International Journal of Latest Engineering and Management Research (IJLEMR)
ISSN: 2455-4847
www.ijlemr.com || Volume 09 – Issue 12 || December 2024 || PP. 28-31

Urban Boulevards in the Investigation of Traffic Flow Parameters: Ankara, Eryaman Road

Dr. Hikmet Bayırtepe[1], Burcu Büşra Koçak[2]

[1]*Associate Professor Dr., Department of Civil Engineering, Faculty of Engineering, Institute of Science, Gazi University, Türkiye*

[2]*Department of Civil Engineering, Faculty of Engineering, Institute of Science, Gazi University, Türkiye*

Abstract: The central boulevards and main arteries of Ankara are monitored by the city security management system (KGYS) within the governorship. It processes direction and lane information with cameras installed at specified points. All vehicles in designated areas are recorded with their passing dates, speeds, direction and lane information, and entry and exit distances to the camera recording. In this study, the data collected from server number 7, section number 125, camera number 88 (right lane) on Eryaman road are organized and used. It aims to reveal traffic characteristics and trends according to directions and lanes for selected sections, after that compare them with each other and observe their similarities and differences. It is thought that the results of this study will contribute to planning by considering the behavior of these segments and to making predictions for other roads with similar characteristics.

Keywords: Traffic Engineering, Traffic Flow Parameters, Statistical Methods

I. Introduction

For these studies, firstly, the KGYS system is applied and the data received from here are processed and modelled. Parameters in traffic modelling studies are divided into two as micro and macro according to the purpose of the study. In the studies of evaluating the elements of the traffic flow, with the measurements we need; microscopic parameters are used to examine independently from environmental factors and to evaluate the elements alone. If the elements that make up the traffic are to be considered and analysed as a whole depending on the relationships between them, the studies are carried out with macroscopic parameters.

II. Parameters

Speed, density and flow are macroscopic parameters. The number of vehicles passing through a given road section per unit time is called 'flow' (q). When the number of vehicles is denoted by 'n' and the time of measurement is denoted by 't', the current formula is calculated as follows.

$$q = \frac{\mathrm{n}}{\mathrm{t}}$$

The distance travelled per unit time is the definition of 'velocity' (v). Speed, which is one of the most important elements of macroscopic parameters, is generally calculated in 2 ways. The instantaneous measured speed of the vehicle at a certain point is called 'time mean speed', and the speed calculated by dividing the length of a certain road section by the travelling time is called 'space mean speed'.

The number of vehicles measured at a given road section at any given moment, independent of the observed time, is called 'density' (k). The length of the road section is called 'x', the number of vehicles is called 'n'and the density is calculated as follows.

$$k = \frac{\mathrm{n}}{\mathrm{x}}$$

Within the scope of this study, the measurements of camera 88 (right lane) of the camera system (Section 125), which is located at the Eryaman entrance of Eryaman Road in the centre of Ankara and which takes recordings for the direction to Eryaman, are examined and the microscopic parameters of this road are studied. The most commonly used microscopic parameters for planning and analysing traffic flows are 'space headway' and 'time headway'.

These microscopic parameters are used to determine the flow behaviour of boulevards with four lanes in the direction of arrival and departure. The trends that will emerge with this condition are compared with each other and their similarities and differences are observed.

III. Methodology

For analysing the traffic flow behaviour, the study starts by obtaining a mixed set of measurements of all lanes from KGYS. Then, the measurements are sorted according to direction and lanes by various methods and sorted according to dates. With this data, vehicle following data tables to be used are created. For the studies on vehicle following, leading (front) vehicle speed (Vf), following (back) vehicle speed (Vb), inter-vehicle speed difference (Vb-Vf) and time headway (ht) values are created with the vehicle measurements in the traffic flow of the lane. Using descriptive statistics for these values, cluster analyses and discriminant analyses are performed and cluster characteristics and relationships are revealed.

IV. Data and Descriptive Statistics

Measurements and studies carried out with the section numbered 125 at the Eryaman entrance of Eryaman Road, the nearside lane lane from which camera number 88 receives data are given.

Variable	Mean	Mean. std. error	St. Dev.	Min.	Median	Max.	Mode	Skewness	Kurtosis
Vb	55.14	0.035	7.32	19.0	56.0	116.0	57	-0.32	1.67
Vf	53.67	0.036	7.56	19.0	54.0	117.0	55	-0.43	1.15
ht	2.29	0.013	2.84	0.00	1.0	28.00	0	2.10	7.44
Vb-Vf	1.45	0.029	6.09	-59.0	0.0	58.00	0	1.09	6.05

Table 1: Descriptive statistics for camera 88 data

Camera 88, which collects data for the nearside lane at section 125, recorded 43 972 vehicle passes during the observation interval. The detailed statistical analysis of this data is given in Table 1. The values are analysed by starting with the speeds (Vb, Vf). The arithmetic mean speed of the leading vehicles is approximately 54 km/h, while the arithmetic mean speed of the following vehicles is approximately 55 km/h. For this lane, the average speed of the leading vehicle is higher than that of the following vehicle. The standard error of the means of the leading and trailing vehicle speed values are very close to each other and are in the 0.04 band. This similarity is also observed in the standard deviation of the two speed groups. The standard deviations of the leading and following vehicle speed values are around 7. These deviations are within acceptable values compared to the average values. The mode, median and arithmetic mean values of both speed values are very close to each other. Therefore, it can be concluded that the distribution of the velocity data is regular. In order to verify this conclusion, the skewness and kurtosis values of the velocity data can also be used. Although these values are also very small, they show that the measurements follow a normal distribution.

When the difference in speeds, which is one of the main parameters, is analyzed, it is observed that the arithmetic mean is 1.45. The standard error is very low at 0.029. The standard deviation is relatively high with a value of 6.09 for the case where the mean is 1.45. Here, the similarity between the mean, median and mode value is lower. This can also be confirmed by the relatively large values of skewness and kurtosis.

The analysis of the main parameters continues with the time d. The arithmetic mean of the time headway between the leading vehicle and the following vehicle is 2.29 s. The standard error of the mean is very low at 0.013 and the standard deviation is relatively high at 2.84. The irregularity indicated by this deviation is also shown by the difference between the mean, mode and median values.

Cluster Name	Number of observations	Sum of squares	Average Distance from the centre	Max. Distance from the centre
Cluster 1	4271	23664.5	2.16	10.48
Cluster 2	2606	48205.8	3.78	20.29
Cluster 3	4741	37688.5	2.54	12.73
Cluster 4	1476	32876.7	3.62	46.15
Cluster 5	4010	20745.3	1.98	12.68
Cluster 6	12498	7544.7	0.63	2.77
Cluster 7	697	42479.1	6.67	33.99
Cluster 8	5538	7657.5	1.05	2.37
Cluster 9	8135	9424.0	0.82	3.66

Chart 2: Analyses of Clusters

The summary information of the 9 groups separated by clustering analysis to better understand the behaviour of the data is as shown in Chart 2. Here, the number of data in each group, the average distance from the centre and the maximum distance from the centre are given. The sum of squares column is determined by the sum of squares of the difference in speeds and time headway values of all vehicles in the group, leading and following. Group 6 has the highest data in terms of observation values. Group 7 has the least data. Group 6 has the lowest mean centre distance. Group 6 data also gives the lowest value in the maximum distance value with 2.77. The highest mean distance from the centre value is observed in group 7, while the highest maximum distance value is in group 4. The highest distance values are determined in the groups with the lowest number of observations

Parameter	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Cluster 9	Main Cluster Centre
ht	3.59	6.47	4.27	3.23	4.97	0.25	11.94	1.74	0.32	2.29
Vb-Vf	-4.70	14.26	7.38	-12.96	1.93	-0.33	24.94	-0.25	1.39	1.45

Chart 3: Cluster Centres

Chart 3 shows the cluster centres for the velocity difference and time headway values for the measurements within the group. In the last column, the main cluster centre values covering all data are given. According to these values, group 6 and group 9 centres are closest to each other in terms of temporal range. In addition, group 8 is the closest to the main cluster centre. According to the velocity difference, the closest centred groups are group 6 and group 8. The closest to the main centre is group 9.

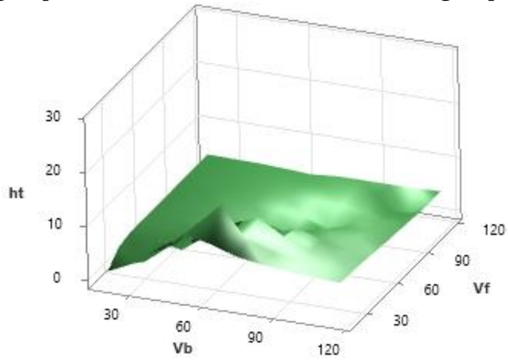

Figure 1: Surface Chart For Vf And Vb Data

For the surface chart, velocities are positioned on the horizontal axes as in the scatter plot. Temporal interval values are used on the Z axis, i.e. as height. It is possible to make the same observations as in scatter Plot. In the intervals where the difference between the leading vehicle speed and the following vehicle speed is close to "0", the time headway also take their minimum values. On the other hand, in the area where the speeds of the vehicle coming from behind are around 60 km/h and the vehicle travelling in front is around 45 km/h, the heights, i.e. the time headway values increase.

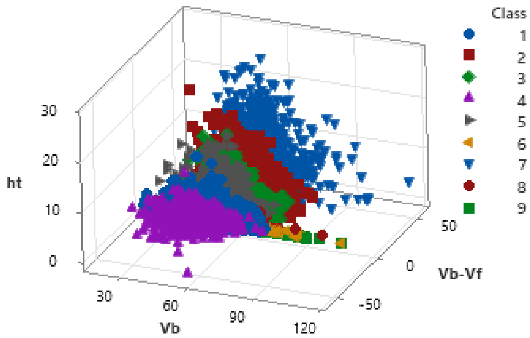

Figure 2: Scatter Plot of Vf and Vb data

In the analysis of the main parameters, 3D scatter plots are prepared in order to see the relationships between the data and to see the spread of these data within the values. All data within the 9 groups are marked here. By using different colours for each group, it becomes possible to evaluate between groups. In this graph, the difference in velocities and the time headway value are placed on the horizontal plane. The following vehicle speed is preferred to be analysed in the vertical plane. The reason for this is that while there is no restriction for the movement of the vehicle in front, the vehicle coming from behind has different behaviours compared to the vehicle in front. When the graph is analysed, it is seen that group 7 data is the most spread out. In the part where the speed difference is close to 0, the data in group 3, group 5 and group 8 are more concentrated.

V. Conclusions and Assessments

Working with data clustered in line with the determined criteria gives us more significant results. The initial distribution of the group is observed with the number of elements of the clusters prepared with these criteria. After that, assessments are made with the behaviour of these cluster elements in other parameters. After the lane is evaluated within itself, the study background is prepared for modelling the city centre traffic flow by comparing other lanes, other directions and finally other similar arteries.

VI. Literature Review

These topics and parameters that we have studied have been discussed many times before in scientific articles and theses within the framework of transport-traffic engineering, and their differences have been underlined. There are still ongoing researches to observe vehicle speed and tracking information and to improve urban transport standards.

If we look at the first period of these studies, 'A Study OfTraffic Capacity' (1935) by Greenshields and Brooks appears before us. This study made inferences for capacity calculation, speed, density and intervals between vehicles based on measurements made on a two-lane road section.

In 2007, in Maimon's study 'Learning Headway Estimation in Driving', vehicle following modelling was again performed. The main focus of this study is to find the safe temporal intervals required for vehicle following of drivers and it has provided guiding findings on this subject.

K. Liu, P. Green and Y. Liu's (2019) study titled 'Traffic and Ratings of Driver Workload: The Effect of the Number of Vehicles and Their Distance Headways' aimed to conduct more detailed studies on a similar basis. This was done by conducting tests on drivers with different characteristics and examining the load, i.e. the effort expended, of these drivers in traffic in different situations and conditions.

Recently (2023), Yinlong and his research team compared kinematic-centric, psychological-centric and dynamic flow-centric vehicle following models according to the vehicle following behaviour and revealed the strengths and weaknesses of different models. In addition, they used vehicle following models in harmony with the latest technology and emphasised that artificial intelligence can improve vehicle following models and help in solving complex vehicle following behaviours.