LANE CHOICE BEHAVIOR

Nidhi B Randeria[1], Nehal C Chaudhari[2]
Nirav B Mehta[3] ,Mit M Desai[4]

MTech in Construction Mnagement, MITCOM , MIT ADT University, Maharastra, India

ABSTRACT

The main objective of the study is to study the lane usage characteristics on Majura gate-Udhana darwaja road stretch,Surat which is a urban multi-lane road .Lane use distributions represent the proportion of an individual lane's traffic out of the total traffic at a given multilane roadway. The distribution of total volume on lanes is an important feature of the traffic flow analysis on multilane roads. Usually, models describe traffic flow in one dimension i.e. along the road axis (longitudinal direction) even though traffic flow across the roadway width is generally not uniformly distributed. The trucks and slow-moving vehicles generally use the leftmost (shoulder-side) lane. Furthermore, the distribution of vehicles on lanes, especially that of heavy vehicles, is important for pavement maintenance management schemes, since pavement deterioration is not uniform on all lanes, but depends on the number of vehicles using each particular lane. Lane utilization represents how the rate of traffic flow is distributed among the available number of lanes in a given section. This utilization or split is affected by several factors including traffic flow rates, speed etc. The importance of studying lane utilization comes from the fact that it is one of the important parameters for refining the performance of micro-simulation traffic models. The researchers in developed countries used regression models to represent the effect of parameters such as traffic volume, traffic composition, average speeds of different vehicle types and stream speed, etc on lane utilization behavior. The present study is focused on study of lane utilization using multivariate analysis using lane utilization as a dependent variable and parameters like classified traffic volume, average speed of each category of vehicle, traffic composition and stream speed as independent variables.

Keyword: - *Lane use, lane utilization factor, traffic flow.*

1. INTRODUCTION

Roads in India are vastly different from Roads or freeways in other countries due to its varied disciplined vehicle composition. Traffic movement on Indian Expressways may be said to be quasi-lane disciplined with some vehicles following a lane-based driving and many others not. Moreover, the level of lane-discipline may change significantly based on the traffic flow level and its composition. Very limited research has been done on lane choice behavior on these highest classes of roadway facilities. The lane choosing behavior is affected by several factors like carnage width, side friction, vehicle composition, traffic flow rate, vehicular speeds etc. In this paper an attempt is made to develop a random utility based discrete multinomial choice model using SPSS for the behavior of automobile drivers while selecting

lanes on urban roads and expressway. For this study, six hours of video graphic data was collected on a road stretch on Majura Gate-Udhana Darwaja, road incorporating both peak and off peak hours. Vehicle composition and lane discipline on this road are studied along with the lane choosing behavior for four different vehicle categories. Two separate models arc developed using stream speed and lane utilization factor. Study also attempts to determine if there is any unique pattern across vehicle classes in choosing lanes. It is found that cars will prefer median side lanes, however trucks will prefer shoulder side lane. Hence class of vehicle is observed to affect choice of lane. Moreover, it is also demonstrated that stream speed along with class of vehicle affects the choice behavior of lane more significantly as compared to lane usage factor.

1.1 Objectives

The objectives of the study are as follows:
   1) To study statistics of lane discipline behavior for different category of vehicles.
   2) To develop relationship between lane choice behavior and other parameters like lane utilization factor and average stream speed for a specific road.
   3) To compare lane choice behavior models with different parameters like lane utilization factors, vehicle classes and stream speed.

1.2 Scope of study

The scope of the study is limited to the following aspects:
   1) The study results are given based on the data that is extracted from the video captured from the camera installed on the foot-over bridge.
   2) This study and model can be useful for the traffic design and signaling as well as the geometric design is concerned.
   3) The study is limited to only four different vehicle categories namely, Two-wheeler, Three-wheeler, Car, Heavy Motorized Vehicles (bus and trucks) on Indian Expressway.
   4) It is found that, there was no occurrence of incidents or accidents that could disturb the data collection and analysis.

1.3 Methodology

The present study aims to model the lane choice behavior for an expressway. The lane choice model was developed with the aid of video data collected on a road stretch of Majura Gate-Udhana Darwaja road,Surat.

2. DATA COLLECTION AND ANALYSIS

Majura Gate — Udhna Darwaja is a ring road of Surat and also get so much congested in pick hours as this is only road to link both well-known Surat industries Diamond and Textile to residential zone . So suitable site location for the collection of video data has been selected. It is consists of 8 lane divided road, road links, service roads and Foot over Bridges (FoBs). The selection was certainly limited by the location for camera setup and visibility across lanes.

Videography was conducted on three days one week days and two weekends having both the observation of day pick time and evening pick time on Majura-udhna darwaja Ring road, surat: Pick time were taken

after prior study of traffic flow and that was 10:30am to 1:00am for morning and 7:30pm to 8:00pm evening .Suitable place were found on site to take photography

Total 3hr of video collected for analysis. This video graphic data was captured for peak and non-peak hours in one of the directions of traffic flow. No obstruction has been occurred at site. So Interruption free observations are taken.

2.1 Data Extraction

Three hour's data is utilized in calculating the lane utilization factor as well as stream speed. The observed time period (3 hr) was further divided into short intervals of 1 minute for analyzing the lane utilization behavior of different class of vehicles available at that time for different flow levels. For this purpose, the flow values and lane usage factors were extracted from the video-graphic data using four reference points (to form rectangle) as identified in the field while capturing data.

Figure 1:Location on map

Figure 2:Observation point

Broadly, five vehicle categories were observed on the study stretch, namely cars, buses and trucks, motorized three -wheelers and motorized two-wheelers on the selected study section of the expressway. Classified volume count is done for the interval of 1 minute from 3 hours video captured. Stream speed is calculated by taking average speed of all vehicles occupying trap length of 65 meters for each 1 minute interval. For the purpose of calculating lane utilization, the lanes were classified into four distinct types (1, 2, 3, 4), each representing vehicle position on the followed from the median, hence making it possible to quantify the degree of lane discipline under prevailing roadway and traffic conditions. In this, median side lane is represented

Lane I, shoulder side lane is considered as lane 4. Lanes between median and shoulder side lane in considered as Lane 2 and Lane 3,
Lane Utilization Factor (LUF) is estimated using equation 1. In this study, LUF is defined for each 1 min interval.

$$LUF_i = \frac{V_i}{V} X100 \dots \dots \dots \dots (1)$$

Where,
Vi—Traffic volume for i^{th} lane (veh/hr)
V= Total volume (vehi/hr)
LUFi— Lane Utilization Factor in percentage for i^{th} lane

Stream Speed is measured from trap length of 65 m for each vehicle. Average speed for each category of vehicle besides the stream speed is calculated for given time interval.

2.2 Descriptive Statistics

A comparative evaluation of lane distribution for each lane and each vehicle category is presented in the form of pie charts and bar charts. Furthermore, different models are developed using lane choice as dependent variable and lane utilization factor, vehicle classes and stream speed as independent variable in SPSS.
Lane usage characteristics for different vehicle categories namely car, two wheeler, three wheeler and heavy motorized vehicle (i.e. bus and trucks) are shown in Figure 2. It is observed that majority of cars use 1st lane where as two wheelers and three wheelers prefer 2nd or 3rd lane. Heavy motorized vehicles (HMV) such as buses, trucks choose 4th lane over rest other lanes.
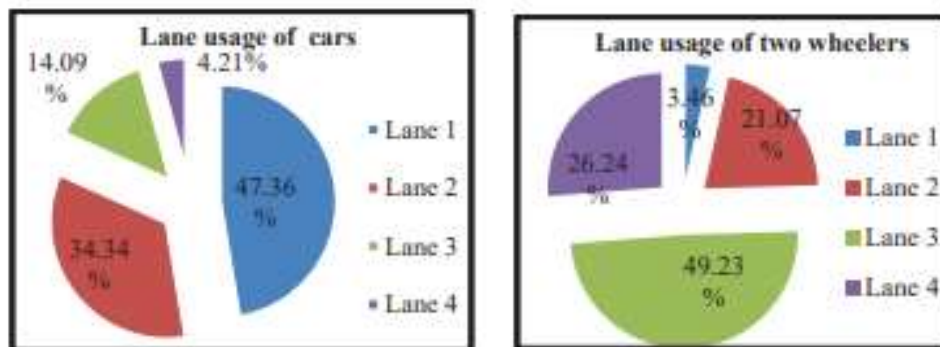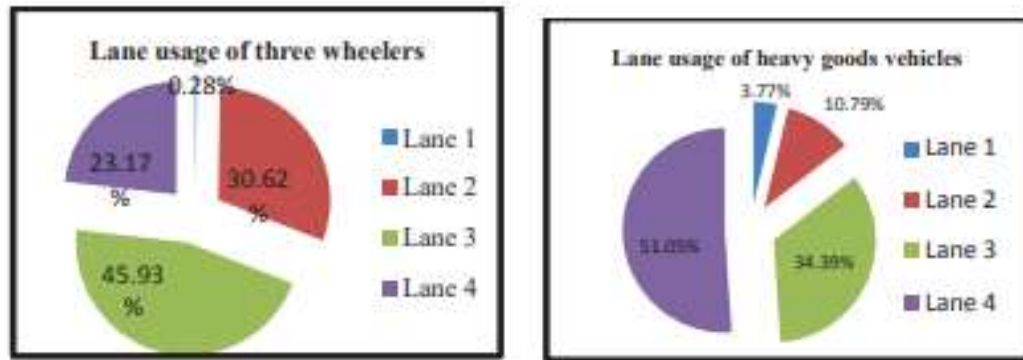
Figure 3:Lane usage of different categories of vehicles

Lane discipline followed by different categories of vehicles on Delhi-Gurgaon Expressway is shown in Figure 3. As far as the lane discipline is concerned, 80.49% of cars, 100% of the bikes, 84.16% of the three wheelers and 78.30% of the heavy vehicles follow the lane discipline.
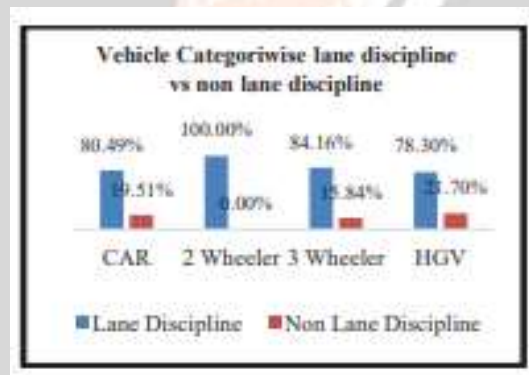

Figure 4:Vehicle category wise lane discipline

In addition to this, vehicle composition for each lane for every one minute interval is estimated.
While cars proportion is highly significant in Lane 1, the share of other vehicles is depicted in the descriptive statistics as shown in Figure 4
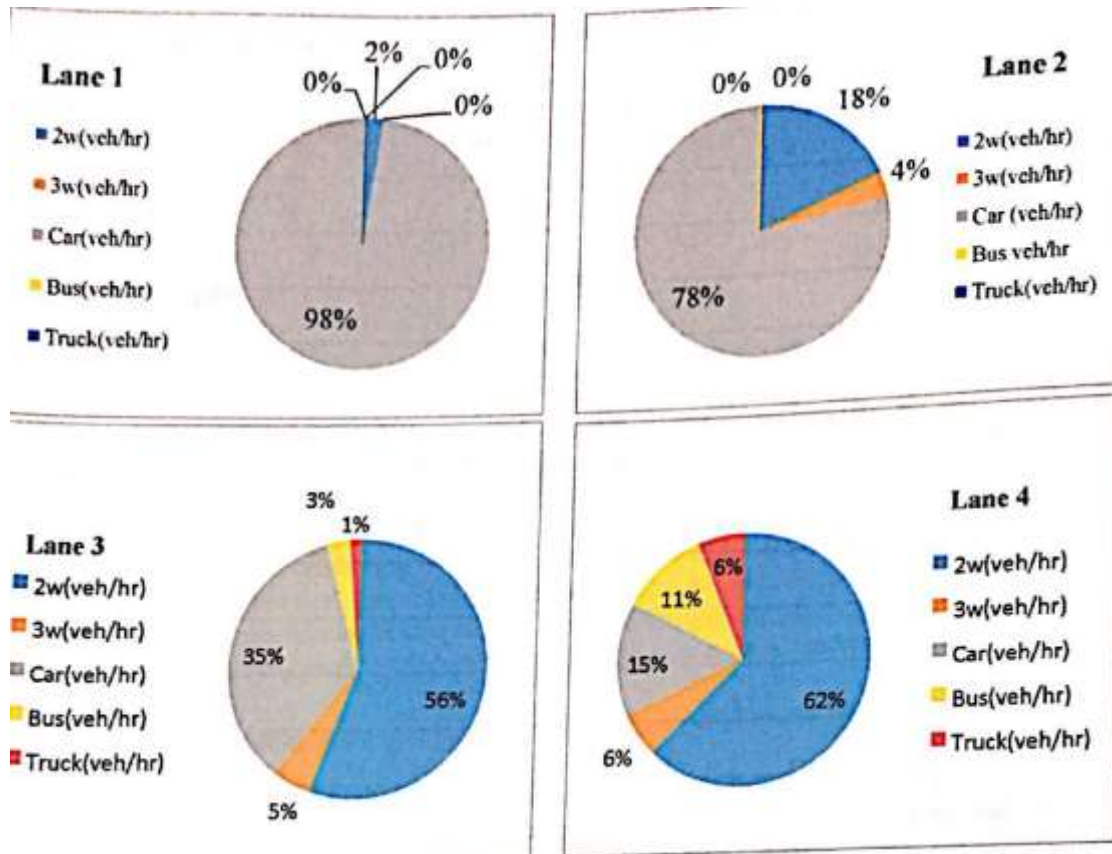
Figure 5:Lane wise vehicle composition

3. MODEL DEVEDOPLMENT

As mentioned earlier, interval of 1 minute was used to find classified volume count. Resulting volume was classified into different vehicle categories namely: car, two wheeler, three wheeler, bus, and truck. For model development vehicle categories namely truck and bus are combined together as Heavy Motorized Vehicles (HMV). Average stream speed as well as observed Lane Utilization Factor was calculated for each 1 minute interval.

Three different models were developed to study lane choice behavior of vehicles on selected. The analysis of data suggests that lane selection of individual vehicle is dependent on lane utilization factor and class of vehicles. Effect of stream speed can also be taken into account. In order to study individual effect of each of the factors, multinomial logit models for lane choice are developed.

In multinomial logit model it is assumed that, the log-odds (preference) of each choice follow linear Model.(Rodriguez, 2007)

$$n_{ij} = \log \frac{\pi_{ij}}{\pi_{ij}} = \alpha_j + x_i \beta_j \ldots \ldots \ldots \ldots (2)$$

Where α_j is a constant and β_j is a vector of regression coefficients, for j— 1, 2, 3... , J-1. J is a base response variable. π_{ij} is a probability of i choosing j-th choice. The original probabilities of selecting each choice are given in Equation (3).

$$\boldsymbol{\pi_{ij}} = \frac{e^{n_{ij}}}{\sum_{k=1}^{j} e^{n_{ij}}} \dots \dots \dots \dots (\mathbf{3})$$

Where j=1,2,3….j

4. CONCLUSIONS

This study evaluates the lane choice behavior of vehicles on Majura-udhna darvaja where high speed vehicle maneuverability is allowed. The lane choice behavior by different vehicle categories is observed well in the descriptive statistics. The multinomial logit models developed show, the significant influence of the roles played by different vehicle categories in choosing the lanes. The model gives better results for predicting lane choice of different vehicle categories if influence of stream speed is considered. In addition to this, it was concluded that the complexity of lane Choosing behavior of vehicles can be represented by Lane utilization factor. This is because lane utilization factor gives aggregate characteristics of traffic on expressway including traffic flow, speed etc.

Thus, the actual lane choosing behavior is replicated through variables such as stream speed and vehicle composition

It was found that high speed vehicles like cars prefer median side lane. However, heavy motorized vehicles like buses, trucks prefer shoulder side lane. Moreover, two wheelers and three wheelers prefer middle (second and third) lane. Thus this study gives the simple and yet scientific approach for predicting the complex lane choice behavior.

5. REFERENCES

[1]May, A. (1990). "Traffic Flow Fundamentals." Prentice-Hall, Englewood Cliffs, NJ

[2]Moriarty, D. and Langley, P. (1998). "Distributed learning of lane-selection strategies for traffic management (Technical Report 98-2). Daimler-Benz Research & Technology Center, Palo Alto, CA

[3]Sagar Kurle , Krishna N. S. Behara , Rajendra Prasad J. , Shriniwas Arkatkarb, Ashoke Kumar Sarkara "Study of Lane Utilization on Delhi-Gurgaon Expressway", Transportation Research Procedia 17 (2016) 674 – 684