	0	0	2	3	2	104	70	1	0
8:45 AM - 9:00AM	2	0	1	1	1	111	74	1	1
9:00 AM - 9:15AM	1	2	2	2	2	101	76	1	1
9:15 AM - 9:30AM	2	1	3	1	2	91	45	1	0
9:30 AM - 9:45AM	1	1	1	2	1	96	52	0	2
9:45 AM - 10:00AM	0	2	2	1	2	98	36	0	0
10:00 AM - 10:15AM	0	1	2	3	3	96	39	0	0
10:15 AM - 10:30AM	0	2	2	4	2	95	47	0	0
10:30 AM - 10:45AM	2	1	2	4	3	107	82	1	0
10:45 AM - 11:00AM	1	1	3	3	2	101	84	1	0
11:00 AM - 11:15AM	3	2	3	4	5	106	80	2	0

11:15 AM - 11:30AM	2	3	2	1	2	109	91	0	1
11:30 AM - 11:45AM	2	1	1	4	3	107	95	2	0
11:45 AM - 12:00PM	2	2	3	3	3	102	98	2	1
12:00 PM - 12:15PM	2	1	2	4	3	106	95	0	0
12:15 PM - 12:30PM	2	2	1	4	2	96	76	2	1
12:30 PM - 12:45PM	3	3	2	3	4	93	84	1	1
12:45 PM - 1:00PM	0	2	2	4	4	92	86	1	1
1:00 PM - 1:15PM	1	3	3	2	2	94	99	0	1
1:15 PM- 1:30PM	2	2	3	3	4	98	74	2	0
1:30 PM - 1:45PM	1	1	2	1	2	87	79	1	0
1:45 PM - 2:00PM	2	2	1	4	4	104	77	0	0
2:00 PM - 2:15PM	1	2	1	3	1	107	76	1	1
2:15 PM - 2:30PM	0	1	2	1	4	105	68	0	0
2:30 PM - 2:45PM	0	1	3	3	0	115	66	0	1
2:45 PM - 3:00PM	1	0	1	2	0	104	80	1	0
3:00 PM - 3:15PM	0	0	2	1	4	107	86	0	1
3:15 PM - 3:30PM	0	0	1	2	2	102	87	0	0
3:30 PM - 3:45PM	0	1	2	2	3	106	75	0	0
3:45 PM - 4:00PM	1	0	2	3	4	101	73	1	1
4:00 PM - 4:15PM	2	0	1	1	5	95	74	2	0
4:15 PM - 4:30PM	0	2	2	3	4	96	71	2	1
4:30 PM - 4:45PM	0	2	3	2	5	95	85	1	0
4:45 PM - 5:00PM	0	1	3	4	3	84	71	2	1
5:00 PM - 5:15PM	1	1	2	4	2	76	75	0	1
5:15 PM - 5:30PM	0	1	1	3	1	61	86	1	1
5:30 PM - 5:45PM	1	0	2	4	2	68	91	1	1
5:45 PM - 6:00PM	0	0	3	4	2	64	94	2	0
6:00 PM - 6:15PM	0	1	2	3	1	98	70	3	0
6:15 PM - 6:30PM	0	0	1	2	1	96	85	1	0
Total vehicles	44	51	85	117	120	4693	3499	37	24

Table 7-10: Wednesday Volume Count in PCU

Time	Vehicle Type									Total Vehicle (PCU)
	Truck	Bus	Pickup	Car	Minibus	Bajaj	Motorcycle	Bicycle	Animal Driven Carts	
6:30 AM - 6:45AM	0	0	0	0	4	60	17	0	0	81
6:45 AM - 7:00AM	0	0	0	1	2	67	19	0	0	89
7:00 AM - 7:15AM	6	0	0	2	4	64	25	0	4	105
7:15 AM - 7:30AM	0	0	0	1	6	72	37	0	0	115
7:30 AM - 7:45AM	3	0	2	1	6	76	36	0	4	129
7:45 AM - 8:00AM	0	3	2	1	4	81	38	0	0	128
8:00 AM - 8:15AM	6	3	2	1	6	82	35	0	8	143
8:15 AM - 8:30AM	3	3	6	2	4	74	39	0	4	135
8:30 AM - 8:45AM	0	0	4	3	4	73	39	0	0	123
8:45 AM - 9:00AM	6	0	2	1	2	78	41	0	4	134
9:00 AM - 9:15AM	3	6	4	2	4	71	42	0	4	136
9:15 AM - 9:30AM	6	3	6	1	4	64	25	0	0	109

9:30 AM - 9:45AM	3	3	2	2	2	67	29	0	8	116
9:45 AM - 10:00AM	0	6	4	1	4	69	20	0	0	104
10:00 AM - 10:15AM	0	3	4	3	6	67	22	0	0	105
10:15 AM - 10:30AM	0	6	4	4	4	67	26	0	0	110
10:30 AM - 10:45AM	6	3	4	4	6	75	45	0	0	143
10:45 AM - 11:00AM	3	3	6	3	4	71	46	0	0	136
11:00 AM - 11:15AM	9	6	6	4	10	74	44	0	0	154
11:15 AM - 11:30AM	6	9	4	1	4	76	50	0	4	154
11:30 AM - 11:45AM	6	3	2	4	6	75	52	0	0	149
11:45 AM - 12:00PM	6	6	6	3	6	72	54	0	4	157
12:00 AM - 12:15AM	6	3	4	4	6	74	52	0	0	150
12:15 AM - 12:30AM	6	6	2	4	4	67	42	0	4	136
12:30 AM - 12:45AM	9	9	4	3	8	65	46	0	4	149
12:45 AM - 1:00PM	0	6	4	4	8	64	47	0	4	138
1:00 PM - 1:15PM	3	9	6	2	4	66	55	0	4	148
1:15 PM- 1:30PM	6	6	6	3	8	69	41	0	0	139
1:30 PM - 1:45PM	3	3	4	1	4	61	44	0	0	120
1:45 PM - 2:00PM	6	6	2	4	8	73	43	0	0	141
2:00 PM - 2:15PM	3	6	2	3	2	75	42	0	4	137
2:15 PM - 2:30PM	0	3	4	1	8	74	38	0	0	127
2:30 PM - 2:45PM	0	3	6	3	0	81	36	0	4	133
2:45 PM - 3:00PM	3	0	2	2	0	73	44	0	0	124
3:00 PM - 3:15PM	0	0	4	1	8	75	47	0	4	140
3:15 PM - 3:30PM	0	0	2	2	4	72	48	0	0	128
3:30 PM - 3:45PM	0	3	4	2	6	74	41	0	0	131
3:45 PM - 4:00PM	3	0	4	3	8	71	40	0	4	133
4:00 PM - 4:15PM	6	0	2	1	10	67	41	0	0	127
4:15 PM - 4:30PM	0	6	4	3	8	67	39	0	4	132
4:30 PM - 4:45PM	0	6	6	2	10	67	47	0	0	138
4:45 PM - 5:00PM	0	3	6	4	6	59	39	0	4	121
5:00 PM - 5:15PM	3	3	4	4	4	53	41	0	4	117
5:15 PM - 5:30PM	0	3	2	3	2	43	47	0	4	104
5:30 PM - 5:45PM	3	0	4	4	4	48	50	0	4	117
5:45 PM - 6:00PM	0	0	6	4	4	45	52	0	0	111
6:00 PM - 6:15PM	0	3	4	3	2	69	39	1	0	120
6:15 PM - 6:30PM	0	0	2	2	2	67	47	0	0	120
Total vehicles	131	151	170	117	240	3290	1931	7	96	6134

Table 7-11: Wednesday traffic Volume computed from consecutive 15min interval

Time (min)	Volume PCU/min	Volume PCU/hr	Time (min)	Volume PCU/min	Volume PCU/hr
6:30 AM - 6:45AM	81	390	12:15 PM - 12:30PM	136	571
6:45 AM - 7:00AM	89		12:30 PM - 12:45PM	149	
7:00 AM - 7:15AM	105		12:45 PM - 1:00PM	138	
7:15 AM - 7:30AM	115		1:00 PM - 1:15PM	148	
6:45 AM - 7:00AM	89	438	12:30 PM - 12:45PM	149	574
7:00 AM - 7:15AM	105		12:45 PM - 1:00PM	138	
7:15 AM - 7:30AM	115		1:00 PM - 1:15PM	148	
7:30 AM - 7:45AM	129		1:15 PM- 1:30PM	139	

7:00 AM - 7:15AM	105	477	12:45 PM - 1:00PM	138	545
7:15 AM - 7:30AM	115		1:00 PM - 1:15PM	148	
7:30 AM - 7:45AM	129		1:15 PM- 1:30PM	139	
7:45 AM - 8:00AM	128		1:30 PM - 1:45PM	120	
7:15 AM - 7:30AM	115	516	1:00 PM - 1:15PM	148	548
7:30 AM - 7:45AM	129		1:15 PM- 1:30PM	139	
7:45 AM - 8:00AM	128		1:30 PM - 1:45PM	120	
8:00 AM - 8:15AM	143		1:45 PM - 2:00PM	141	
7:30 AM - 7:45AM	129	535	1:15 PM- 1:30PM	139	537
7:45 AM - 8:00AM	128		1:30 PM - 1:45PM	120	
8:00 AM - 8:15AM	143		1:45 PM - 2:00PM	141	
8:15 AM - 8:30AM	135		2:00 PM - 2:15PM	137	
7:45 AM - 8:00AM	128	529	1:30 PM - 1:45PM	120	525
8:00 AM - 8:15AM	143		1:45 PM - 2:00PM	141	
8:15 AM - 8:30AM	135		2:00 PM - 2:15PM	137	
8:30 AM - 8:45AM	123		2:15 PM - 2:30PM	127	
8:00 AM - 8:15AM	143	535	1:45 PM - 2:00PM	141	539
8:15 AM - 8:30AM	135		2:00 PM - 2:15PM	137	
8:30 AM - 8:45AM	123		2:15 PM - 2:30PM	127	
8:45 AM - 9:00AM	134		2:30 PM - 2:45PM	133	
8:15 AM - 8:30AM	135	527	2:00 PM - 2:15PM	137	521
8:30 AM - 8:45AM	123		2:15 PM - 2:30PM	127	
8:45 AM - 9:00AM	134		2:30 PM - 2:45PM	133	
9:00 AM - 9:15AM	136		2:45 PM - 3:00PM	124	
8:30 AM - 8:45AM	123	501	2:15 PM - 2:30PM	127	524
8:45 AM - 9:00AM	134		2:30 PM - 2:45PM	133	
9:00 AM - 9:15AM	136		2:45 PM - 3:00PM	124	
9:15 AM - 9:30AM	109		3:00 PM - 3:15PM	140	
8:45 AM - 9:00AM	134	494	2:30 PM - 2:45PM	133	524
9:00 AM - 9:15AM	136		2:45 PM - 3:00PM	124	
9:15 AM - 9:30AM	109		3:00 PM - 3:15PM	140	
9:30 AM - 9:45AM	116		3:15 PM - 3:30PM	128	
9:00 AM - 9:15AM	136	464	2:45 PM - 3:00PM	124	522
9:15 AM - 9:30AM	109		3:00 PM - 3:15PM	140	
9:30 AM - 9:45AM	116		3:15 PM - 3:30PM	128	
9:45 AM - 10:00AM	104		3:30 PM - 3:45PM	131	
9:15 AM - 9:30AM	109	433	3:00 PM - 3:15PM	140	531
9:30 AM - 9:45AM	116		3:15 PM - 3:30PM	128	
9:45 AM - 10:00AM	104		3:30 PM - 3:45PM	131	
10:00 AM - 10:15AM	105		3:45 PM - 4:00PM	133	
9:30 AM - 9:45AM	116	435	3:15 PM - 3:30PM	128	518
9:45 AM - 10:00AM	104		3:30 PM - 3:45PM	131	
10:00 AM - 10:15AM	105		3:45 PM - 4:00PM	133	
10:15 AM - 10:30AM	110		4:00 PM - 4:15PM	127	
9:45 AM - 10:00AM	104	462	3:30 PM - 3:45PM	131	523
10:00 AM - 10:15AM	105		3:45 PM - 4:00PM	133	
10:15 AM - 10:30AM	110		4:00 PM - 4:15PM	127	
10:30 AM - 10:45AM	143		4:15 PM - 4:30PM	132	
10:00 AM - 10:15AM	105	495	3:45 PM - 4:00PM	133	530

10:15 AM - 10:30AM	110		4:00 PM - 4:15PM	127	
10:30 AM - 10:45AM	143		4:15 PM - 4:30PM	132	
10:45 AM - 11:00AM	136		4:30 PM - 4:45PM	138	
10:15 AM - 10:30AM	110	544	4:00 PM - 4:15PM	127	518
10:30 AM - 10:45AM	143		4:15 PM - 4:30PM	132	
10:45 AM - 11:00AM	136		4:30 PM - 4:45PM	138	
11:00 AM - 11:15AM	154		4:45 PM - 5:00PM	121	
10:30 AM - 10:45AM	143	588	4:15 PM - 4:30PM	132	508
10:45 AM - 11:00AM	136		4:30 PM - 4:45PM	138	
11:00 AM - 11:15AM	154		4:45 PM - 5:00PM	121	
11:15 AM - 11:30AM	154		5:00 PM - 5:15PM	117	
10:45 AM - 11:00AM	136	593	4:30 PM - 4:45PM	138	480
11:00 AM - 11:15AM	154		4:45 PM - 5:00PM	121	
11:15 AM - 11:30AM	154		5:00 PM - 5:15PM	117	
11:30 AM - 11:45AM	149		5:15 PM - 5:30PM	104	
11:00 AM - 11:15AM	154	614	4:45 PM - 5:00PM	121	460
11:15 AM - 11:30AM	154		5:00 PM - 5:15PM	117	
11:30 AM - 11:45AM	149		5:15 PM - 5:30PM	104	
11:45 AM - 12:00PM	157		5:30 PM - 5:45PM	117	
11:15 AM - 11:30AM	154	610	5:00 PM - 5:15PM	117	449
11:30 AM - 11:45AM	149		5:15 PM - 5:30PM	104	
11:45 AM - 12:00PM	157		5:30 PM - 5:45PM	117	
12:00 PM - 12:15PM	150		5:45 PM - 6:00PM	111	
11:30 AM - 11:45AM	149	591	5:15 PM - 5:30PM	104	453
11:45 AM - 12:00PM	157		5:30 PM - 5:45PM	117	
12:00 PM - 12:15PM	150		5:45 PM - 6:00PM	111	
12:15 PM - 12:30PM	136		6:00 PM - 6:15PM	120	
11:45 PM - 12:00PM	157	591	5:30 PM - 5:45PM	117	469
12:00 PM - 12:15PM	150		5:45 PM - 6:00PM	111	
12:15 PM - 12:30PM	136		6:00 PM - 6:15PM	120	
12:30 PM - 12:45PM	149		6:15 PM - 6:30PM	120	
12:00 PM - 12:15PM	150	572			
12:15 PM - 12:30PM	136				
12:30 PM - 12:45PM	149				
12:45 PM - 1:00PM	138				

Table 7-12: Thursday Morning Volume, veh

	Vehicle Type								
Time	Truck	Bus	Pickup	Car	Minibus	Bajaj	Motorcycle	Bicycle	Animal Driven Carts
6:30 AM - 6:45AM	0	0	0	1	4	81	63	1	0
6:45 AM - 7:00AM	0	1	1	1	3	80	65	2	0
7:00 AM - 7:15AM	0	0	2	2	5	74	60	1	1
7:15 AM - 7:30AM	0	0	4	4	6	76	66	2	0
7:30 AM - 7:45AM	1	2	5	4	5	119	75	2	1

7:45 AM - 8:00AM	1	1	4	3	7	121	89	3	0
8:00 AM - 8:15AM	3	1	5	2	6	125	75	2	2
8:15 AM - 8:30AM	3	1	3	3	7	128	96	3	1
8:30 AM - 8:45AM	1	0	6	6	7	126	92	2	0
8:45 AM - 9:00AM	3	0	5	3	2	125	96	1	1
9:00 AM - 9:15AM	2	2	4	5	5	118	99	2	1
9:15 AM - 9:30AM	3	2	5	4	4	92	98	1	0
9:30 AM - 9:45AM	4	1	3	3	3	96	92	1	2
9:45 AM - 10:00AM	3	2	5	5	4	126	131	2	0
10:00 AM - 10:15AM	2	3	7	6	6	129	125	3	0
10:15 AM - 10:30AM	6	4	7	9	9	125	109	8	1
10:30 AM - 10:45AM	5	3	5	8	7	117	110	4	2
10:45 AM - 11:00AM	5	3	6	6	8	77	104	2	2
11:00 AM - 11:15AM	6	5	9	7	7	82	102	4	0
11:15 AM - 11:30AM	4	4	7	5	7	68	101	1	2
11:30 AM - 11:45AM	5	2	6	6	8	74	107	4	1
11:45 AM - 12:00PM	6	3	9	5	7	76	109	1	2
12:00 PM - 12:15PM	4	4	5	6	6	72	97	0	1
12:15 PM - 12:30PM	4	2	7	8	5	73	98	2	2
12:30 PM - 12:45PM	6	6	5	7	7	71	96	3	2
12:45 PM - 1:00PM	1	8	4	9	8	74	87	1	0
1:00 PM - 1:15PM	5	6	6	4	6	75	91	0	0
1:15 PM- 1:30PM	4	4	5	6	8	79	89	2	1
1:30 PM - 1:45PM	1	5	4	3	4	125	87	1	0
1:45 PM - 2:00PM	3	4	3	5	7	127	86	0	1
2:00 PM - 2:15PM	1	4	3	4	5	123	79	1	1
2:15 PM - 2:30PM	0	3	4	2	6	121	74	0	0
2:30 PM - 2:45PM	0	2	5	5	2	120	76	1	1
2:45 PM - 3:00PM	1	1	3	3	3	104	66	1	0
3:00 PM - 3:15PM	0	2	4	3	5	127	68	0	1
3:15 PM - 3:30PM	1	2	3	2	5	128	84	1	0
3:30 PM - 3:45PM	0	1	6	4	6	117	81	2	0
3:45 PM - 4:00PM	1	1	4	5	8	118	83	1	1
4:00 PM - 4:15PM	3	0	5	2	7	124	107	2	0
4:15 PM - 4:30PM	0	2	8	6	8	129	106	3	1
4:30 PM - 4:45PM	0	2	7	5	9	119	104	2	0
4:45 PM - 5:00PM	0	1	6	9	8	123	105	2	1
5:00 PM - 5:15PM	1	2	8	9	9	124	101	1	2
5:15 PM - 5:30PM	0	2	7	9	7	87	71	2	1
5:30 PM - 5:45PM	1	1	8	8	8	75	64	2	2
5:45 PM - 6:00PM	0	1	6	7	9	54	61	3	0
6:00 PM - 6:15PM	0	2	5	6	5	51	63	5	0
6:15 PM - 6:30PM	0	1	2	4	3	52	60	2	0
Total vehicles	100	109	241	239	291	4827	4617	92	37

Table 7-13: Thursday Volume Count in PCU

Time	Vehicle Type									Total Vehicle (PCU)
	Truck	Bus	Pickup	Car	Minibus	Bajaj	Motorcycle	Bicycle	Animal Driven Carts	
6:30 AM - 6:45AM	0	0	0	1	8	57	35	0	0	101
6:45 AM - 7:00AM	0	3	2	1	6	56	36	0	0	104
7:00 AM - 7:15AM	0	0	4	2	10	52	33	0	4	105
7:15 AM - 7:30AM	0	0	8	4	12	53	36	0	0	114
7:30 AM - 7:45AM	3	6	10	4	10	83	41	0	4	162
7:45 AM - 8:00AM	3	3	8	3	14	85	49	1	0	166
8:00 AM - 8:15AM	9	3	10	2	12	88	41	0	8	173
8:15 AM - 8:30AM	9	3	6	3	14	90	53	1	4	182
8:30 AM - 8:45AM	3	0	12	6	14	88	51	0	0	175
8:45 AM - 9:00AM	9	0	10	3	4	88	53	0	4	171
9:00 AM - 9:15AM	6	6	8	5	10	83	55	0	4	177
9:15 AM - 9:30AM	9	6	10	4	8	64	54	0	0	156
9:30 AM - 9:45AM	12	3	6	3	6	67	51	0	8	156
9:45 AM - 10:00AM	9	6	10	5	8	88	72	0	0	199
10:00 AM - 10:15AM	6	9	14	6	12	90	69	1	0	207
10:15 AM - 10:30AM	18	12	14	9	18	88	60	2	4	224
10:30 AM - 10:45AM	15	9	10	8	14	82	61	1	8	207
10:45 AM - 11:00AM	15	9	12	6	16	54	57	0	8	178
11:00 AM - 11:15AM	18	15	18	7	14	57	56	1	0	186
11:15 AM - 11:30AM	12	12	14	5	14	48	56	0	8	168
11:30 AM - 11:45AM	15	6	12	6	16	52	59	1	4	171
11:45 AM - 12:00PM	18	9	18	5	14	53	60	0	8	185
12:00 AM - 12:15AM	12	12	10	6	12	50	54	0	4	160
12:15 AM - 12:30AM	12	6	14	8	10	51	54	0	8	164
12:30 AM - 12:45AM	18	18	10	7	14	50	53	1	8	178
12:45 AM - 1:00PM	3	24	8	9	16	52	48	0	0	160
1:00 PM - 1:15PM	15	18	12	4	12	53	50	0	0	163
1:15 PM- 1:30PM	12	12	10	6	16	55	49	0	4	165
1:30 PM - 1:45PM	3	15	8	3	8	88	48	0	0	173
1:45 PM - 2:00PM	9	12	6	5	14	89	47	0	4	186
2:00 PM - 2:15PM	3	12	6	4	10	86	44	0	4	169
2:15 PM - 2:30PM	0	9	8	2	12	85	41	0	0	157
2:30 PM - 2:45PM	0	6	10	5	4	84	42	0	4	155
2:45 PM - 3:00PM	3	3	6	3	6	73	36	0	0	130
3:00 PM - 3:15PM	0	6	8	3	10	89	38	0	4	158
3:15 PM - 3:30PM	3	6	6	2	10	90	46	0	0	163
3:30 PM - 3:45PM	0	3	12	4	12	82	45	0	0	158
3:45 PM - 4:00PM	3	3	8	5	16	83	46	0	4	168
4:00 PM - 4:15PM	9	0	10	2	14	87	59	0	0	181

4:15 PM - 4:30PM	0	6	16	6	16	90	59	1	4	198
4:30 PM - 4:45PM	0	6	14	5	18	83	57	0	0	184
4:45 PM - 5:00PM	0	3	12	9	16	86	58	0	4	189
5:00 PM - 5:15PM	3	6	16	9	18	87	56	0	8	203
5:15 PM - 5:30PM	0	6	14	9	14	61	39	0	4	148
5:30 PM - 5:45PM	3	3	16	8	16	53	35	0	8	142
5:45 PM - 6:00PM	0	3	12	7	18	38	34	1	0	112
6:00 PM - 6:15PM	0	6	10	6	10	36	35	1	0	104
6:15 PM - 6:30PM	0	3	4	4	6	36	33	0	0	87
Total vehicles	297	323	483	239	583	3384	2345	18	148	7820

Table 7-14: Thursday traffic Volume computed from consecutive 15min interval

Time (min)	Volume PCU/min	Volume PCU/hr	Time (min)	Volume PCU/min	Volume PCU/hr
6:30 AM - 6:45AM	101	424	12:15 PM - 12:30PM	164	665
6:45 AM - 7:00AM	104		12:30 PM - 12:45PM	178	
7:00 AM - 7:15AM	105		12:45 PM - 1:00PM	160	
7:15 AM - 7:30AM	114		1:00 PM - 1:15PM	163	
6:45 AM - 7:00AM	104	486	12:30 PM - 12:45PM	178	666
7:00 AM - 7:15AM	105		12:45 PM - 1:00PM	160	
7:15 AM - 7:30AM	114		1:00 PM - 1:15PM	163	
7:30 AM - 7:45AM	162		1:15 PM- 1:30PM	165	
7:00 AM - 7:15AM	105	547	12:45 PM - 1:00PM	160	661
7:15 AM - 7:30AM	114		1:00 PM - 1:15PM	163	
7:30 AM - 7:45AM	162		1:15 PM- 1:30PM	165	
7:45 AM - 8:00AM	166		1:30 PM - 1:45PM	173	
7:15 AM - 7:30AM	114	615	1:00 PM - 1:15PM	163	687
7:30 AM - 7:45AM	162		1:15 PM- 1:30PM	165	
7:45 AM - 8:00AM	166		1:30 PM - 1:45PM	173	
8:00 AM - 8:15AM	173		1:45 PM - 2:00PM	186	
7:30 AM - 7:45AM	162	683	1:15 PM- 1:30PM	165	693
7:45 AM - 8:00AM	166		1:30 PM - 1:45PM	173	
8:00 AM - 8:15AM	173		1:45 PM - 2:00PM	186	
8:15 AM - 8:30AM	182		2:00 PM - 2:15PM	169	
7:45 AM - 8:00AM	166	696	1:30 PM - 1:45PM	173	684
8:00 AM - 8:15AM	173		1:45 PM - 2:00PM	186	
8:15 AM - 8:30AM	182		2:00 PM - 2:15PM	169	
8:30 AM - 8:45AM	175		2:15 PM - 2:30PM	157	
8:00 AM - 8:15AM	173	701	1:45 PM - 2:00PM	186	667
8:15 AM - 8:30AM	182		2:00 PM - 2:15PM	169	
8:30 AM - 8:45AM	175		2:15 PM - 2:30PM	157	
8:45 AM - 9:00AM	171		2:30 PM - 2:45PM	155	
8:15 AM - 8:30AM	182	704	2:00 PM - 2:15PM	169	611
8:30 AM - 8:45AM	175		2:15 PM - 2:30PM	157	
8:45 AM - 9:00AM	171		2:30 PM - 2:45PM	155	
9:00 AM - 9:15AM	177		2:45 PM - 3:00PM	130	
8:30 AM - 8:45AM	175	678	2:15 PM - 2:30PM	157	600
8:45 AM - 9:00AM	171		2:30 PM - 2:45PM	155	

9:00 AM - 9:15AM	177		2:45 PM - 3:00PM	130	
9:15 AM - 9:30AM	156		3:00 PM - 3:15PM	158	
8:45 AM - 9:00AM	171	659	2:30 PM - 2:45PM	155	606
9:00 AM - 9:15AM	177		2:45 PM - 3:00PM	130	
9:15 AM - 9:30AM	156		3:00 PM - 3:15PM	158	
9:30 AM - 9:45AM	156		3:15 PM - 3:30PM	163	
9:00 AM - 9:15AM	177	687	2:45 PM - 3:00PM	130	609
9:15 AM - 9:30AM	156		3:00 PM - 3:15PM	158	
9:30 AM - 9:45AM	156		3:15 PM - 3:30PM	163	
9:45 AM - 10:00AM	199		3:30 PM - 3:45PM	158	
9:15 AM - 9:30AM	156	718	3:00 PM - 3:15PM	158	647
9:30 AM - 9:45AM	156		3:15 PM - 3:30PM	163	
9:45 AM - 10:00AM	199		3:30 PM - 3:45PM	158	
10:00 AM - 10:15AM	207		3:45 PM - 4:00PM	168	
9:30 AM - 9:45AM	156	786	3:15 PM - 3:30PM	163	670
9:45 AM - 10:00AM	199		3:30 PM - 3:45PM	158	
10:00 AM - 10:15AM	207		3:45 PM - 4:00PM	168	
10:15 AM - 10:30AM	224		4:00 PM - 4:15PM	181	
9:45 AM - 10:00AM	199	837	3:30 PM - 3:45PM	158	705
10:00 AM - 10:15AM	207		3:45 PM - 4:00PM	168	
10:15 AM - 10:30AM	224		4:00 PM - 4:15PM	181	
10:30 AM - 10:45AM	207		4:15 PM - 4:30PM	198	
10:00 AM - 10:15AM	207	816	3:45 PM - 4:00PM	168	731
10:15 AM - 10:30AM	224		4:00 PM - 4:15PM	181	
10:30 AM - 10:45AM	207		4:15 PM - 4:30PM	198	
10:45 AM - 11:00AM	178		4:30 PM - 4:45PM	184	
10:15 AM - 10:30AM	224	795	4:00 PM - 4:15PM	181	752
10:30 AM - 10:45AM	207		4:15 PM - 4:30PM	198	
10:45 AM - 11:00AM	178		4:30 PM - 4:45PM	184	
11:00 AM - 11:15AM	186		4:45 PM - 5:00PM	189	
10:30 AM - 10:45AM	207	740	4:15 PM - 4:30PM	198	773
10:45 AM - 11:00AM	178		4:30 PM - 4:45PM	184	
11:00 AM - 11:15AM	186		4:45 PM - 5:00PM	189	
11:15 AM - 11:30AM	168		5:00 PM - 5:15PM	203	
10:45 AM - 11:00AM	178	703	4:30 PM - 4:45PM	184	723
11:00 AM - 11:15AM	186		4:45 PM - 5:00PM	189	
11:15 AM - 11:30AM	168		5:00 PM - 5:15PM	203	
11:30 AM - 11:45AM	171		5:15 PM - 5:30PM	148	
11:00 AM - 11:15AM	186	711	4:45 PM - 5:00PM	189	681
11:15 AM - 11:30AM	168		5:00 PM - 5:15PM	203	
11:30 AM - 11:45AM	171		5:15 PM - 5:30PM	148	
11:45 AM - 12:00PM	185		5:30 PM - 5:45PM	142	
11:15 AM - 11:30AM	168	684	5:00 PM - 5:15PM	203	605
11:30 AM - 11:45AM	171		5:15 PM - 5:30PM	148	
11:45 AM - 12:00PM	185		5:30 PM - 5:45PM	142	
12:00 PM - 12:15PM	160		5:45 PM - 6:00PM	112	
11:30 AM - 11:45AM	171	679	5:15 PM - 5:30PM	148	506
11:45 AM - 12:00PM	185		5:30 PM - 5:45PM	142	
12:00 PM - 12:15PM	160		5:45 PM - 6:00PM	112	

12:15 PM - 12:30PM	164		6:00 PM - 6:15PM	104	
11:45 PM - 12:00PM	185	687	5:30 PM - 5:45PM	142	445
12:00 PM - 12:15PM	160		5:45 PM - 6:00PM	112	
12:15 PM - 12:30PM	164		6:00 PM - 6:15PM	104	
12:30 PM - 12:45PM	178		6:15 PM - 6:30PM	87	
12:00 PM - 12:15PM	160	661			
12:15 PM - 12:30PM	164				
12:30 PM - 12:45PM	178				
12:45 PM - 1:00PM	160				

Table 7-15: Friday Morning Volume, veh

	Vehicle Type								
Time	Truck	Bus	Pickup	Car	Minibus	Bajaj	Motorcycle	Bicycle	Animal Driven Carts
6:30 AM - 6:45AM	0	0	6	3	0	65	60	0	0
6:45 AM - 7:00AM	0	1	8	5	2	64	55	0	0
7:00 AM - 7:15AM	1	1	6	3	1	72	59	0	0
7:15 AM - 7:30AM	1	0	8	5	3	76	61	1	0
7:30 AM - 7:45AM	1	1	4	3	5	73	65	2	0
7:45 AM - 8:00AM	1	1	4	2	4	74	76	1	1
8:00 AM - 8:15AM	1	1	2	4	5	128	81	1	0
8:15 AM - 8:30AM	1	2	5	4	3	124	91	2	1
8:30 AM - 8:45AM	1	1	2	5	1	114	98	0	0
8:45 AM - 9:00AM	1	2	3	3	2	102	107	2	0
9:00 AM - 9:15AM	1	1	2	1	3	117	91	1	1
9:15 AM - 9:30AM	0	2	0	4	2	119	81	0	0
9:30 AM - 9:45AM	1	2	3	2	0	105	85	1	0
9:45 AM - 10:00AM	2	1	2	0	1	105	119	0	0
10:00 AM - 10:15AM	1	0	2	2	3	100	125	1	0
10:15 AM - 10:30AM	2	1	3	3	4	111	124	0	1
10:30 AM - 10:45AM	2	2	3	2	3	109	126	1	0
10:45 AM - 11:00AM	2	1	1	3	4	98	127	2	1
11:00 AM - 11:15AM	2	2	4	1	3	116	126	0	0
11:15 AM - 11:30AM	0	1	5	3	3	94	125	1	1
11:30 AM - 11:45AM	3	2	6	6	8	88	127	1	1
11:45 AM - 12:00PM	1	3	9	5	7	93	126	1	2
12:00 PM - 12:15PM	4	6	5	7	7	91	128	1	1
12:15 PM - 12:30PM	2	5	6	6	6	94	77	1	1
12:30 PM - 12:45PM	3	3	7	8	5	97	76	2	2
12:45 PM - 1:00PM	2	8	4	9	8	89	75	1	0
1:00 PM - 1:15PM	4	6	6	4	6	78	73	0	0
1:15 PM- 1:30PM	3	4	5	6	8	76	71	2	1
1:30 PM - 1:45PM	2	7	6	5	6	67	72	1	0
1:45 PM - 2:00PM	2	5	4	6	4	37	62	0	1
2:00 PM - 2:15PM	1	4	3	5	6	44	56	1	1
2:15 PM - 2:30PM	2	3	5	3	5	48	64	1	0

2:30 PM - 2:45PM	1	1	3	3	1	119	84	0	1
2:45 PM - 3:00PM	0	1	2	1	2	101	107	1	0
3:00 PM - 3:15PM	1	0	3	0	3	105	101	0	1
3:15 PM - 3:30PM	1	1	2	1	3	101	101	1	0
3:30 PM - 3:45PM	2	1	3	4	4	99	108	0	0
3:45 PM - 4:00PM	1	0	4	2	4	103	98	1	1
4:00 PM - 4:15PM	2	1	3	3	2	109	75	0	0
4:15 PM - 4:30PM	1	1	2	2	4	115	78	1	1
4:30 PM - 4:45PM	2	0	4	3	3	117	72	1	0
4:45 PM - 5:00PM	1	1	5	8	9	119	70	2	1
5:00 PM - 5:15PM	2	2	9	6	8	121	78	3	0
5:15 PM - 5:30PM	1	2	2	5	9	48	75	1	1
5:30 PM - 5:45PM	2	1	3	2	6	42	65	3	2
5:45 PM - 6:00PM	3	0	3	3	4	40	70	2	1
6:00 PM - 6:15PM	2	1	2	2	2	46	69	0	1
6:15 PM - 6:30PM	1	0	3	2	4	34	70	0	0
Total vehicles	73	92	192	175	196	4287	4210	44	26

Table 7-16: Friday Volume Count in PCU

Time	Vehicle Type									Total Vehicle (PCU)
	Truck	Bus	Pickup	Car	Minibus	Bajaj	Motorcycle	Bicycle	Animal Driven Carts	
6:30 AM - 6:45AM	0	0	12	3	0	46	33	0	0	94
6:45 AM - 7:00AM	0	3	16	5	4	45	30	0	0	103
7:00 AM - 7:15AM	3	3	12	3	2	50	33	0	0	106
7:15 AM - 7:30AM	3	0	16	5	6	53	34	0	0	117
7:30 AM - 7:45AM	3	3	8	3	10	51	36	0	0	114
7:45 AM - 8:00AM	3	3	8	2	8	52	42	0	4	122
8:00 AM - 8:15AM	3	3	4	4	10	90	45	0	0	159
8:15 AM - 8:30AM	3	6	10	4	6	87	50	0	4	170
8:30 AM - 8:45AM	3	3	4	5	2	80	54	0	0	151
8:45 AM - 9:00AM	3	6	6	3	4	72	59	0	0	153
9:00 AM - 9:15AM	3	3	4	1	6	82	50	0	4	153
9:15 AM - 9:30AM	0	6	0	4	4	83	45	0	0	142
9:30 AM - 9:45AM	3	6	6	2	0	74	47	0	0	138
9:45 AM - 10:00AM	6	3	4	0	2	74	66	0	0	154
10:00 AM - 10:15AM	3	0	4	2	6	70	69	0	0	154
10:15 AM - 10:30AM	6	3	6	3	8	78	68	0	4	176
10:30 AM - 10:45AM	6	6	6	2	6	76	70	0	0	172
10:45 AM - 11:00AM	6	3	2	3	8	69	70	0	4	165
11:00 AM - 11:15AM	6	6	8	1	6	81	70	0	0	178
11:15 AM - 11:30AM	0	3	10	3	6	66	69	0	4	161
11:30 AM - 11:45AM	9	6	12	6	16	62	70	0	4	185
11:45 AM - 12:00PM	3	9	18	5	14	65	70	0	8	192

12:00 AM - 12:15AM	12	18	10	7	14	64	71	0	4	199
12:15 AM - 12:30AM	6	15	12	6	12	66	43	0	4	163
12:30 AM - 12:45AM	9	9	14	8	10	68	42	0	8	168
12:45 AM - 1:00PM	6	24	8	9	16	62	41	0	0	167
1:00 PM - 1:15PM	12	18	12	4	12	55	40	0	0	153
1:15 PM- 1:30PM	9	12	10	6	16	53	39	0	4	150
1:30 PM - 1:45PM	6	21	12	5	12	47	40	0	0	143
1:45 PM - 2:00PM	6	15	8	6	8	26	34	0	4	107
2:00 PM - 2:15PM	3	12	6	5	12	31	31	0	4	104
2:15 PM - 2:30PM	6	9	10	3	10	34	35	0	0	107
2:30 PM - 2:45PM	3	3	6	3	2	83	46	0	4	151
2:45 PM - 3:00PM	0	3	4	1	4	71	59	0	0	142
3:00 PM - 3:15PM	3	0	6	0	6	74	56	0	4	148
3:15 PM - 3:30PM	3	3	4	1	6	71	56	0	0	144
3:30 PM - 3:45PM	6	3	6	4	8	69	60	0	0	156
3:45 PM - 4:00PM	3	0	8	2	8	72	54	0	4	151
4:00 PM - 4:15PM	6	3	6	3	4	76	41	0	0	140
4:15 PM - 4:30PM	3	3	4	2	8	81	43	0	4	148
4:30 PM - 4:45PM	6	0	8	3	6	82	40	0	0	145
4:45 PM - 5:00PM	3	3	10	8	18	83	39	0	4	168
5:00 PM - 5:15PM	6	6	18	6	16	85	43	1	0	180
5:15 PM - 5:30PM	3	6	4	5	18	34	41	0	4	115
5:30 PM - 5:45PM	6	3	6	2	12	29	36	1	8	103
5:45 PM - 6:00PM	9	0	6	3	8	28	39	0	4	97
6:00 PM - 6:15PM	6	3	4	2	4	32	38	0	4	93
6:15 PM - 6:30PM	3	0	6	2	8	24	39	0	0	81
Total vehicles	217	273	385	175	393	3005	2324	9	104	6884

Table 7-17: Friday traffic Volume computed from consecutive 15min interval

Time (min)	Volume PCU/min	Volume PCU/hr	Time (min)	Volume PCU/min	Volume PCU/hr
6:30 AM - 6:45AM	94	420	12:15 PM - 12:30PM	163	651
6:45 AM - 7:00AM	103		12:30 PM - 12:45PM	168	
7:00 AM - 7:15AM	106		12:45 PM - 1:00PM	167	
7:15 AM - 7:30AM	117		1:00 PM - 1:15PM	153	
6:45 AM - 7:00AM	103	441	12:30 PM - 12:45PM	168	637
7:00 AM - 7:15AM	106		12:45 PM - 1:00PM	167	
7:15 AM - 7:30AM	117		1:00 PM - 1:15PM	153	
7:30 AM - 7:45AM	114		1:15 PM- 1:30PM	150	
7:00 AM - 7:15AM	106	460	12:45 PM - 1:00PM	167	612
7:15 AM - 7:30AM	117		1:00 PM - 1:15PM	153	
7:30 AM - 7:45AM	114		1:15 PM- 1:30PM	150	
7:45 AM - 8:00AM	122		1:30 PM - 1:45PM	143	
7:15 AM - 7:30AM	117	512	1:00 PM - 1:15PM	153	552
7:30 AM - 7:45AM	114		1:15 PM- 1:30PM	150	
7:45 AM - 8:00AM	122		1:30 PM - 1:45PM	143	
8:00 AM - 8:15AM	159		1:45 PM - 2:00PM	107	

7:30 AM - 7:45AM	114	566	1:15 PM- 1:30PM	150	503
7:45 AM - 8:00AM	122		1:30 PM - 1:45PM	143	
8:00 AM - 8:15AM	159		1:45 PM - 2:00PM	107	
8:15 AM - 8:30AM	170		2:00 PM - 2:15PM	104	
7:45 AM - 8:00AM	122	602	1:30 PM - 1:45PM	143	461
8:00 AM - 8:15AM	159		1:45 PM - 2:00PM	107	
8:15 AM - 8:30AM	170		2:00 PM - 2:15PM	104	
8:30 AM - 8:45AM	151		2:15 PM - 2:30PM	107	
8:00 AM - 8:15AM	159	633	1:45 PM - 2:00PM	107	469
8:15 AM - 8:30AM	170		2:00 PM - 2:15PM	104	
8:30 AM - 8:45AM	151		2:15 PM - 2:30PM	107	
8:45 AM - 9:00AM	153		2:30 PM - 2:45PM	151	
8:15 AM - 8:30AM	170	628	2:00 PM - 2:15PM	104	504
8:30 AM - 8:45AM	151		2:15 PM - 2:30PM	107	
8:45 AM - 9:00AM	153		2:30 PM - 2:45PM	151	
9:00 AM - 9:15AM	153		2:45 PM - 3:00PM	142	
8:30 AM - 8:45AM	151	599	2:15 PM - 2:30PM	107	548
8:45 AM - 9:00AM	153		2:30 PM - 2:45PM	151	
9:00 AM - 9:15AM	153		2:45 PM - 3:00PM	142	
9:15 AM - 9:30AM	142		3:00 PM - 3:15PM	148	
8:45 AM - 9:00AM	153	586	2:30 PM - 2:45PM	151	585
9:00 AM - 9:15AM	153		2:45 PM - 3:00PM	142	
9:15 AM - 9:30AM	142		3:00 PM - 3:15PM	148	
9:30 AM - 9:45AM	138		3:15 PM - 3:30PM	144	
9:00 AM - 9:15AM	153	587	2:45 PM - 3:00PM	142	590
9:15 AM - 9:30AM	142		3:00 PM - 3:15PM	148	
9:30 AM - 9:45AM	138		3:15 PM - 3:30PM	144	
9:45 AM - 10:00AM	154		3:30 PM - 3:45PM	156	
9:15 AM - 9:30AM	142	588	3:00 PM - 3:15PM	148	599
9:30 AM - 9:45AM	138		3:15 PM - 3:30PM	144	
9:45 AM - 10:00AM	154		3:30 PM - 3:45PM	156	
10:00 AM - 10:15AM	154		3:45 PM - 4:00PM	151	
9:30 AM - 9:45AM	138	622	3:15 PM - 3:30PM	144	591
9:45 AM - 10:00AM	154		3:30 PM - 3:45PM	156	
10:00 AM - 10:15AM	154		3:45 PM - 4:00PM	151	
10:15 AM - 10:30AM	176		4:00 PM - 4:15PM	140	
9:45 AM - 10:00AM	154	657	3:30 PM - 3:45PM	156	595
10:00 AM - 10:15AM	154		3:45 PM - 4:00PM	151	
10:15 AM - 10:30AM	176		4:00 PM - 4:15PM	140	
10:30 AM - 10:45AM	172		4:15 PM - 4:30PM	148	
10:00 AM - 10:15AM	154	668	3:45 PM - 4:00PM	151	584
10:15 AM - 10:30AM	176		4:00 PM - 4:15PM	140	
10:30 AM - 10:45AM	172		4:15 PM - 4:30PM	148	
10:45 AM - 11:00AM	165		4:30 PM - 4:45PM	145	
10:15 AM - 10:30AM	176	691	4:00 PM - 4:15PM	140	601
10:30 AM - 10:45AM	172		4:15 PM - 4:30PM	148	
10:45 AM - 11:00AM	165		4:30 PM - 4:45PM	145	
11:00 AM - 11:15AM	178		4:45 PM - 5:00PM	168	
10:30 AM - 10:45AM	172	676	4:15 PM - 4:30PM	148	642

10:45 AM - 11:00AM	165		4:30 PM - 4:45PM	145	
11:00 AM - 11:15AM	178		4:45 PM - 5:00PM	168	
11:15 AM - 11:30AM	161		5:00 PM - 5:15PM	180	
10:45 AM - 11:00AM	165	689	4:30 PM - 4:45PM	145	609
11:00 AM - 11:15AM	178		4:45 PM - 5:00PM	168	
11:15 AM - 11:30AM	161		5:00 PM - 5:15PM	180	
11:30 AM - 11:45AM	185		5:15 PM - 5:30PM	115	
11:00 AM - 11:15AM	178	716	4:45 PM - 5:00PM	168	567
11:15 AM - 11:30AM	161		5:00 PM - 5:15PM	180	
11:30 AM - 11:45AM	185		5:15 PM - 5:30PM	115	
11:45 AM - 12:00PM	192		5:30 PM - 5:45PM	103	
11:15 AM - 11:30AM	161	737	5:00 PM - 5:15PM	180	495
11:30 AM - 11:45AM	185		5:15 PM - 5:30PM	115	
11:45 AM - 12:00PM	192		5:30 PM - 5:45PM	103	
12:00 PM - 12:15PM	199		5:45 PM - 6:00PM	97	
11:30 AM - 11:45AM	185	740	5:15 PM - 5:30PM	115	408
11:45 AM - 12:00PM	192		5:30 PM - 5:45PM	103	
12:00 PM - 12:15PM	199		5:45 PM - 6:00PM	97	
12:15 PM - 12:30PM	163		6:00 PM - 6:15PM	93	
11:45 PM - 12:00PM	192	723	5:30 PM - 5:45PM	103	375
12:00 PM - 12:15PM	199		5:45 PM - 6:00PM	97	
12:15 PM - 12:30PM	163		6:00 PM - 6:15PM	93	
12:30 PM - 12:45PM	168		6:15 PM - 6:30PM	81	
12:00 PM - 12:15PM	199	698			
12:15 PM - 12:30PM	163				
12:30 PM - 12:45PM	168				
12:45 PM - 1:00PM	167				

7.3. Appendix C: On Street Parking parameters result

Table 7-18:Available On street Parking Space From Adare Hospital to Mobile Sefer.(m^2)

Section Length(km)	Parking Space curb Length (m)		Vehicle type	Standard car length	Avg. Car Width (m)	Parking Space (m^2)		Total on Street Parking Area (m^2)
	Left	Right				Left	Right	
1.67	1200.00	835.00	truck	7.5	3.75	4500.00	3131.25	7631.25
			car	5	2.5	3000.00	2087.50	5087.50

Table 7-19: Prevailing condition of the study area

Study Date	Monday, March 9, 2020, 6:30 AM	**Weather condition**	Sunny
Parking base length (m)	120	**Parking Volume (veh)**	16.00
Std. Car Length (m)	7.5	**Initial Count (veh)**	5
lane Width (m)	5.53		

Table 7-20: In and Out method of parking survey at Arab Sefer node, Monday

Time	In	Out	Accumulation	Occupancy Rate	Parking Index	Parking Load
6:30 AM - 6:45AM	3	0	8	50.00	0.50	2.00
6:45 AM - 7:00AM	2	0	10	62.50	0.63	2.50
7:00 AM - 7:15AM	3	1	12	75.00	0.75	3.00
7:15 AM - 7:30AM	1	1	12	75.00	0.75	3.00
7:30 AM - 7:45AM	3	0	15	93.75	0.94	3.75
7:45 AM - 8:00AM	4	1	18	112.50	1.13	4.50
8:00 AM - 8:15AM	2	1	19	118.75	1.19	4.75
8:15 AM - 8:30AM	1	2	18	112.50	1.13	4.50
8:30 AM - 8:45AM	2	4	16	100.00	1.00	4.00
8:45 AM - 9:00AM	3	5	14	87.50	0.88	3.50
9:00 AM - 9:15AM	3	6	11	68.75	0.69	2.75
9:15 AM - 9:30AM	4	5	10	62.50	0.63	2.50
9:30 AM - 9:45AM	3	5	8	50.00	0.50	2.00
9:45 AM - 10:00AM	3	1	10	62.50	0.63	2.50
10:00 AM - 10:15AM	4	2	12	75.00	0.75	3.00
10:15 AM - 10:30AM	5	4	13	81.25	0.81	3.25
10:30 AM - 10:45AM	3	2	14	87.50	0.88	3.50
10:45 AM - 11:00AM	2	1	15	93.75	0.94	3.75
11:00 AM - 11:15AM	3	2	16	100.00	1.00	4.00
11:15 AM - 11:30AM	6	5	17	106.25	1.06	4.25
11:30 AM - 11:45AM	5	4	18	112.50	1.13	4.50
11:45 AM - 12:00PM	4	6	16	100.00	1.00	4.00
12:00 PM - 12:15PM	3	4	15	93.75	0.94	3.75
12:15 PM - 12:30PM	1	3	13	81.25	0.81	3.25
12:30 PM - 12:45PM	4	5	12	75.00	0.75	3.00
12:45 PM - 1:00PM	6	8	10	62.50	0.63	2.50
1:00 PM - 1:15PM	2	5	7	43.75	0.44	1.75
1:15 PM- 1:30PM	1	2	6	37.50	0.38	1.50
1:30 PM - 1:45PM	3	3	6	37.50	0.38	1.50

1:45 PM - 2:00PM	4	5	5	31.25	0.31	1.25
2:00 PM - 2:15PM	2	1	6	37.50	0.38	1.50
2:15 PM - 2:30PM	1	4	3	18.75	0.19	0.75
2:30 PM - 2:45PM	6	2	7	43.75	0.44	1.75
2:45 PM - 3:00PM	5	1	11	68.75	0.69	2.75
3:00 PM - 3:15PM	6	2	15	93.75	0.94	3.75
3:15 PM - 3:30PM	4	1	18	112.50	1.13	4.50
3:30 PM - 3:45PM	2	3	17	106.25	1.06	4.25
3:45 PM - 4:00PM	2	2	17	106.25	1.06	4.25
4:00 PM - 4:15PM	2	1	18	112.50	1.13	4.50
4:15 PM - 4:30PM	4	6	16	100.00	1.00	4.00
4:30 PM - 4:45PM	3	3	16	100.00	1.00	4.00
4:45 PM - 5:00PM	6	4	18	112.50	1.13	4.50
5:00 PM - 5:15PM	4	5	17	106.25	1.06	4.25
5:15 PM - 5:30PM	3	4	16	100.00	1.00	4.00
5:30 PM - 5:45PM	3	4	15	93.75	0.94	3.75
5:45 PM - 6:00PM	2	6	11	68.75	0.69	2.75
6:00 PM - 6:15PM	1	2	10	62.50	0.63	2.50
6:15 PM - 6:30PM	0	3	7	43.75	0.44	1.75

7.4. Appendix D: SPSS Output for Independent Variables

Table 7-21SPSS Output For Traffic Flow

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	349960.004	2	174980.002	191.322	.000[b]
	Residual	38412.440	42	914.582		
	Total	388372.444	44			

a. Dependent Variable: Traffic Flow (PCU/hr)
b. Predictors: (Constant), Pedestrian Count (n), On Street Parking Load (veh hr)

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	502.5632	792.5679	684.1111	89.18316	45
Std. Predicted Value	-2.036	1.216	.000	1.000	45
Standard Error of Predicted Value	4.972	10.809	7.656	1.555	45
Adjusted Predicted Value	498.6916	791.3434	684.0372	89.53193	45
Residual	-66.39693	40.26040	.00000	29.54674	45
Std. Residual	-2.196	1.331	.000	.977	45
Stud. Residual	-2.320	1.414	.001	1.014	45
Deleted Residual	-74.13698	45.40944	.07392	31.81755	45
Stud. Deleted Residual	-2.455	1.431	-.005	1.028	45
Mahal. Distance	.211	4.643	1.956	1.180	45
Cook's Distance	.000	.209	.026	.034	45
Centered Leverage Value	.005	.106	.044	.027	45

a. Dependent Variable: Traffic Flow (PCU/hr)

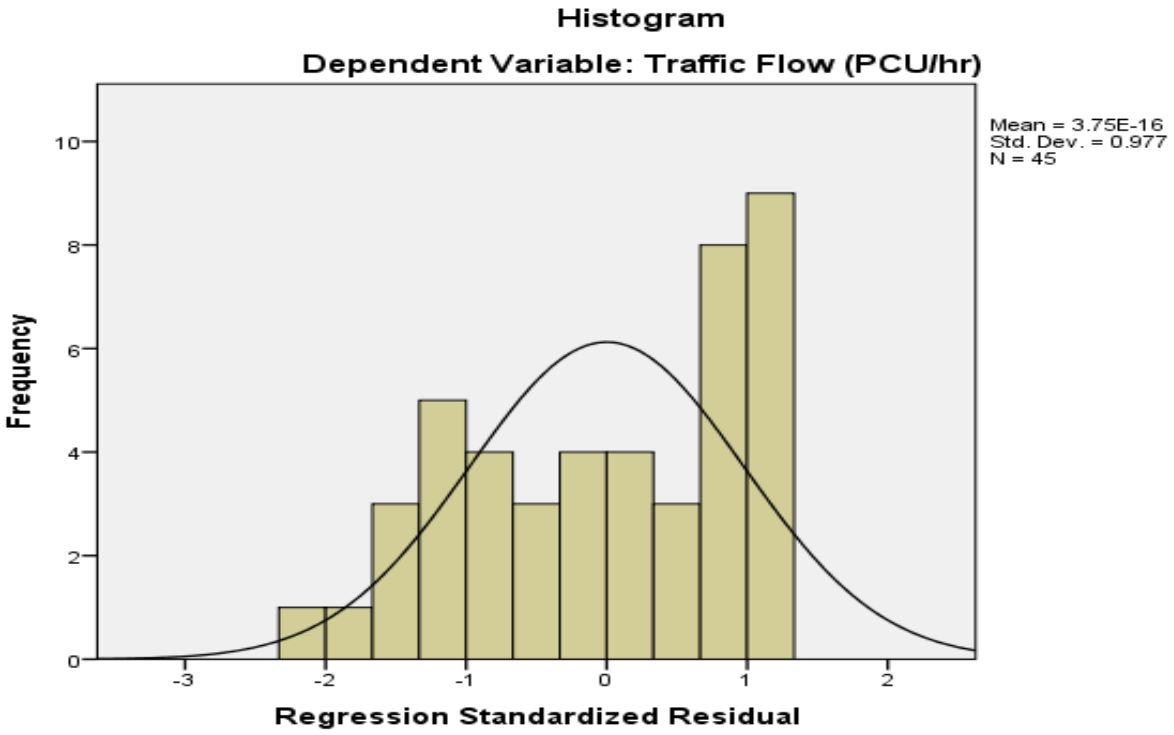


Figure 7-1: Histogram and Normal Distribution Curve for Traffic Flow

Table 7-22: SPSS Output for Average Travel Speed

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1203.628	2	601.814	153.332	.000[b]
	Residual	164.846	42	3.925		
	Total	1368.474	44			

a. Dependent Variable: Average Travel Speed (km/hr)
b. Predictors: (Constant), Pedestrian Count (n), On Street Parking Load (veh hr)

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	16.7648	33.7469	23.1333	5.23022	45
Std. Predicted Value	-1.218	2.029	.000	1.000	45
Standard Error of Predicted Value	.326	.708	.502	.102	45
Adjusted Predicted Value	16.8160	33.8151	23.1227	5.22940	45
Residual	-3.76493	3.55969	.00000	1.93559	45
Std. Residual	-1.900	1.797	.000	.977	45
Stud. Residual	-2.008	1.872	.003	1.011	45
Deleted Residual	-4.20312	3.86408	.01059	2.07408	45
Stud. Deleted Residual	-2.087	1.932	.003	1.025	45
Mahal. Distance	.211	4.643	1.956	1.180	45
Cook's Distance	.000	.156	.024	.031	45
Centered Leverage Value	.005	.106	.044	.027	45

a. Dependent Variable: Average Travel Speed (km/hr)

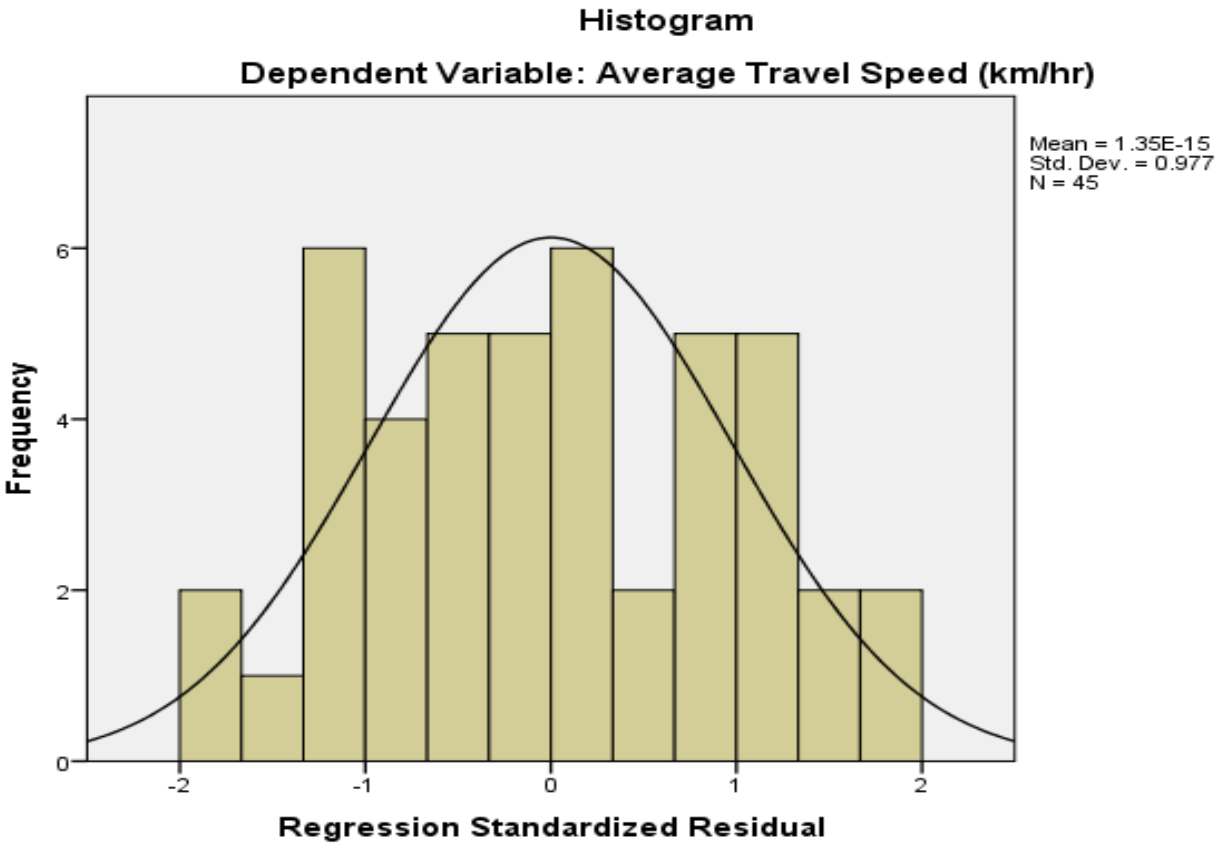


Figure 7-2: Histogram and Normal distribution curve for Average Travel Speed

Table 7-23: SPSS Output for Density

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4848.990	2	2424.495	135.846	.000[b]
	Residual	749.588	42	17.847		
	Total	5598.578	44			

a. Dependent Variable: Density (veh/km)
b. Predictors: (Constant), Pedestrian Count (n), On Street Parking Load (veh hr)

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	11.1340	45.0752	32.1778	10.49782	45
Std. Predicted Value	-2.005	1.229	.000	1.000	45
Standard Error of Predicted Value	.695	1.510	1.069	.217	45
Adjusted Predicted Value	10.5678	44.6511	32.1672	10.55121	45
Residual	-8.60527	6.92483	.00000	4.12748	45
Std. Residual	-2.037	1.639	.000	.977	45
Stud. Residual	-2.122	1.700	.001	1.014	45
Deleted Residual	-9.34111	7.44608	.01060	4.44621	45
Stud. Deleted Residual	-2.219	1.740	.000	1.028	45
Mahal. Distance	.211	4.643	1.956	1.180	45
Cook's Distance	.000	.159	.026	.034	45
Centered Leverage Value	.005	.106	.044	.027	45

a. Dependent Variable: Density (veh/km)

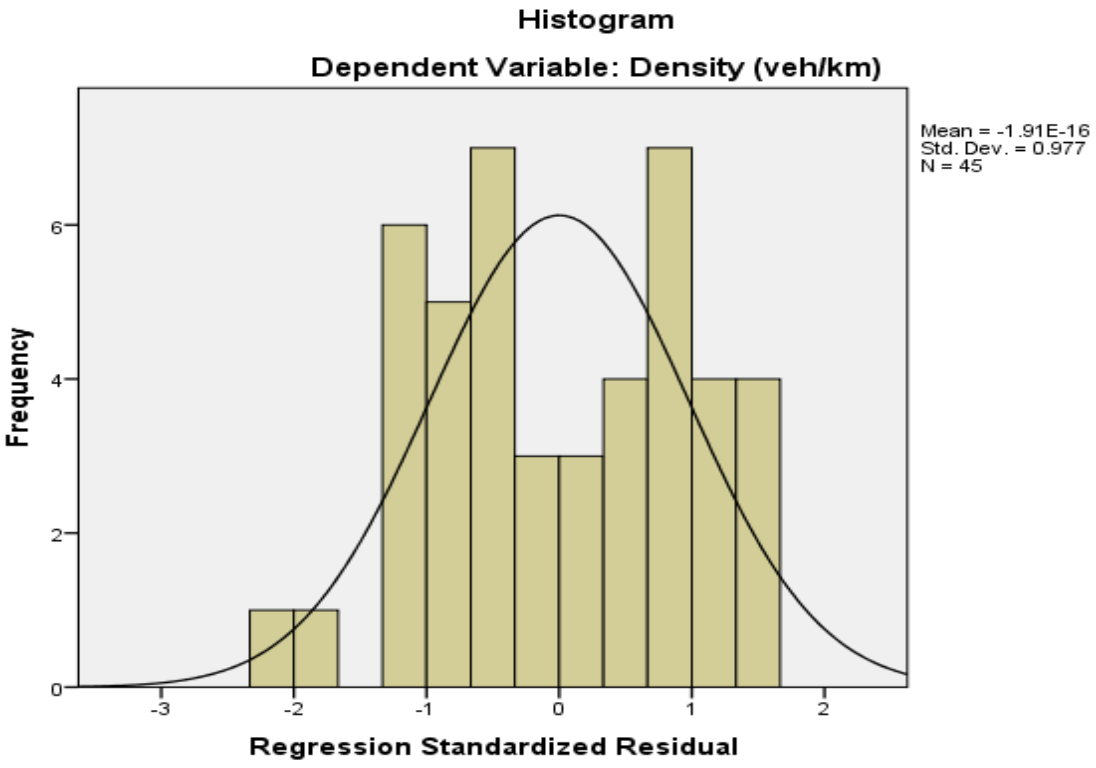


Figure 7-3: Histogram and Normal Distribution Curve for Density

Table 7-24: SPSS Output for Remaining Lane Width

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	40.358	2	20.179	314.546	.000[b]
	Residual	2.694	42	.064		
	Total	43.052	44			

a. Dependent Variable: Remaining lane width (m)
b. Predictors: (Constant), Pedestrian Count (n), On Street Parking Load (veh hr)

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1.7092	4.7773	2.9711	.95772	45
Std. Predicted Value	-1.318	1.886	.000	1.000	45
Standard Error of Predicted Value	.042	.091	.064	.013	45
Adjusted Predicted Value	1.7024	4.7718	2.9692	.95639	45
Residual	-.52948	.47485	.00000	.24746	45
Std. Residual	-2.090	1.875	.000	.977	45
Stud. Residual	-2.143	1.961	.004	1.009	45
Deleted Residual	-.55642	.51961	.00196	.26418	45
Stud. Deleted Residual	-2.244	2.033	.000	1.026	45
Mahal. Distance	.211	4.643	1.956	1.180	45
Cook's Distance	.000	.121	.023	.026	45
Centered Leverage Value	.005	.106	.044	.027	45

a. Dependent Variable: Remaining lane width (m)

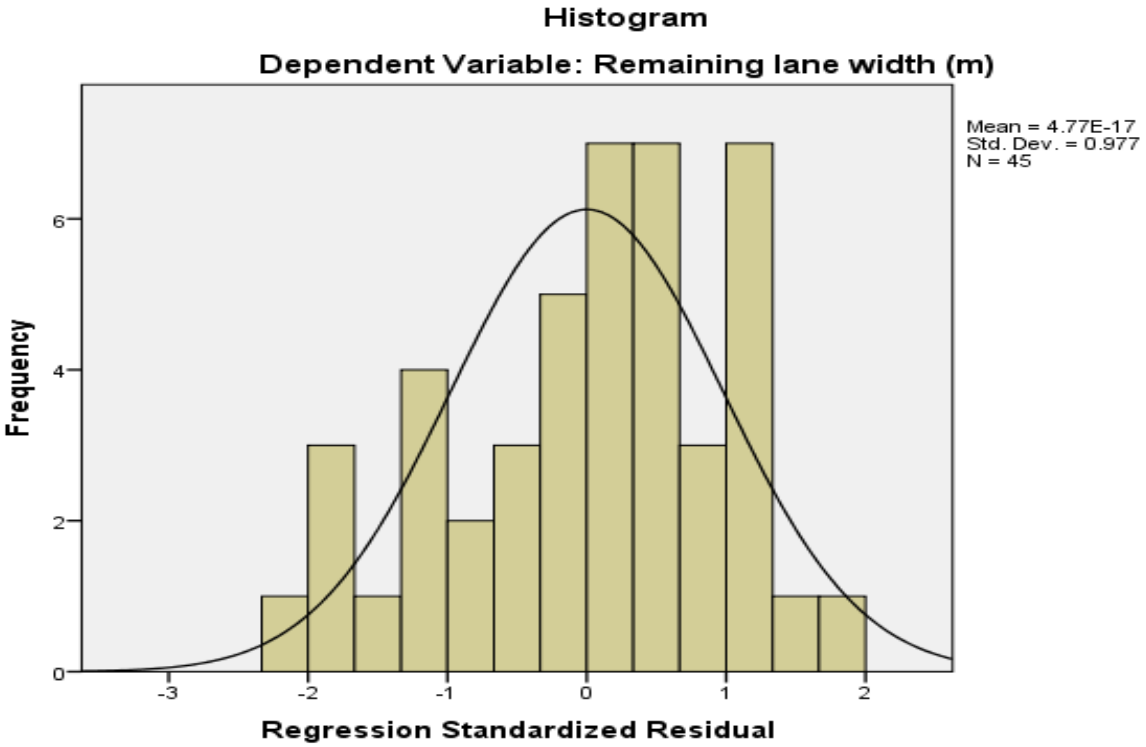


Figure 7-4: Histogram and Normal Distribution Curve for Remaining Lane Width

Table 7-25: SPSS Output for Average Maneuvering Time

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4039.556	2	2019.778	286.161	.000[b]
	Residual	296.444	42	7.058		
	Total	4336.000	44			

a. Dependent Variable: Average maneuvering time (Sec)
b. Predictors: (Constant), Pedestrian Count (n), On Street Parking Load (veh hr)

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	10.0254	40.9852	29.0000	9.58165	45
Std. Predicted Value	-1.980	1.251	.000	1.000	45
Standard Error of Predicted Value	.437	.950	.673	.137	45
Adjusted Predicted Value	9.8827	40.6830	29.0041	9.59775	45
Residual	-5.89218	4.01481	.00000	2.59564	45
Std. Residual	-2.218	1.511	.000	.977	45
Stud. Residual	-2.320	1.567	-.001	1.015	45
Deleted Residual	-6.44769	4.31701	-.00408	2.80064	45
Stud. Deleted Residual	-2.455	1.596	-.005	1.030	45
Mahal. Distance	.211	4.643	1.956	1.180	45
Cook's Distance	.000	.169	.027	.035	45
Centered Leverage Value	.005	.106	.044	.027	45

a. Dependent Variable: Average maneuvering time (Sec)

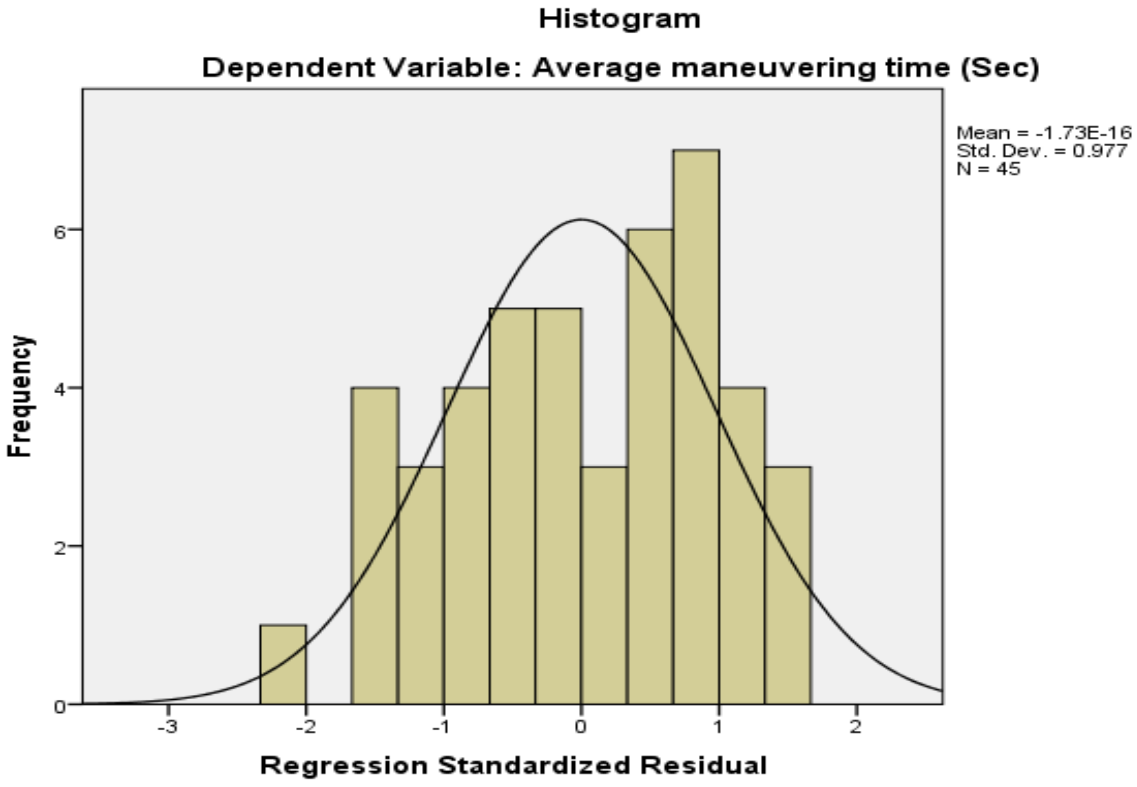


Figure 7-5: Histogram and Normal Distribution Curve for Average Maneuvering Time