Pakistan Geographical Review, Vol.75, No2, December. 2020, PP 234-263

IMPACT OF A NON-DEDICATED U-TURN ON TRAFFIC: A CASE STUDY OF PHASE-III CHOKE, PESHAWAR CITY, PAKISTAN

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ABSTRACT

Non-dedicated U turn has a direct effect on road safety, capacity and congestion during the traffic flow. U turn can have significant supemacey on traffic flow and headway. Therefore to study the impact of non-dedicated u turns on traffic is the ultimate requirement of the current time. This is a microscopic traffic study in which the data from a U turn (33°59’48.2"N 71°27’30.2"E) on road leading to Hayatabad and Karkhano in Peshawar is evaluated in terms of headway, speed and flow rate of traffic. Factual data is presented which shows that the average time headway surges when the traffic is interfered by the U turning vehicles. The probability density functions and cumulative density functions fit to the datasets of headway are then evaluated by the techniques of anova analysis to determine which distribution is the most suitable one for the data. Distribution data specific with the interfering U turn was taken in a separate set and evaluated. The result obtained show that the Burr Distribution and Generalized Extreme Value Distribution are the optimum to illustrate the headway data of traffic being interfered by U turning vehicles. This ligitimize the utilization of various time headway distributions of vehicles being interfered by U turning for traffic modeling.

KEYWORDS: Non- Dedicated U turn, Time Headway, Headway Distributions, Probability Density Functions, Cumulative Density Functions.

1. INTRODUCTION

On the road while driving the driver not only acts as a controller, but also the vital umpire of the quality of the path that is being followed. The chain followed by researchers in driving behavior is known as driver-vehicle-road system. Driver is the weakest part of the driver-vehicle-road system because of the variation of driving experiences, emotions, driving predilection and so on between drivers. And different scenarios shows distinguishable behaviors also called driving style. Drivers’ characteristics are identified based on the operation behavior of the vehicle. While driving a vehicle, the driver has his/her own intention and selects a pattern of driving behavior that are most suitable for the current driving conditions U turns are used as open areas for two ways traffic flow on the road mostly set at the middle of the road section. U turn behaviors of vehicles have monumental impact on the traffic performance. Normally straight vehicle should have priority over U turning vehicles because straight moving vehicles suffers more during the congestion caused by the queues of the U turning vehicle which in turn affect the smooth flow of traffic The absence of U turns or medians at the required points on road sections does not allow the drivers to turn and move along in the opposite direction. Thus the drivers generally find other ways to turn or make a u turn in the road section where it is normally not allowed. Such factors considerably elevate the risk of accidents with other vehicles (while making a U turn) forcing the rear vehicle to decelerate or change their direction. But the composition of a dedicated U turns is complicated as it compromises the width of the road as well as tendencies of the vehicle to move to the first lane which generally acts as a fast speed lane. The fast speed lane has the opportunity to take a U turn. This causes congestion of vehicles (Lin et al. 2014).

Peshawar is progressively transforming into a city of congested traffic and ill traffic management issues due to existence of high demand of traffic while the road infrastructure remains the same without necessary improvements. It was noted that in the period 1998-2000, the proportion increase in the number of vehicles was 124.6 percent , while the expansion and developments in the road network was 0.85 percent. in that 124.6 percent, majority belong to a group of private car holders, which constitute 75.35 percent of the total vehicles (Ali et al. 2012).

The factors that influence the road traffic are driver’s behavior, size and shape of the road and the land use in case the bordering properties are occupied. When the bordering properties along the roads are occupied, then the infrastructure administrators have to face difficulties acquiring that land for necessary improvements in the road infrastructure. The characterization of driver’s behavior, road geometry and land use into numerical verbalization or mathematical models is difficult because of their dependence on each other and their abnormality because the conditions are not ordinary every time (Chang et al. 2007).

(Zhang et al. 2007) Presented a comprehensive study on performance of distribution models for headways. Precise data regarding headway was gathered on a highway in Seattle (USA). That data was used to examine the performance of different headway models. Vehicle headway distribution is fundamental for several significant traffic research and simulation issues. Numerous headway models are characterized over the previous decades. Every one of them has its own quality and shortcoming under certain conditions. In some cases, the observations fits well in distribution while in other cases the fitness value of observation crosses the range and does not fit well to the same distribution. Determination of the most reasonable model for a specific traffic condition stays an open issue. Vehicle headway is a measure of space between two vehicles, and is characterized as: the elapsed time between the appearance of the main vehicle and the accompanying vehicle at an assigned test point. It is normally estimated in seconds. Since the headway is the reciprocal of flow rate, vehicle headways represent microscopic measures of flows passing a point. In other words, headway characterizes the roadway capacity. Accurate and adequate characterization of vehicle headway distribution is required to amplify roadway capacity and reduces the travelling time.

(Liu et al. 2005) studied U turns showing that distance between two vehicles significantly impacts safety on street segments between driveways and downstream U-turn locations; a 10 percent increase in separation distance will result in a 3.3 percent decrease in total crashes and a 4.5 percent decrease in crashes which are related with right-turns followed by U-turns.

Zhou et al. (2003) examined vehicle operations for right turns followed by U-turn movements on urban and suburban multi-lane roadways. A model was developed that could serve as guide for U-turn median location by minimizing the mean delay for U-turn movements. This case study demonstrates operations and safety improvements of ideal U-turn median design.

During traffic alignment at u turns, congestion occurs, which affects headway. Best fit distribution is required to assess the variation in headway in different lanes of a road when a u turning vehicle is noticed. Best fit distributions development is significant for predicting heterogeneous traffic.

This research is an attempt to explore driver behavior specifically moving straight and is not intending to take the u turn. More it can help in the amelioration of current systems for the U turn systems as it will provide an idea about working of the existing U turns and its impact on the straight moving vehicles. It is therefore, the main objectives for this study includes the impact of straight moving vehicles when interfered by a u turning vehicles and secondly, the interpretation of a driver when he/she notices a u turning vehicles in front of him/her.

2. MATERIAL AND METHODS

2.1. The Study Area

The study area selected was the U turn near Bab e Peshawar (phase 3 flyover of Hayatabad), Peshawar, (33°59’48.2”N, 71°27’30.2”E) Pakistan shown in figure 1. It is a three-lane road with the one lane that is mostly used as overtaking lane and in most cases considered by the vehicles taking the U turn. The speed limit on this highway is 40 kilometers per hour (km/h). The location of the data collection point on Google maps is shown in Figure 1. This section of highway is free of emergency refuge areas, ramps, and bus stops as well as traffic lights, so there is no obstruction for U turning vehicles.

2.2. Data Collection

Video recording was used to collect the headway data. Cameras were installed on the top of the Bab-e-Peshawar Bridge. The two reference lines for vehicles ingress and egress were marked for the detection of vehicles. The two lines are 40 meters apart which can be easily distinguished in the video. These reference lines are indicated in Figure 2.

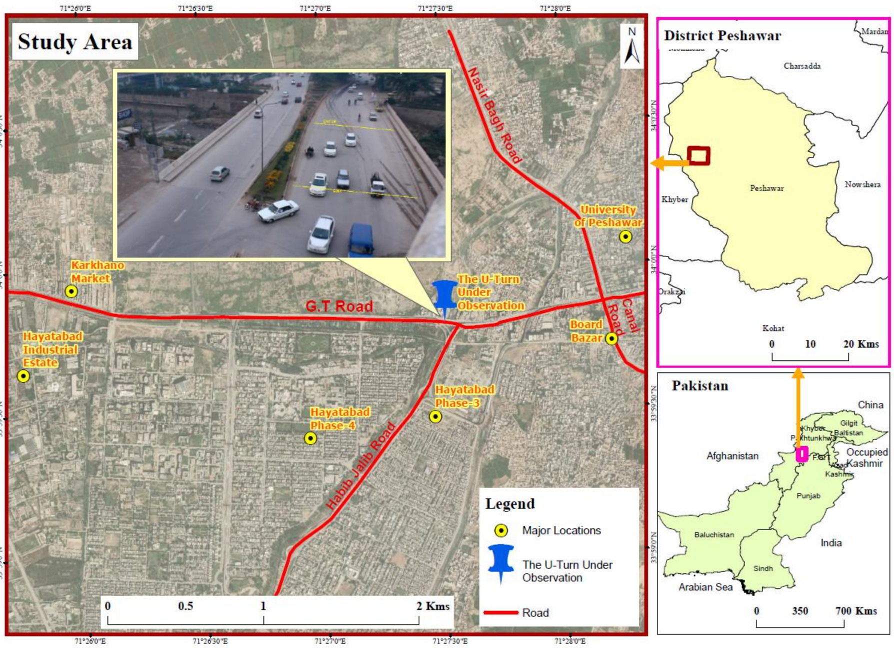


Figure 1: Location of the study area

Figure 2: Satellite Image of the U turn

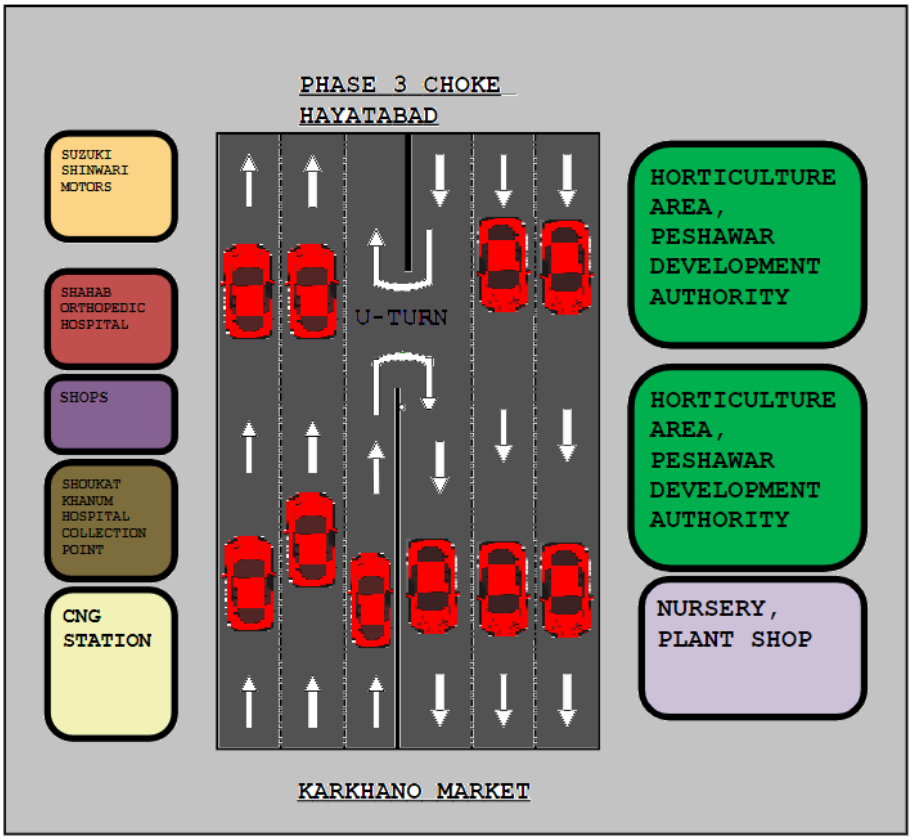


Figure 3: Schematic Diagram of the U turn

2.3 Data analysis and presetation

The video was recorded at a rate of 25 frames per second which is the required frame rate for a video that is to be processed by the software.

Traffic data such as speed of vehicles and time headway was extracted with software (CAMLYTICS). Information such as the vehicle headway, and vehicle speed was obtained. The time headway was determined as the difference between the time when the first car passes the enter mark and then the second, third and so on. As vehicle speed is defined as the time taken by a vehicle to cover a known distance. In this case the 40 meters is the distance and the duration of time is the times travelled by a vehicle from enter mark to exit, so the distance 40 meters is divided by that elapse time which gives speed. v=s/t v Is the speed,s is the distance between the two marks which 40 meters and t is the time taken for car to travel between to marks. The headway data sets were than process through easyfit software to find the bestfit distribution for the data and than the most probable and realistic outcome was determined in the basis of the suitable distribution. The straight moving vehicles reduce their speed when congestion becomes active.

3. ANALYSIS, RESULTS AND DISCUSSION

3.1 Best Fit distribution

“Distribution fitting is the process of selecting a statistical distribution that best fits to a data set generated by some random process. In other words, if some random data available and the researcher would want to know the type of distribution that could be best in describing the data. Best fit distribution process is used in actuarial science, risk analysis and reliability engineering etc” (Walpole et al. 2012). To find the best headway distribution, the nine function described previously were used to model each headway dataset. The best fit distribution was done on easyfit software. The CDF of Figure 4 shows 85 to 90 percent probability for vehicles having headway less than 4 s and 10 to 15 percent probability for headway greater than 4 s. the PDF and CDF indicates that Burr and Generalized Extreme Value Distribution fit the data.

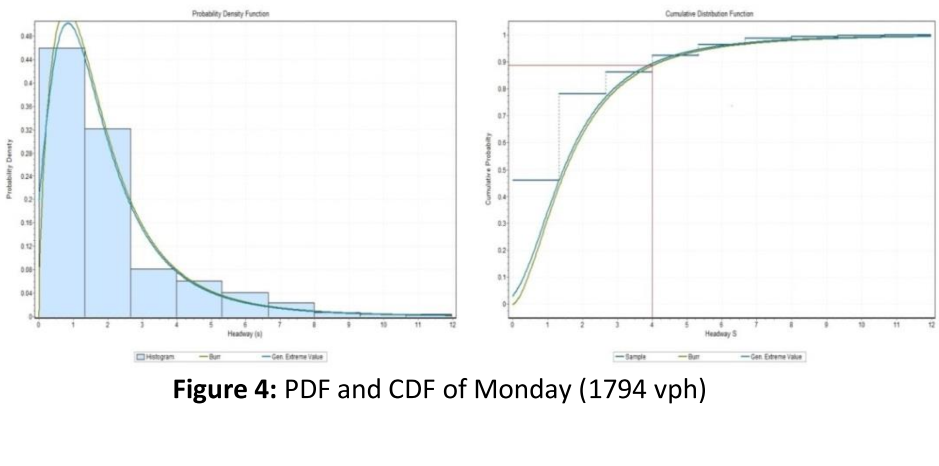


Figure 4: PDF and CDF of Monday (1794 vph)

The CDF of figure 5 shows 85 to 90 percent probability for vehicles having headway less than 4 s and 10 to 15 percent probability for headway greater than 4 s. The PDF and CDF indicate that Gamma, Weibull and Generalized Extreme Value Distribution fit the data.

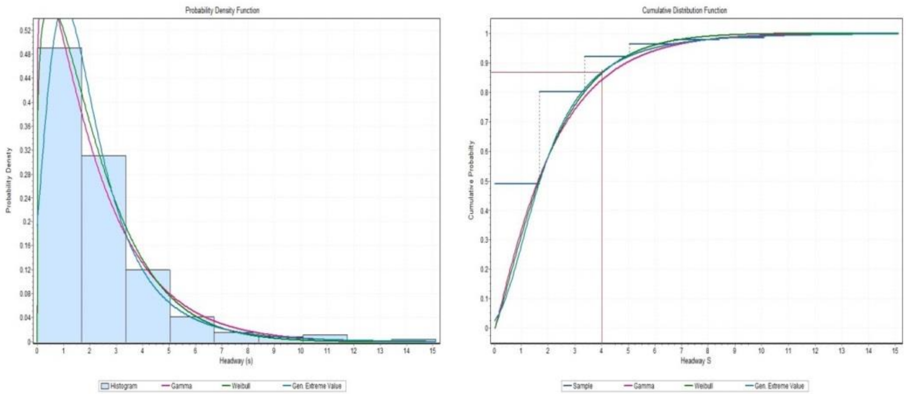


Figure 5: PDF of Tuesday (1608 vph)

The CDF of figure 6 shows 90 percent probability for vehicles of headway less than 4 s and 10 percent probability for vehicles having headways greater than 4 s. It is also observed that Generalized Extreme Value Distribution fits the data.

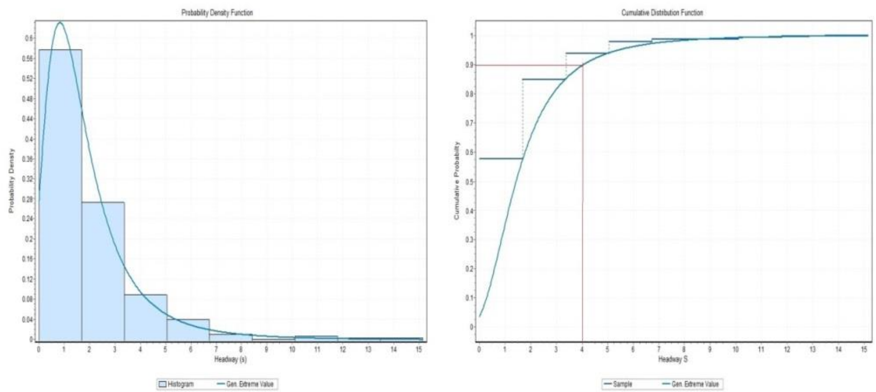


Figure 6: PDF and CDF of Wednesday (1836 vph)

The CDF of figure 7 shows 80 to 90 percent probability for vehicles having headway less than 4 s and 10 to 20 percent probability for headways greater than 4 s. the PDF and CDF depicts that Burr and Generalized Extreme Value Distribution fit the data.

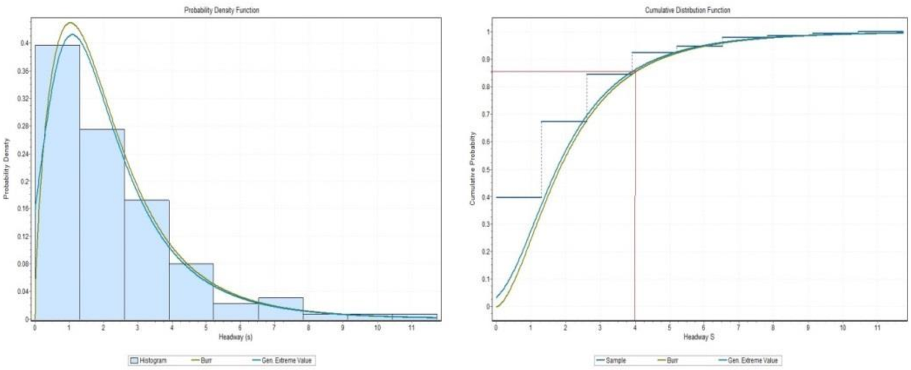


Figure 7: PDF and CDF of Thursday (1578 vph)

The CDF of figure 8 shows 80 percent probability for vehicles having headway less than 4 s and 20 percent probability for headways greater than 4 s. It is also observed from the PDF and CDF that Burr and Generalized Extreme Value Distribution fit the data.

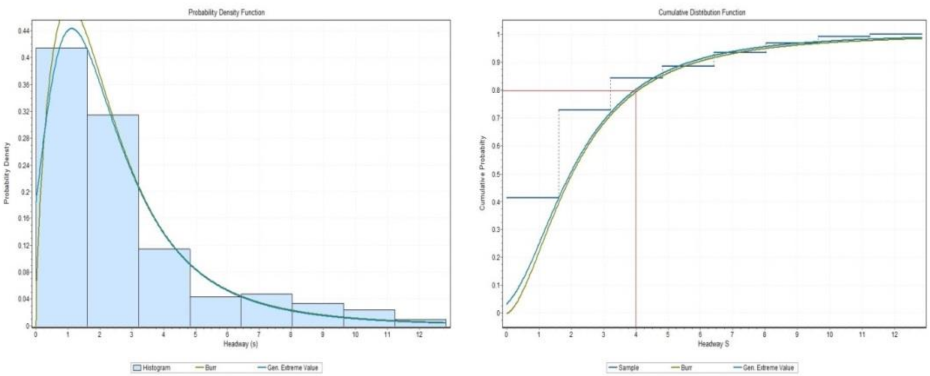


Figure 8: PDF and CDF of Friday (1266 vph)

The CDF of figure 9 shows 30 percent probability for vehicles having headway less than 4 s and 70 percent probability for headways greater than 4 s. It is also observed that Burr and Generalized Extreme Value Distribution fit the data.

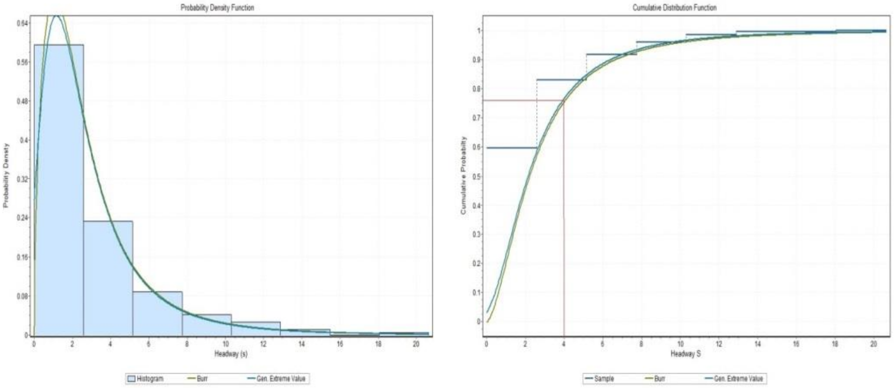


Figure 9: PDF and CDF of Saturday (1165 vph)

The CDF of figure 10 shows 30 percent probability for vehicles having headway less than 4 s and 70 percent probability headways greater than 4 s. It is also observed that Burr and Generalized Extreme Value Distribution fit the data.

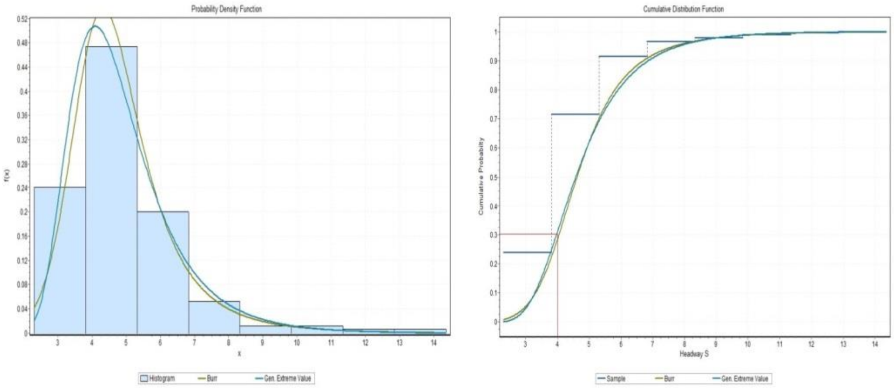


Figure 10: PDF and CDF of Sunday (1015 vph)

3.2 Goodness of Fit

To determine well a distribution fits to datasets of observations, the goodness of fit test is used. To evaluate how well the distributions fit the headway datasets, three goodness of fit tests are used here (Cowan 1975). Quantile-quantile (Q-Q) plot is determined that indicated the graphical closeness of the data to the specific distribution. At first the dataset is arranged in ascending order (Massey et al. 1951). Then the data is plotted against $F^{-1}([i-0.5]/n)$, where F is the Cumulative Density Function. If the points of Q-Q plots are align with a 45 degree line, then it is confirmed that the data sets are taken from the distribution for which it is tested. Figures (10-24) show that Q-Q plots of the analyzed nine distributions for data sets. If in the Q-Q plot the data is aligned to the 45 degree line, so distribution is considered the best fit. Figure 11 and 12 shows Q-Q plots for distributions for the headway data of Monday. The data is aligned with the 45 degree line for Burr Distribution and Generalized Extreme Value Distributions are the best fit for the headway data sets of Monday.

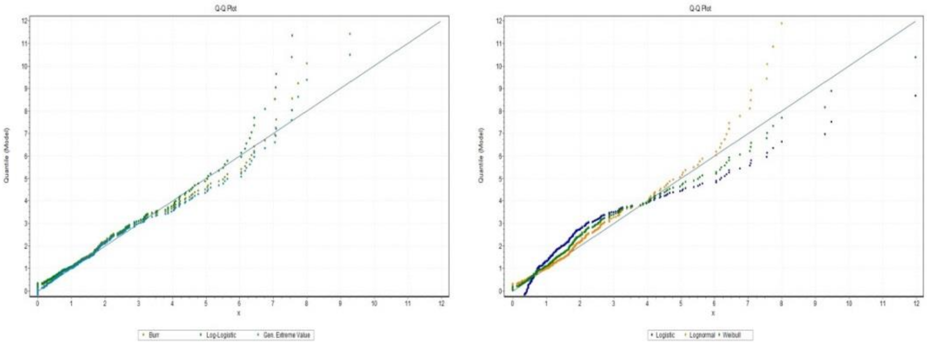


Figure 11: QQ plots for Monday (1794 vph) of Burr, Loglogistic, Generalized Extreme Value, Logistic, Lognormal And Weibull Distribution

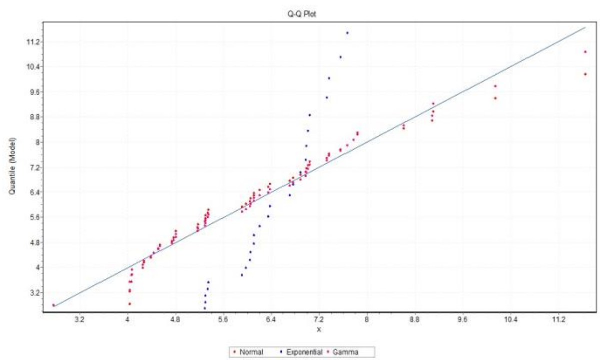


Figure 12: QQ plots for Monday (1794 vph) of Normal, Exponantial and Gamma Distribution

Figure 13 and 14 shows Q-Q plots for distributions for the headway data of Tuesday. The data is approximately aligned with the 45 degree line for Burr Distribution and Generalized Extreme Value Distributions are the best fit for the headway data sets of Tuesday.

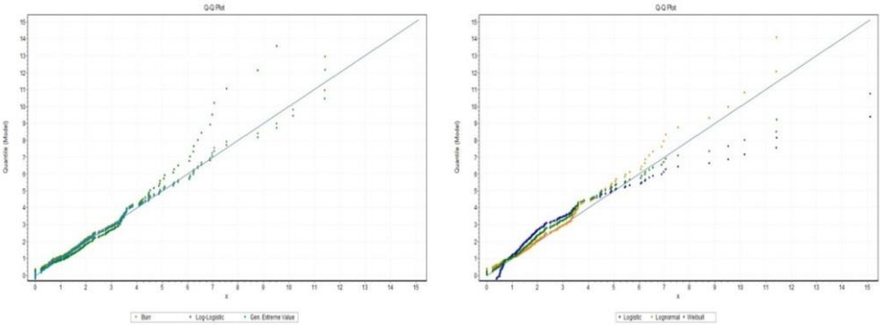


Figure 13: QQ plots for Tuesday (1608 vph) of Burr, Loglogistic, Generalized Extreme Value, Logistic, Lognormal And Weibull Distribution

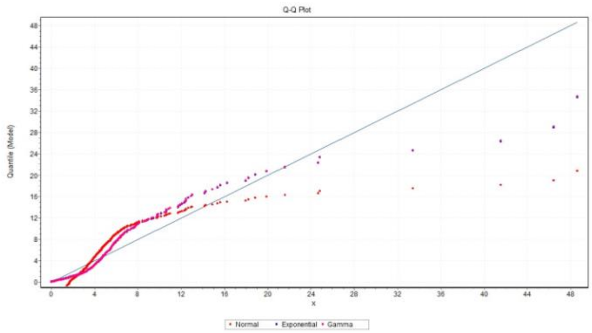


Figure 14: QQ plots for Tuesday (1608 vph) of Normal, Exponantial and Gamma Distribution

Figure 15 and 16 shows Q-Q plots for distributions for the headway data of Wednesday. The data is aligned with the 45 degree line for Burr Distribution and Generalized Extreme Value Distributions are the best fit for the headway data sets of Wednesday.

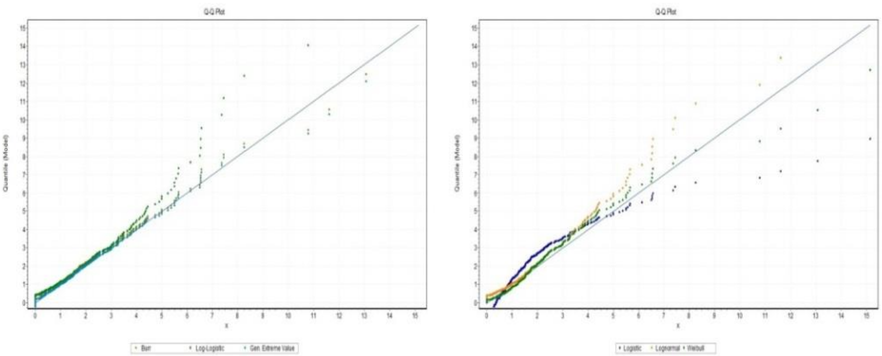


Figure 15: QQ plots for Wednesday (1836 vph) of Burr, Loglogistic, Generalized Extreme Value, Logistic, Lognormal And Weibull Distribution

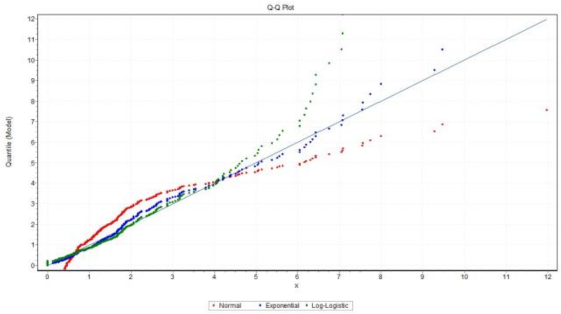


Figure 16: QQ plots for Wednesday (1836 vph) of Normal, Exponantial and Gamma Distribution

Figure 17 and 18 shows Q-Q plots for distributions for the headway data of Thursday. The data is aligned with the 45 degree line for Burr Distribution and Generalized Extreme Value Distributions are the best fit for the headway data sets of Thursday.

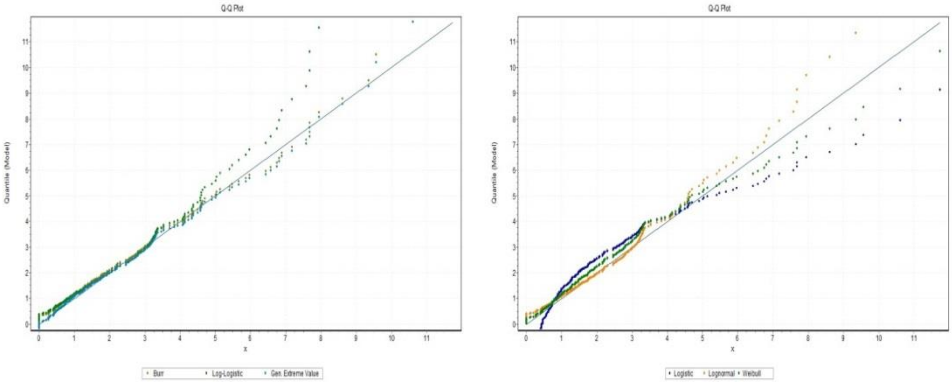


Figure 17: QQ plots for Thursday (1578 vph) of Burr, Loglogistic, Generalized Extreme Value, Logistic, Lognormal And Weibull Distribution

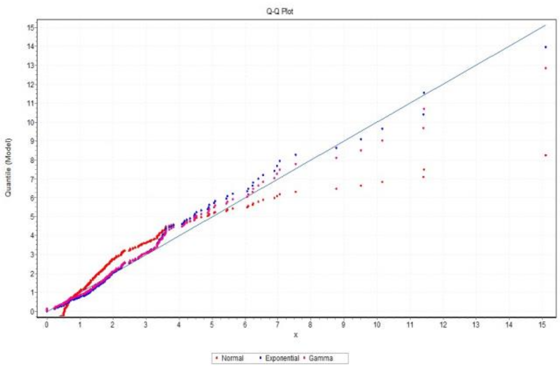


Figure 18: QQ plots for Thursday (1578 vph) of Normal, Exponantial and Gamma Distribution

Figure 19 and 20 shows Q-Q plots for distributions for the headway data of Friday. The data is aligned with the 45 degree line for Burr Distribution and Generalized Extreme Value Distributions are the best fit for the headway data sets of Friday.

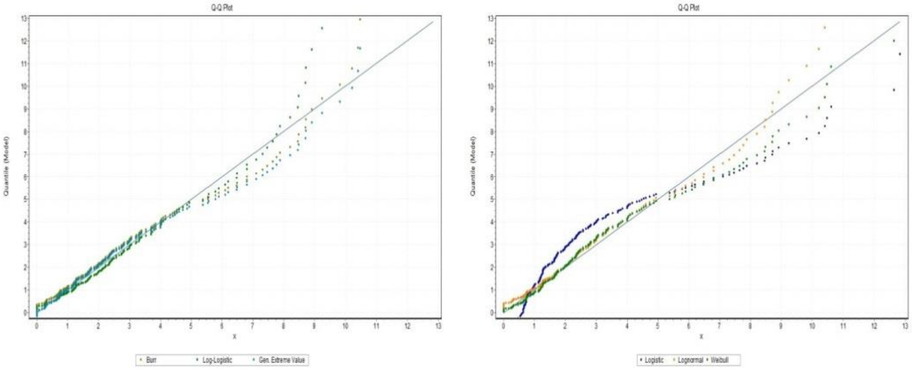


Figure 19: QQ plots for Friday (1266 vph) of Burr, Loglogistic, Generalized Extreme Value, Logistic, Lognormal And Weibull Distribution

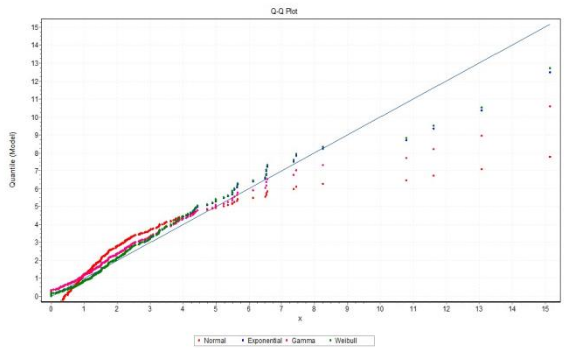


Figure 20: QQ plots for Friday (1266 vph) of Normal, Exponantial and Gamma Distribution

Figure 21 and 22 shows Q-Q plots for distributions for the headway data of Saturday. The data is aligned with the 45 degree line for Burr Distribution, so Burr Distribution the best fit for the headway data sets of Saturday.

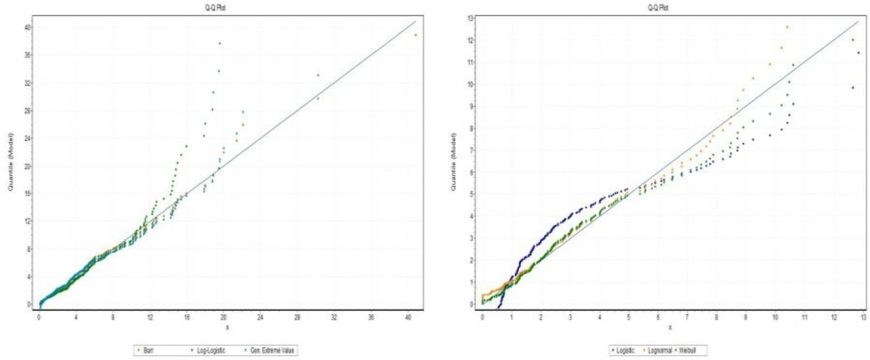


Figure 21: QQ plots for Saturday (1165 vph) of Burr, Loglogistic, Generalized Extreme Value, Logistic, Lognormal And Weibull Distribution

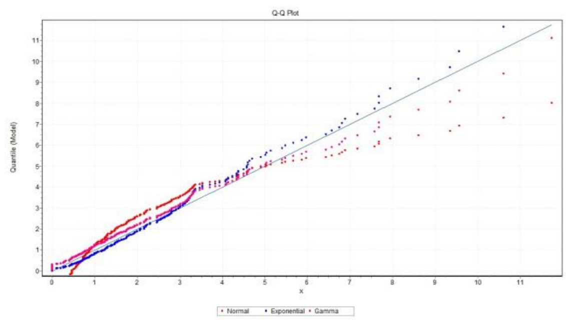


Figure 22: QQ plots for Saturday (1165 vph) of Normal, Exponantial and Gamma Distribution

Figure 23 and 24 shows Q-Q plots for distributions for the headway data of Sunday. The data is aligned with the 45 degree line for Burr Distribution and Generalized Extreme Value Distributions are the best fit for the headway data sets of Sunday.

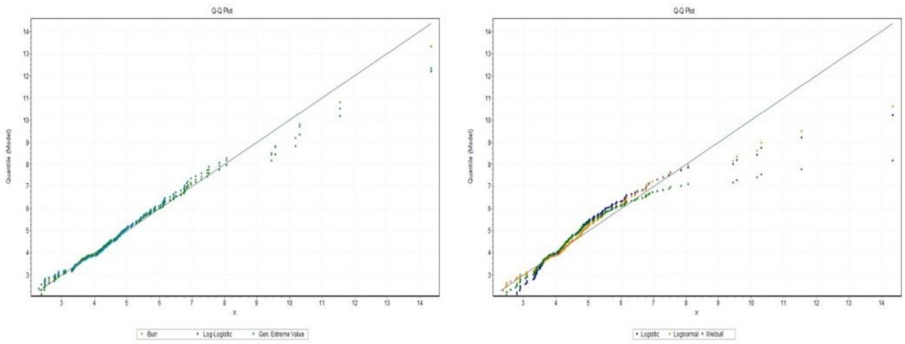


Figure 23: QQ plots for Sunday (1015 vph) of Burr, Loglogistic, Generalized Extreme Value, Logistic, Lognormal And Weibull Distribution

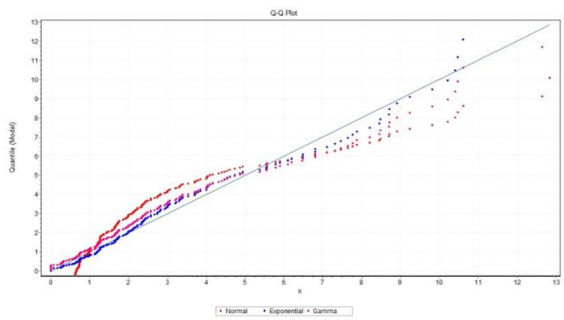


Figure 24: QQ plots for Sunday (1015 vph) of Normal, Exponantial and Gamma Distribution

Comparison of Q-Q plots for the data set shows that Burr Distribution and Generalized Extreme Value Distribution better fit the data set compared to other data sets. The non-linear shape of the Q-Q plots of all datasets for Log-logistic Distribution, Lognormal Distribution, Logistic Distribution, Weibull Distribution, Exponential Distribution, Gamma Distribution and Normal Distribution suggests that are not suitable for modeling the headway data. For numerical results to be supported by the visual evaluation, two statistical goodness of fit test are used. The Chi-Squared (C-S) and Kolmogorov-Smirnov (K-S) tests are used to examine the goodness of fit of a distribution (Das et al. 2017).

3.3 The Kolmogorov-Smirnov (K-S) Test

The K-S test compares the empirical cumulative density function with the cumulative density function. For a data suppose x1,x2,x3,…….xn, the empirical cumulative density function is

$$S_n(x) = k/n$$

Where k is the number of observation less than or equal to x. The K-S formula is (Massey et al. 1951):

$$d =_x^{max} |F(x) - S_n(x)|$$

d is the absolute difference between cumulative density function and empirical cumulative density function for the entire data set. A significance level of 5 percent is set to test the hypothesis below H0: the data is from the distribution, H1: the data is not from the distribution For testing of the hypothesis, the p value of the K-S statistic is compared with significance level. The expression for the p value is .

$$p = d\sum_{j=1}^{|n(1-d|} \binom{n}{j}(1-d-\tfrac{j}{n})^{n-j}(d+\tfrac{j}{n})^{j-1}$$

If the value of p is greater than 5 percent, than the distribution is considered to be accepted by the goodness of test, and if the p value is less than 5 percent than the distribution is rejected (Kloke et al. 2014).

3.4 The Chi-Squared (C-S) Test

The Chi-Squared (C-S) test is also a statistical test that checks that goodness of fit for distributions. The C-S test determines that whether or not the dataset comes from a probability distribution. The data is preprocessed to reduce the effects of minor observations error the original data is replaced by it representative in interval (bin), therefore the data is divided in to N bins. The results from the goodness of fit tests are dependent on the bin size. The value from the data that falls into each bin is compared to the values that are expected for that bin. Any distribution that has a cumulative density function can be checked with the C-S test. The Chi-Squared (C-S) test determines whether there is significance difference between the expected values and observed values. The expression for the Chi-Squared (C-S) test is (Kloke et al. 2014):

$$X^2 = \sum_{i=1}^{N} \frac{(O_i - E_i)^2}{E_i}$$

Where N is the number of bins Oi is the frequency observed for the ith bin and Ei is the expected frequency. A statistical software called easyfit recommends $\mathrm{N} = \sqrt[3]{2n}$ to be optimum. (Harrell et al. 2000)The Expression for Ei is

$$E_i = n \times \ P_i$$

With$P_i = P[x_i < x < x_{i+1}] = F(x_{i+1}) - F(x_i)$ Where Pi is the value for probability that falls in the ith bin, F is the cumulative density function of the distribution, and the boundaries of ith bin are $x_{i+1}$and x_i. The hypotheses for the test are H0: There is no difference accountable between expected and observed data, H1: There is difference between the expected and observed data 5 percent significance level was set for the hypothesis testing of a distribution by the comparison of the test statistic to a critical value with N-k-1 degrees of freedom where k is the number of parameters the P value for the C-S statistic (X^2) is (Kloke et al. 2014):

$$p = 1 - F_{X^2}(X_0^2; N-k-1)$$

[h!] Where $F_{X^2}(.N-k-1)$ if the cumulative density function of X^2 distribution with$\mathrm{N-k-1}$ degrees of freedom and $X_0^2$is the C-S statistics. Greater p value represents high compatible distribution for a dataset.

Table 1: Goodness of Fit Test Results For Headway Data

Probability Distribution	Data Set	Chi-Squared Test	P	Kolmogorov-Smirnov Test	P
Burr	Monday (45 v/km)	Accepted	0.06773	Accepted	0.10176
	Tuesday (31 v/km)	Accepted	0.54435	Accepted	0.72907
	Wednesday (63 v/km)	Rejected	0.00675	Accepted	0.12832
	Thursday (56 v/km)	Accepted	0.05505	Rejected	0.0471
	Friday (61 v/km)	Accepted	0.05611	Rejected	0.03505
	Saturday (54 v/km)	Accepted	0.38877	Accepted	0.20305
	Sunday (43 v/km)	Accepted	0.82647	Accepted	0.44223
Generalized Extreme Value	Monday (45 v/km)	Accepted	0.58663	Accepted	0.79181
	Tuesday (31 v/km)	Accepted	0.98185	Accepted	0.91071
	Wednesday (63 v/km)	Rejected	0.03808	Accepted	0.81808
	Thursday (56 v/km)	Accepted	0.55238	Accepted	0.69126
	Friday (61 v/km)	Accepted	0.87556	Accepted	0.77533
	Saturday (54 v/km)	Accepted	0.82193	Accepted	0.89393
	Sunday (43 v/km)	Accepted	0.89582	Accepted	0.89498
Log-Logistic	Monday (45 v/km)	Accepted	0.11654	Rejected	0.02658
	Tuesday (31 v/km)	Accepted	0.41606	Accepted	0.41435
	Wednesday (63 v/km)	Rejected	0.02898	Rejected	0.02393
	Thursday (56 v/km)	Rejected	0.00812	Rejected	0.01512
	Friday (61 v/km)	Rejected	1.21E-04	Rejected	0.00289
	Saturday (54 v/km)	Accepted	0.34111	Accepted	0.0927
	Sunday (43 v/km)	Accepted	0.46548	Accepted	0.15505
	Tuesday0 (40 v/km)	Accepted	0.67652	Accepted	0.27383
Lognormal	Monday (45 v/km)	Rejected	0.03081	Rejected	0.03309
	Tuesday (31 v/km)	Accepted	0.49344	Accepted	0.34134
	Wednesday (63 v/km)	Accepted	0.1169	Accepted	0.28077

	Thursday (56 v/km)	Rejected	0.00537	Accepted	0.06098
	Friday (61 v/km)	Rejected	0.01096	Rejected	0.01809
	Saturday (54 v/km)	Accepted	0.16619	Accepted	0.17747
	Sunday (43 v/km)	Accepted	0.84843	Accepted	0.29789
Logistic	Monday (45 v/km)	Rejected	2.41E-04	Rejected	2.78E-04
	Tuesday (31 v/km)	Rejected	3.73E-09	Rejected	1.85E-04
	Wednesday (63 v/km)	Rejected	1.07E-08	Rejected	6.61E-09
	Thursday (56 v/km)	Rejected	3.04E-06	Rejected	5.17E-06
	Friday (61 v/km)	Rejected	1.04E-08	Rejected	2.27E-07
	Saturday (54 v/km)	Rejected	3.97E-04	Rejected	1.98E-04
	Sunday (43 v/km)	Rejected	5.18E-09	Rejected	1.07E-06
Weibull	Monday (45 v/km)	Accepted	0.22284	Accepted	0.10268
	Tuesday (31 v/km)	Accepted	0.05805	Accepted	0.2974
	Wednesday (63 v/km)	Rejected	0.00683	Accepted	0.25343
	Thursday (56 v/km)	Accepted	0.45111	Accepted	0.37816
	Friday (61 v/km)	Accepted	0.08764	Rejected	0.00881
	Saturday (54 v/km)	Accepted	0.5027	Accepted	0.19445
	Sunday (43 v/km)	Accepted	0.16021	Rejected	0.03574
Exponential	Monday (45 v/km)	Accepted	0.06943	Rejected	0.0168
	Tuesday (31 v/km)	Rejected	2.48E-06	Rejected	3.69E-05
	Wednesday (63 v/km)	Rejected	5.96E-04	Accepted	0.08789
	Thursday (56 v/km)	Rejected	0.01107	Rejected	0.01144
	Friday (61 v/km)	Accepted	0.05907	Accepted	0.05777
	Saturday (54 v/km)	Rejected	0.00133	Rejected	0.04769
	Sunday (43 v/km)	Accepted	0.23119	Accepted	0.13761
Gamma	Monday (45 v/km)	Accepted	0.28677	Accepted	0.24434
	Tuesday (31 v/km)	Rejected	6.11E-04	Rejected	0.00418
	Wednesday (63 v/km)	Rejected	0.02095	Accepted	0.26901
	Thursday (56 v/km)	Accepted	0.10934	Accepted	0.11887
	Friday (61 v/km)	Rejected	0.01467	Rejected	0.01076
	Saturday (54 v/km)	Accepted	0.29473	Accepted	0.18075
	Sunday (43 v/km)	Accepted	0.24364	Accepted	0.42357
Normal	Monday (45 v/km)	Rejected	1.11E-05	Rejected	8.13E-04
	Tuesday (31 v/km)	Accepted	0.49344	Accepted	0.34134
	Wednesday (63 v/km)	Rejected	4.36E-11	Rejected	7.03E-09
	Thursday (56 v/km)	Rejected	1.10E-06	Rejected	3.65E-06

	Friday (61 v/km)	Rejected	1.24E-10	Rejected	1.55E-07
	Saturday (54 v/km)	Rejected	3.06E-07	Rejected	2.64E-04
	Sunday (43 v/km)	Rejected	2.53E-09	Rejected	1.77E-06

If the p value (probability) is less than 0.05, that means that the distribution is rejected by the goodness of fit test, and if the p value is greater than 0.05 means that the goodness of fit test has accepted that distribution. From the results of Chi-Squared (C-S) and Kolmogorov-Smirnov (K-S) test, it was evident that the Burr Distribution and Generalized Extreme Value Distribution were accepted for all the datasets. Thus, it provides best fit for headway of vehicles having some impact or interference by U turning vehicles. Thus Burr Distribution and Generalized Extreme Value Distribution passed both goodness of fit tests at 5% significance level for the five datasets Further, Kolmogorov-Smirnov (K-S) and Chi-Squared (C-S) tests results reinforce the Q-Q plot results which indicated that Burr and Generalized Extreme Value distributions are best for headway data.

3.5 Best Fit Distribution of straight vehicles interfered by U turning vehicles

Datasets of headway of straight moving vehicles being interfered by U turning vehicles were examined. Test was done lane wise for best fit distributions. The distribution curves and histogram of the headway of each dataset are presented in figures. Figure shows that the all headway dataset has the percentage of very small headway values (less than 0.5s) and this is because of congestion. The headway percentages of lane reduce with the passage of time as the congestion increases. The headway values of lane 2 are comparatively less than that of lane 1. The headway values in lane 3 is lesser than both lane 1 and 2 and there is considerable up and down in the histograms, which means that there is congestion and the up and downs are due to interference of other vehicles as the vehicles from lane 1 and lane 2 tries to move to lane 3. Figure (38 to 42) shows PDFs and CDFs of Lane 1, Lane 2 and Lane 3 Respectively

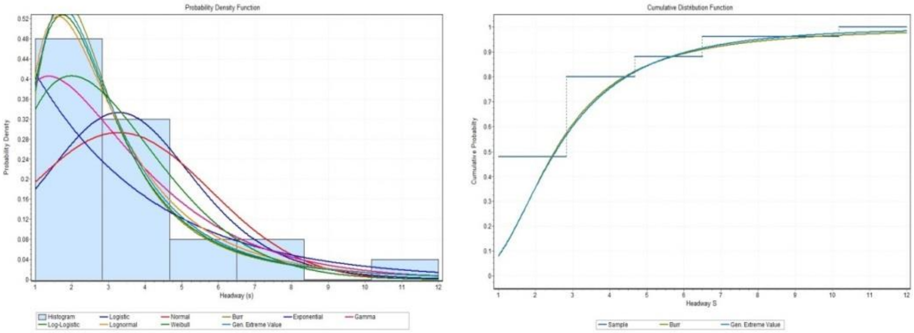


Figure 25: PDF and CDF of LANE 1

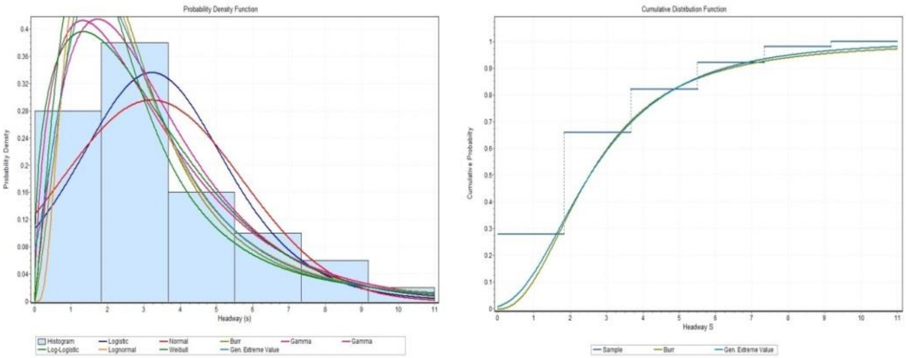


Figure 26: PDF and CDF of LANE 2

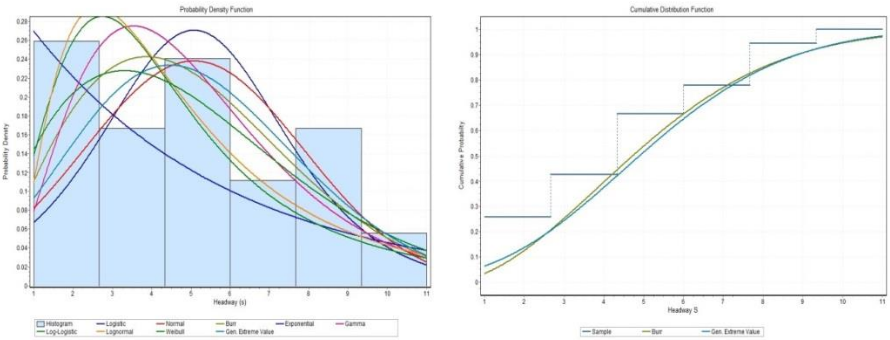


Figure 27: PDF and CDF of LANE 3

3.6 Goodness of Fit

Figures 28 to 42 shows that Q-Q plots of the analyzed nine distributions for lane wise headway data sets. On comparison of the plots it was concluded that headway data set for Burr Distribution, Lognormal

Distribution and Generalized Extreme Value Distribution of all the nine distributions for exact u turning phenomenon are approximately closest to the 45 degree line, so it was decided that burr distribution, log normal distribution, Generalized Extreme Value distribution to be considered the best fit than the other seven distributions for the datasets. Comparison of Q-Q plots for the data set shows that most of the distribution better fit the data set compared to other data sets. The non-linear shape of the Q-Q plots of all datasets for log-logistic distribution, Exponential Distribution, Logistic Distribution, Weibull Distribution, Gamma Distribution and Normal Distribution suggests that are not suitable for modeling the headway data.

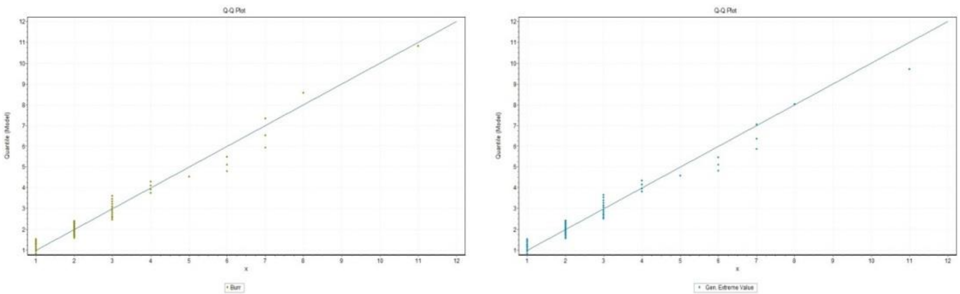


Figure 28: QQ plot for Lane 1 of Burr and Generalized Extreme Value Distribution

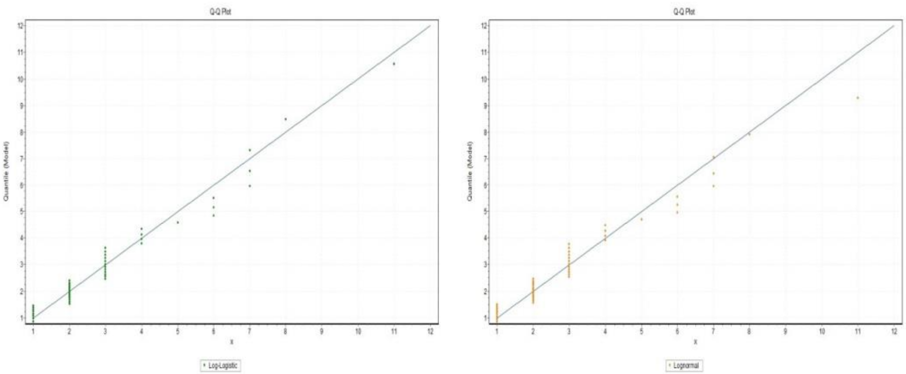


Figure 29: QQ plot for Lane 1 of Loglogistic and Lognormal Distribution

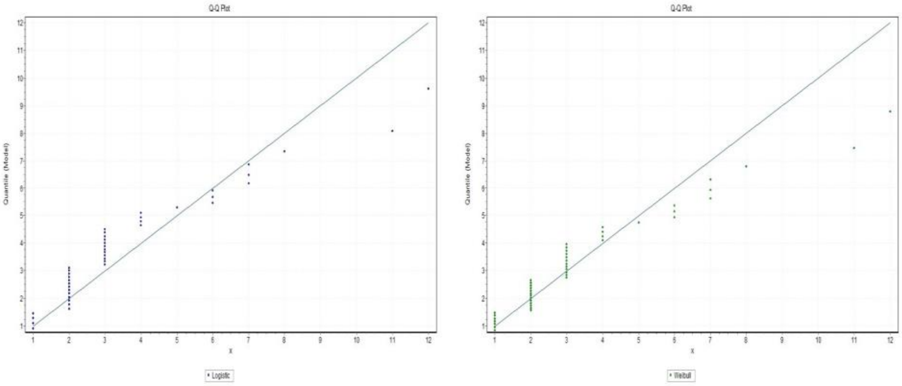


Figure 30: QQ plot for Lane 1 of Logistic and Weibull Distribution

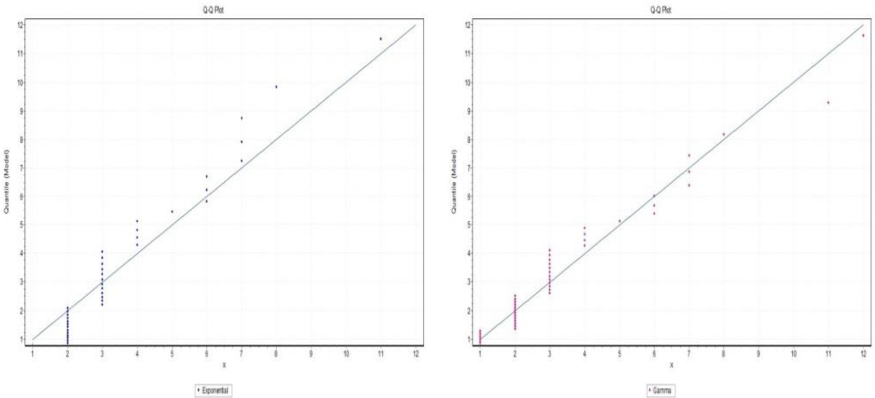


Figure 31: QQ plot for Lane 1 of Exponential and Gamma Distribution

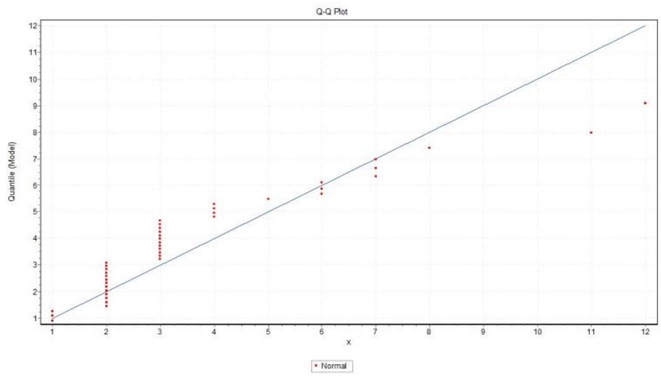


Figure 32: QQ plot for Lane 1 of Normal Distribution

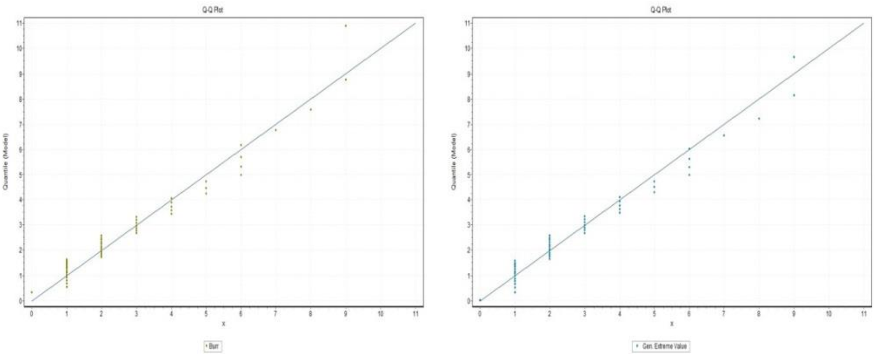


Figure 33: QQ plot for Lane 2 of Burr and Generalized Extreme Value Distribution

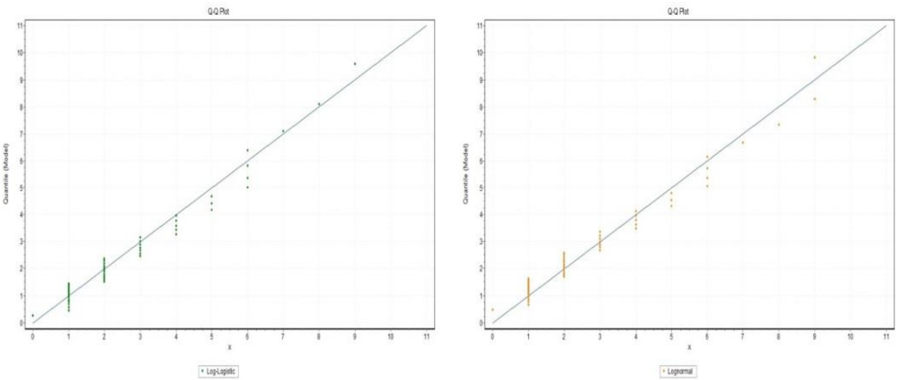


Figure 34: QQ plot for Lane 2 of Loglogistic Distribution and Lognormal Distribution

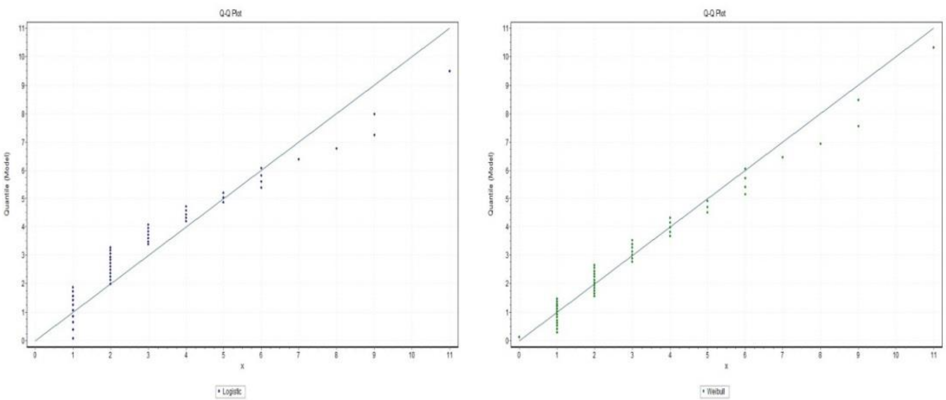
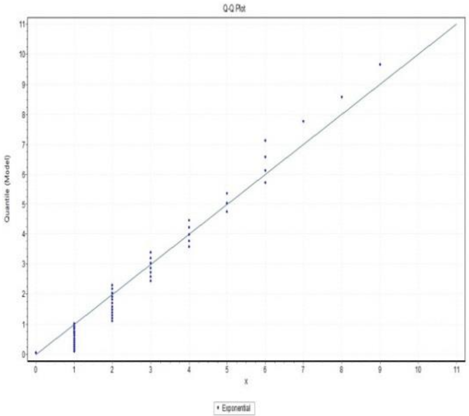


Figure 35: QQ plot for Lane 2 of Logistic and Weibull Distribution



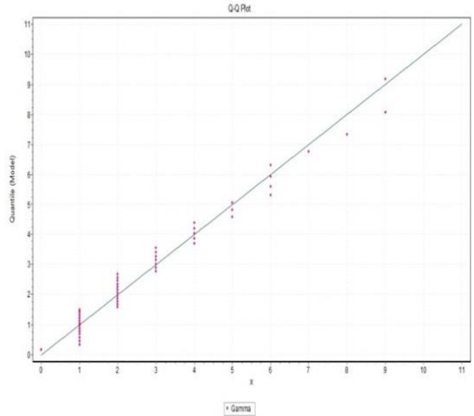


Figure 36: QQ plot for Lane 2 of Exponential and Gamma Distribution

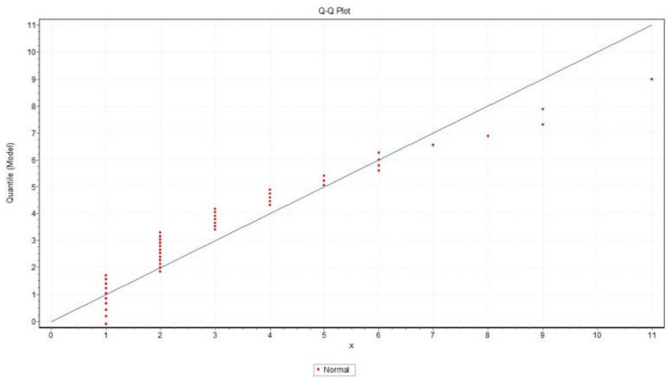
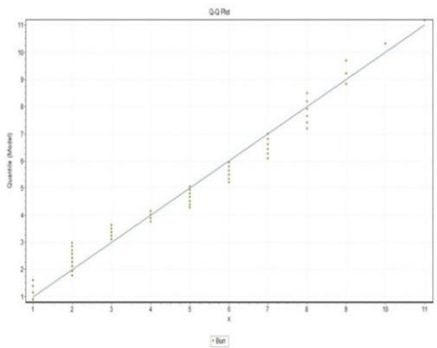


Figure 37: QQ plot for Lane 2 of Normal Distribution



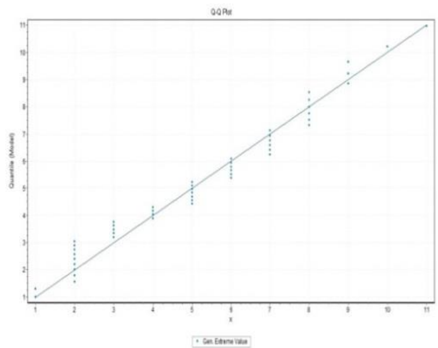


Figure 38: QQ plot for Lane 3 of Burr and Generalized Extreme Value Distribution

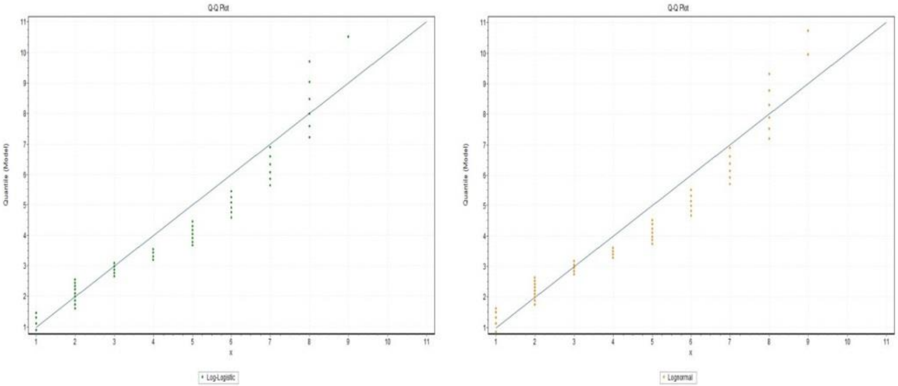


Figure 39: QQ plot for Lane 3 of Loglogistic and Lognormal Distribution

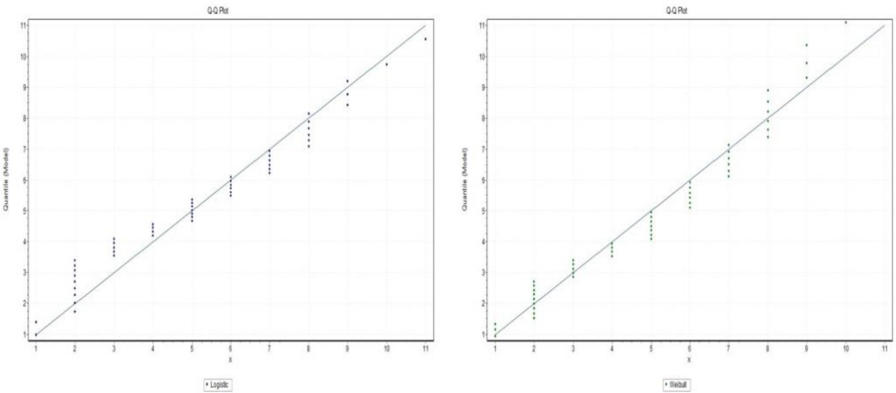


Figure 40: QQ plot for Lane 3 of Logistic and Weibull Distribution

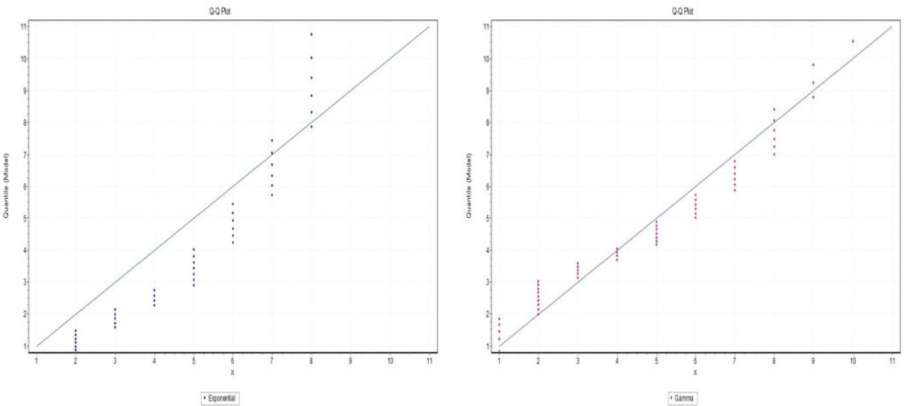


Figure 41: QQ plot for Lane 3 of Exponantial and Gamma Distribution

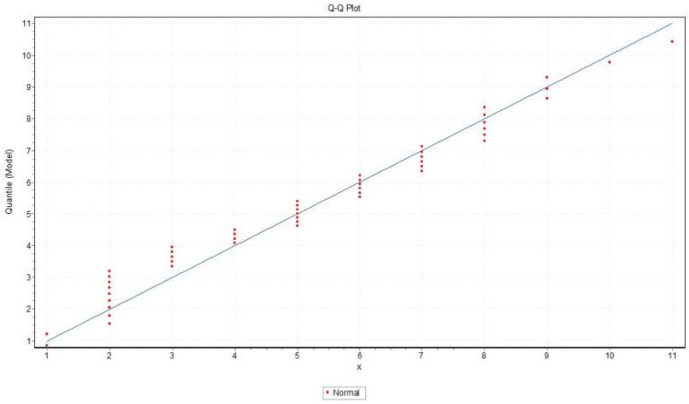


Figure 42: QQ plot for Lane 3 of Normal Distribution

Table 2: goodness of fit test result for the headway data of exact u turning phenomenon

Probability Distribution	Data Set	Chi-Squared Test	P	Kolmogorov-Smirnov Test	P
Burr	Lane 1	Accepted	0.17322	Accepted	0.26062
	Lane 2	Accepted	0.11845	Accepted	0.09006
	Lane 3	Accepted	0.15794	Accepted	0.27042
Generalized Extreme Value	Lane 1	Accepted	0.18252	Accepted	0.26761
	Lane 2	Accepted	0.14652	Accepted	0.21513
	Lane 3	Accepted	0.49344	Accepted	0.37462
Log-Logistic	Lane 1	Accepted	0.1587	Accepted	0.21043
	Lane 2	Accepted	0.12664	Accepted	0.25028
	Lane 3	Rejected	0.0122	Rejected	0.03947
Lognormal	Lane 1	Accepted	0.23589	Accepted	0.26266
	Lane 2	Accepted	0.10874	Accepted	0.06054
	Lane	Accepted	0.06975	Accepted	0.55614

	3				
Logistic	Lane 1	Rejected	0.00757	Rejected	0.001
	Lane 2	Accepted	0.12077	Rejected	0.00845
	Lane 3	Accepted	0.08641	Accepted	0.18456
Weibull	Lane 1	Rejected	0.00598	Accepted	0.0705
	Lane 2	Accepted	0.68209	Accepted	0.19716
	Lane 3	Accepted	0.12605	Accepted	0.23681
Exponential	Lane 1	Rejected	6.1950E-4	Rejected	0.00155
	Lane 2	Accepted	0.66343	Accepted	0.00359
	Lane 3	Rejected	0.00384	Rejected	0.00459
Gamma	Lane 1	Rejected	0.00342	Accepted	0.1244
	Lane 2	Accepted	0.24547	Accepted	0.05733
	Lane 3	Accepted	0.11399	Accepted	0.12515
Normal	Lane 1	Accepted	0.07819	Rejected	0.0014
	Lane 2	Accepted	0.35492	Rejected	0.02165
	Lane 3	Accepted	0.75493	Accepted	0.35175

4. CONCLUSION

To understand the behavior of drivers, the impact of non-dedicated u turn on straight moving vehicles were examined in this thesis. Data obtained from Karkhano road in Peshawar was used to determine the statistical characteristics and several distributions were considered. The headway data, traffic flow rates and average speed during normal traffic and specific phenomenon (only u turn analysis) differ as the traffic flow rate increases then the headway decreases. The non-dedicated U turn was showing evident influence on the straight moving vehicles coming from the opposite direction as they modify their behavior considering the U turning vehicles by either changing the lane or stopping or decreasing the speed.

While determining the speed, it was observed that the speed has inverse relation with the flow rate. With the increase of the flow rate, decrease in the speed and headway was noted and vice versa. Determining the suitable headway distribution is very important for traffic simulation. During the study different statistical distribution were considered and their fit was determined utilizing three goodness of fit tests, Q-Q plot, K-S, C-S, while some distributions were accepted by either of them, some were rejected by all three. Burr distribution and Generalized Extreme value distribution was accepted by all of the three tests.

Comparing the results for headway data it confirms that Burr distribution, Generalized Extreme Value Distribution and Lognormal Distribution are the best for traffic with interfering u turning vehicles. Results show the relation between headway data distribution of straight moving vehicles and interfering u turning vehicles. They will be useful in determining suitable headway distributions for traffic management and control over the use of a non-dedicated u turn.

It was also determined from the statistics that on week days more than 60 percent of the drivers are driving with a headway that is less than the safe headway and on weekends less than 40 percent of the vehicles were observed to have headway less than 4 seconds. The safe headway time in this study was taken as 4 seconds

It was also concluded from the research that vehicle flow rate range 1100vph to 1800vph Burr Distribution and Generalized Extreme Value Distribution were followed. In lane 1 there was significant reduction observed in the headway of straight moving vehicles when interfered by the U turning vehicles. The probability for headway less than or equal to 4 seconds in lane 1 was found to be in range of 35 percent to 40 percent and from the PDF it was noted that the probability of almost every individual headway was fluctuating indicated recurrent congestion. In lane 2 headways were comparatively less than lane 1. The probability for headway less than or equal to 4 seconds in lane 2 was found to be in range of 70 percent to 75 percent and the probability for headways 1 second to 3 seconds in higher (from the PDF). In lane 3 the headways becomes much lesser than both of the lanes as vehicles disseminate more quickly than Lane 1 and lane 2. The probability for headway less than or equal to 4 seconds in lane 3 was found to be in range of 70 percent to 75 percent and the probability for 2 seconds to 3 seconds is higher degree in lane 3 (from

PDF of lane 3).

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