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Modelling of Vehicular Speed and Headway on Urban Route in Amman City

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Abstract

The growth in population causes a rise in demand for transport. The attributes of automobile speed and time travel are central to traffic engineering projects, such as efficiency and quality of operation tests on highways, unmarked intersections and roundabouts. This paper presents a statistical study on fitting distribution using several types of probability distributions. Several types of mixed distribution are proposed and tested in order to determine the best model in describing daily traffic. This project analysed the progress of time and vehicle speed on urban roads and investigated the statistical relationship between them in order to emphasize the ability for enhancing traffic flow Time forward and speed distribution studies afford knowledge into the aggregate flow of vehicles with significant capacity estimation applications, level of service (LOS) analysis, safety examination, etc. On the principle of information gathered from airport road 6-lane highway, a video recording technique was used to analyse the progress and speed of the vehicles. The project aims to research the time forward distribution of vehicles for mixed vehicle movement and separate leader-follower vehicle sets on the foundation of six rates of traffic flow [0-200, 200-400, 400-600, 600-800, 800-1000 and 1000-1200 PCU/h]. The study of the recorded speed data is also carried out in order to acquire the speed distribution trends in mixed traffic and even the vehicle class-wise speed study is carried out in order to assess the effect of the overall movement and vehicle configuration on the distance. The findings of this project can be specifically extended to the creation of micro-simulation models.

Keywords: simulation models, speed, headway, mixed distribution.

I. INTRODUCTION

Headway and speed distribution analysis are critical for traffic engineers, because statistical characteristics offer an in-depth view of the collective actions of automobiles and drivers. Robust modelling and comprehensive study of vehicle speed and forward time distributions are needed to predict road ability, level of service (LOS) study, traffic management and control, health analysis, crash analyses, wait and queue analysis, etc. Speed distribution study is crucial for the geometrical design of roads, the determination of travel time and the fitting of a suitable speed limit to assist the safe and efficient crusade of vehicles. Awareness of speed and time forward distributions is vital as they can also be used as input for the development of a microscopic traffic simulation model. Vehicle transit time is characterized as the difference in inter-arrival time between two consecutive vehicles traveling through the position of the roadway. However, since Indian roads have a heterogeneous mix and low lane-disciplined flow, the actual definition of forward time is invalid. As a result, time progress under mixed traffic conditions is defined as the time difference between the two successive vehicles as they cross the reference line taken over the full width of the roadway.

Additionally, the speed of keeping cars in a heterogeneous state is totally different from that of homogeneous traffic conditions. In Jordan, traffic consists of vehicles with a wide range of static and fluid characteristics and as a result of these characteristics, cars do not conform with the lane discipline and thus slow down the required speed of movement of cars. Speed traffic flow metrics under uniform conditions are evenly distributed, but where the traffic convergence is heterogeneous and both congestion and free movement situations occur, the speed distribution is deviated from the usual curves. Furthermore, under heterogeneous traffic conditions, different vehicles have different manoeuvre ability which allows them to travel at different speeds in a given traffic situation. These situations make the problem of traffic very difficult. The aim of this study is to analyse the progress of vehicle time and speed distribution for mixed-vehicle traffic. Time forward analyses for various leader-follower vehicles-pairs and speed spread characteristics of specific vehicle types are also supplied.

II. LITERATURE REVIEW

Headways maintained by cars under combined situations are totally opposite from those under homogeneous traffic conditions. A significant range of forward-looking theories have been developed over the last decades to describe the production of forward-looking vehicles. The exact distribution of forward time is more between negative exponential and regular distributions. Cowan (1975) considered the time advance to be the sum of two components, the tracking part and the free part, and thus proposed four forward-looking models, M1 for the Poisson loop, M2 for the modified exponential

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distribution, M3 for the mixed and exponential distribution, and M4 for the modified distribution of M3.

Several researchers (e.g. May (1990), Arasan and Koshy (2003), Al-Ghamdi (2001), Reddy and Issac (1995), Kumar and Rao (1998), Hossain and Iqbal (1999) have embraced a negative exponential distribution to describe low traffic flow environments where vehicle motions are fully unpredictable.

One of the drawbacks of the negative exponential model is that it occurs at very short intervals where it cannot absorb the lower variance of the forwards such as in platoons. It can be resolved by a negative exponential distribution equation and, as shown by Al-Ghamdi (2001), was considered a good model for a comparatively long time of development.

However, several distribution models have been proposed for small periods, including Gamma, Erlang, lognormal, log-logistic, etc. Lognormal distribution was known to be the optimum distribution in modelling time in steady-state car-following situations as suggested by Dey and Chandra (2009).

Dawson and Chimni (1968) and Khasnabis and Heimbach (1980) have separately developed the Hyperlang and Schuhl models. The Hyperlang process is a simple combination of the traduced exponential function describing roads in the traffic system and the Erlang function converted, representing the limited routes Dawson and Chimni (1968). This platform also identified data from Chandra and Kumar on residential streets under mixed transport circumstances (2001). The cars in Venice Region were studied by Riccardo and Massimiliano, who in 2012 looked at traffic time on two-wave paths. The Inverse Weibull distribution is well adapted for fluid speeds and logistic ranges. The distribution of the Burr likelihood can be used to map rain and non-rain shifts as described by Alhassan and Edigbe (2012).

Dubey et al. (2012) Multiple mixing models such as WEV and Weibull & Lognormal (WLN) were tried to predict time gaps for 2300 vPh and 1900 vPh, collectively for mixed transport, Dubey and Arkatkar, in conjunction with the general distribution of Pareto, to suit the flow level with the data gap of 1,473 vPh, Dubey et al. (2012) (2013).

Some of the recent progression analysis is more interested in the mixed flow of vehicles but lacks the effect on traffic flow of a single type of vehicle. Owing to their physical and organizational characteristics, the reliability and health of the transport system are threatened by the presence of camions.

Particular types of cars have a range of trailing patterns and lane shifts, which contribute to specific radical properties. Context studies show that uniform distribution can be expressed in homogeneous speeds and progress values of the road conditions, but there are differences in the calculation for mixed traffic situations and that no class-speed study of vehicle has been developed.

III. PROJECT DESCRIPTION

Queen Alia International Airport Route is a six-lane highway, situated in the south of Amman City and one of the main roads in Jordan, linking Amman to the south of Jordan and the airport. The progress of time and the pace of one lane (the lane to the left) over various time periods were investigated to find the correct distribution that matches the results. Figure 1 indicates the data collection locations on Queen Alia International Airport Road.

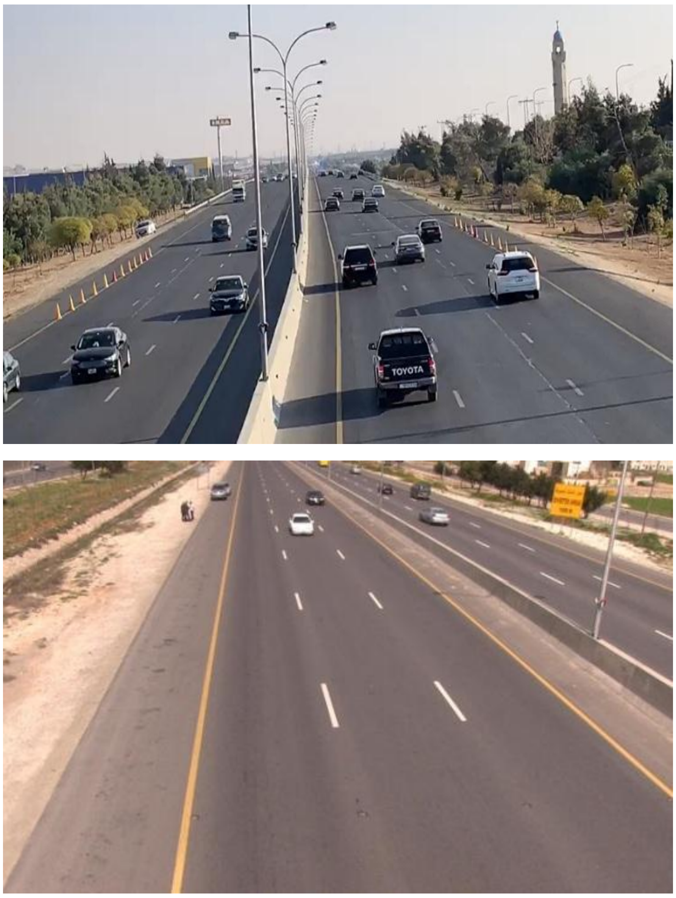

Fig. 1. Queen Alia International Airport Road (data collection location)

IV. SIGNIFICANCE OF THE STUDY

Several computer program models are focused on best-practice driver actions and circumstances, so these software systems are used to simulate local traffic, and there is a need to create a model or simulation software that takes into account local conditions. It can be achieved by gathering actual evidence on the grounds of local driving conduct and traffic rules.

V. OBJECTIVE

There is no programming model or modelling system that is compatible with local Jordanian driver actions or traffic rules, since most modelling programming is focused on European or American norms and requirements, and there is a need to construct a model that is compatible with specific Jordanian requirements. Often, traffic simulation programming is based on a variety of parameters (speed, distance, gap acceptance, clearance time, driver behaviour, etc.) So, test two of these variables (Time forward and speed) by rendering the distribution suitable to extract the best distribution of the data that will be used for simulation modelling.

VI. METHODOLOGY

Vehicles over various time spans were measured, the medium trucks were found to be 3% of the traffic on the road. The traffic flows were separated into periods and have the statistical analysis on each period. Samples were indeed subjected to a statistical analysis using SPSS-software and a chi square check to determine the optimal statistical distribution and to maintain acceptable sample size (nmin) and confidence Level.

VII. DATA COLLECTION

The data examined in this project were collected from the left traffic lane in Amman airport road - Jordan, using a video recording technique, according to which the correct time forward was measured in seconds (front to front) between vehicles and the speed was determined by measuring the time needed for each vehicle to drive at a distance of 25 m of the road segment. The selected straight sections of the road were built on a flat plain and their traffic pattern differed greatly. Traffic data were obtained in good views and the selected traffic components were appropriately distant from the adjacent crossings. A high point of view was mounted on the video camera to capture the flow of the whole width of the both directions. In order to achieve better accuracy, time forward and speed data were obtained from the videos by a rate of 25 frames per second.

VII. STATISTICAL ANALYSIS

Minimum size of observations depends on confidence bounds, standard deviation of the underlying distribution, and tolerance, although larger samples are likely to lead to better estimates of distribution parameters. Therefore, collection gives a good level of confidence. Summary of Sample sizes for different headway and speed intervals are indicated in Table 1.

VIII. DISTRIBUTION FITTINGS

The chi-square method is used to evaluate if there is a substantial gap between the predicted frequencies and the reported frequencies of one or more groups. The Probability Distributions used to fit the experimental data collected were the following:

1. Normal distribution
2. Box-cox transformation distribution
3. Lognormal distribution
4. 3-parameter lognormal distribution
5. Exponential distribution
6. 3-parameter Weibull distribution
7. Smallest extreme value distribution
8. Largest extreme value distribution
9. Gamma distribution
10. 3-parameter gamma distribution
11. Logistic distribution
12. Log logistic distribution
13. 3-parameter log logistic distribution
14. Johnson Transformation

IX. SUMMARY

Figure 2 and Table 2 indicate the best fitting curves distributions for headway intervals. While Figure 2 indicates the Best Fitting curves for the different headway intervals. Figure 3 and Table 3 indicate the best fitting curves distributions for speed intervals of Speed. While for Speed 400-600 interval no best Speed Distributions Fitting.

ANOVA test is used to check the ability to combine all the six studied intervals (0-200, 200-400, 400-600, 600-800, 800-1000, and 1000-1200) in one interval. This analysis was conducted once for the speed data and once for the Headway data. This analysis was performed using the Statistical Package for Social Sciences (SPSS), v. 24.0. In both cases, at level of significance (α= 0.05). The main analysis outcomes are presented and briefly indicated in Figure 4, Figure 5 and Table 4 and Table 5 while Figure 4 indicates the Best Fitting curves for Combined Headway intervals.

X. CONCLUSION

Based on the headway details collected from six intervals and forward range ranges [0-200, 200-400, 400-600, 600-800, 800-1000 and 1000-1200], the strongest delivery patterns have been established. Box-Cox Transformation distribution was found to be the best fit for all forwarding speeds ranging from 0 to 1200 PCU/h. With the exception of exponential and two-parameter exponential distributions, all the best-fitting distributions tested were also considered to be ideally adapted for the definition of the flow rate ranging from 0 to 1200 PCU/h.

Excluding exponential and two-parameter exponential distributions, all the best-fitting distributions tested were also considered to be ideally adapted for the definition of the flow rate ranging from 0 to 1200 PCU/h.

For Speed 400-600 intervals: except for exponential and two-parameter exponential distributions, all the distributions tested match the results. It is also worth mentioning that even though the best suited distributions are specific for the same class of vehicles in separate areas, traditional distributions such as Normal, Lognormal, Gamma and Weibull still pass statistical checks at a very high degree of confidence.

A number of traffic stories demonstrate the findings of this analysis. The results can also be used as an input to create micro-simulation models directly. The results of this study would be used for various traffic applications, such as geometric architecture, measurement of capacity, security analysis and service level analysis. The findings of this article can also be used as guidance for the creation of the models of micro-simulation. As the car pair reveals that quicker traveling vehicles prohibit slower traveling vehicles from continuing. It helps to assess the availability and extent of overtaking areas on the two-lane bi-directional highway.

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Table 1. Summary of Sample sizes for different headway and speed intervals.

Headway interval PCU/h	**0-200**	**200-400**	**400-600**	**600-800**	**800-1000**	**1000-1200**
S	3.45	4.02	6.90	4.73	3.95	4.41
Sample size needed for 99% confidence level	78	27	78	38	26	33
Actual Sample size	320	300	230	290	250	270
Speed interval PCU/h	**0-200**	**200-400**	**400-600**	**600-800**	**800-1000**	**1000-1200**
S	13.65	14.71	11.10	10.15	12.23	13.19
Sample size needed for 95% confidence level	180	209	204	172	249	168
Actual Sample size	230	300	230	290	250	270

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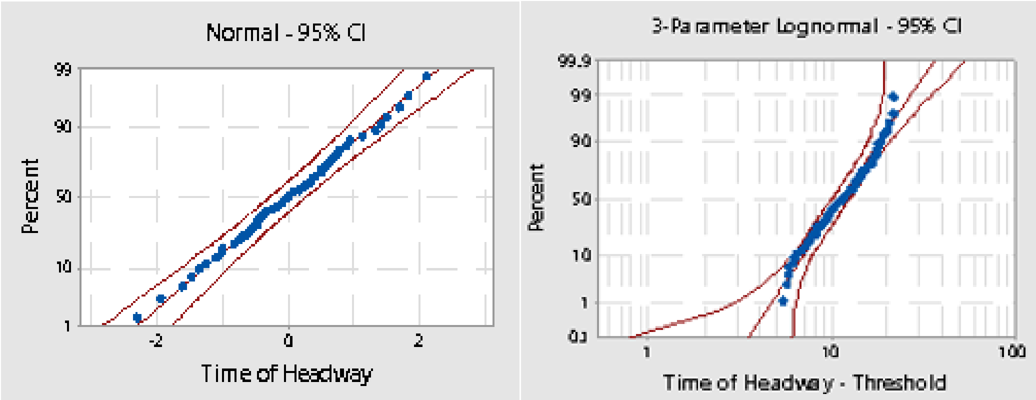
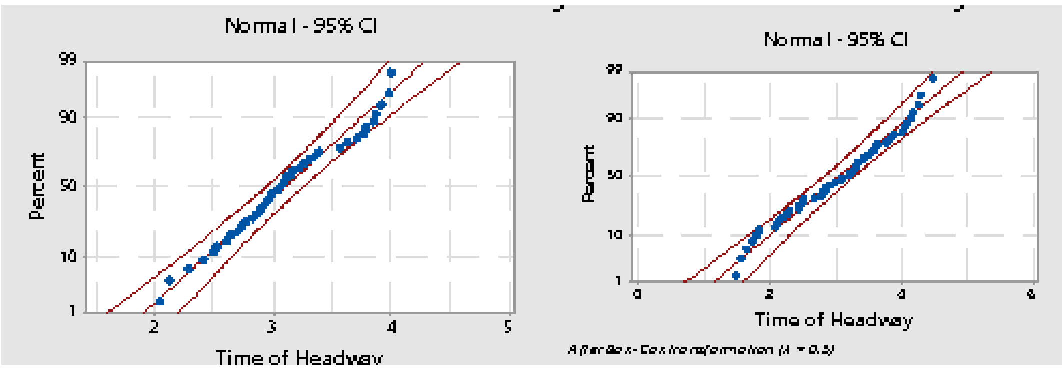
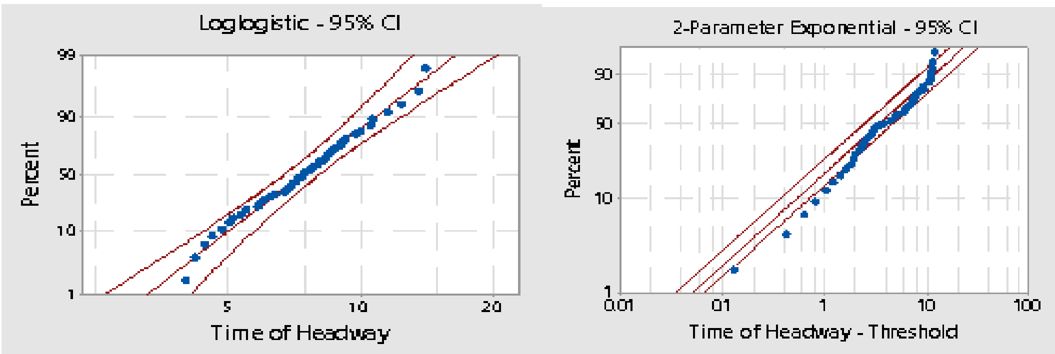


Headway 0-200 Headway 200-400



Headway 400-600 Headway 600-800



Headway 800-1000 Headway 1000-1200: No Good Fitting.

Fig. 2. Best Fitting curves for headway intervals

Best Speed distributions for Speed 0-200 interval

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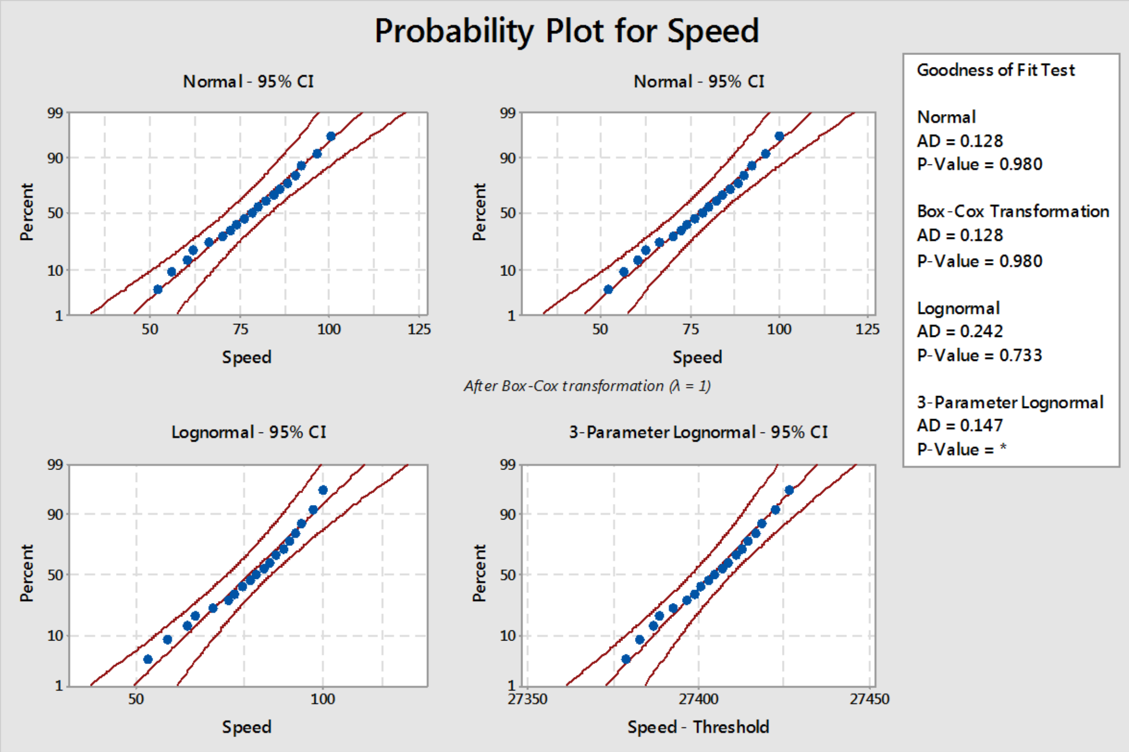
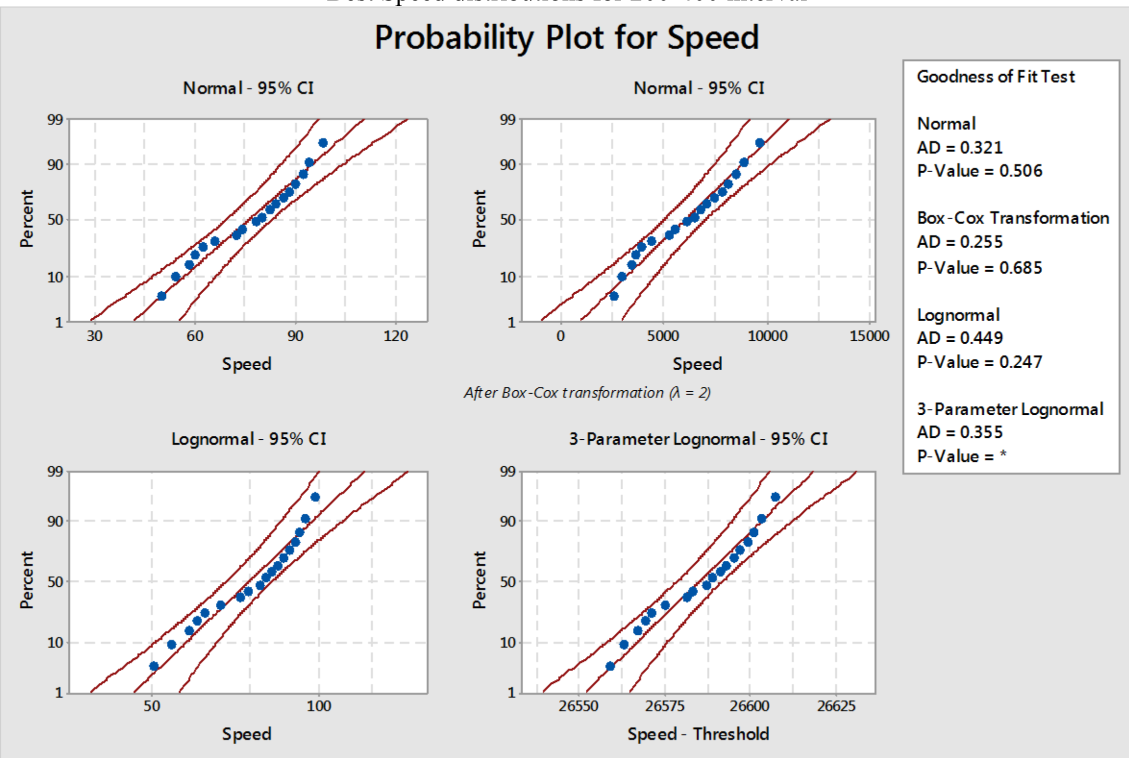
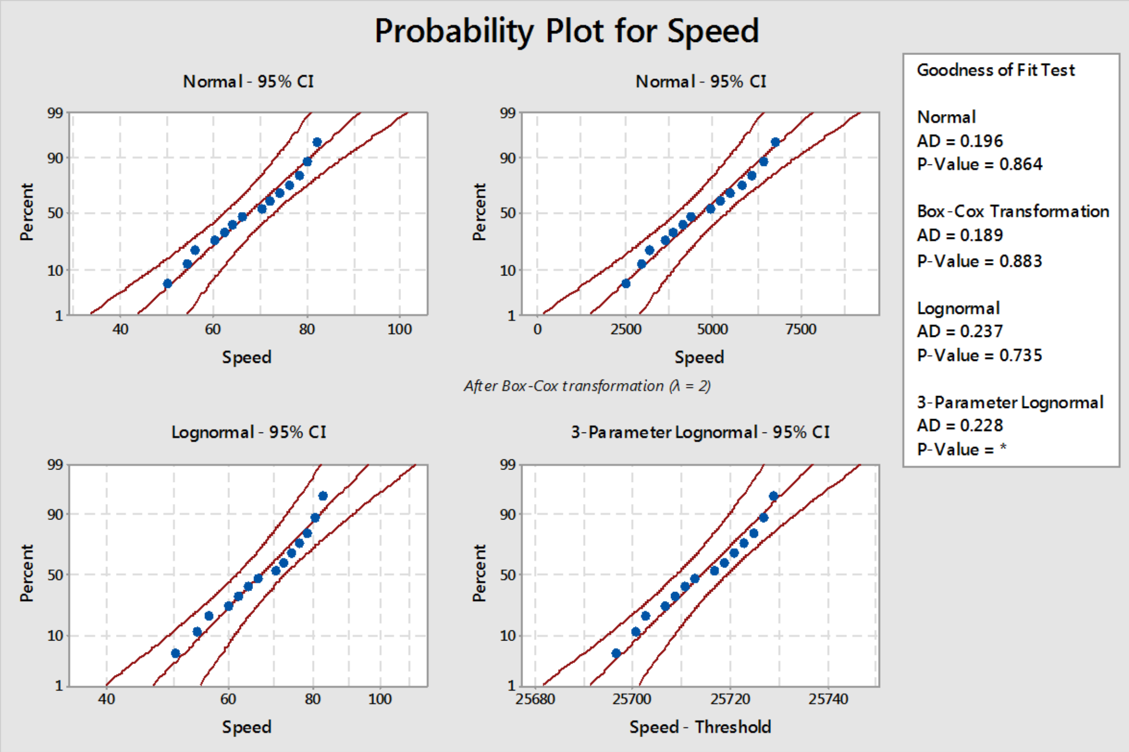


Best Speed distributions for 200-400 interval

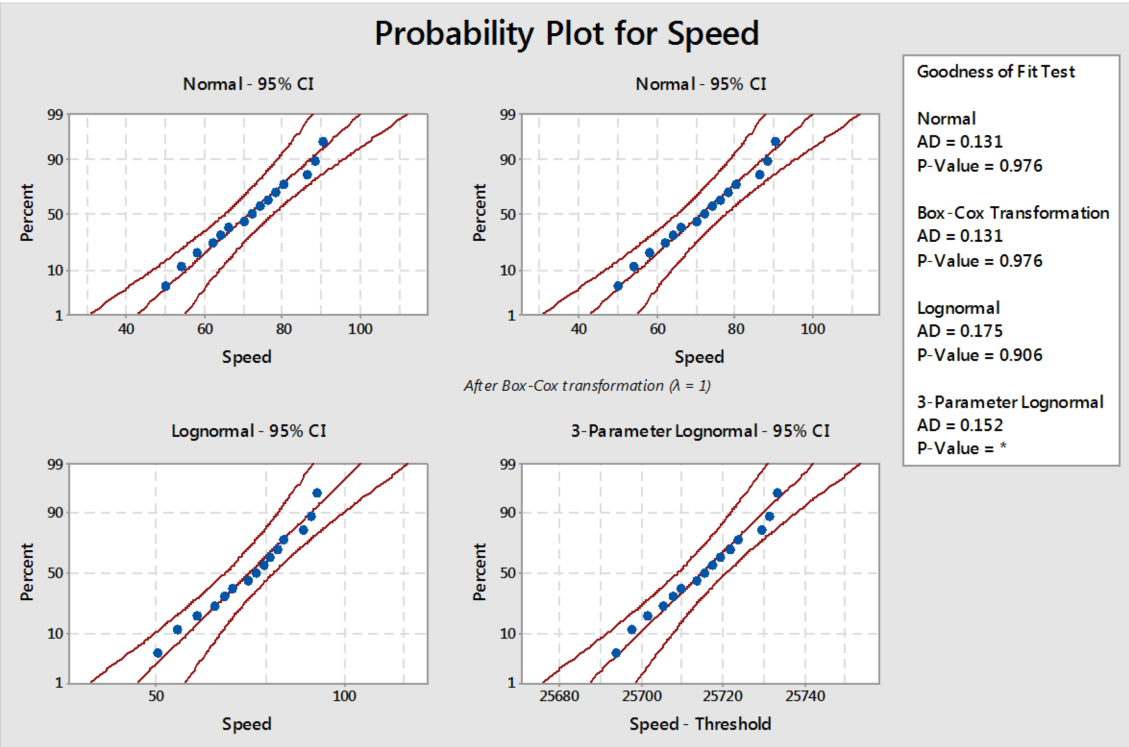


For Speed 400-600 interval no best Speed Distributions Fitting.

Best Speed distributions for 600-800 interval



Best Speed distributions for800-1000 interval



Best Speed distributions for 1000-1200 interval

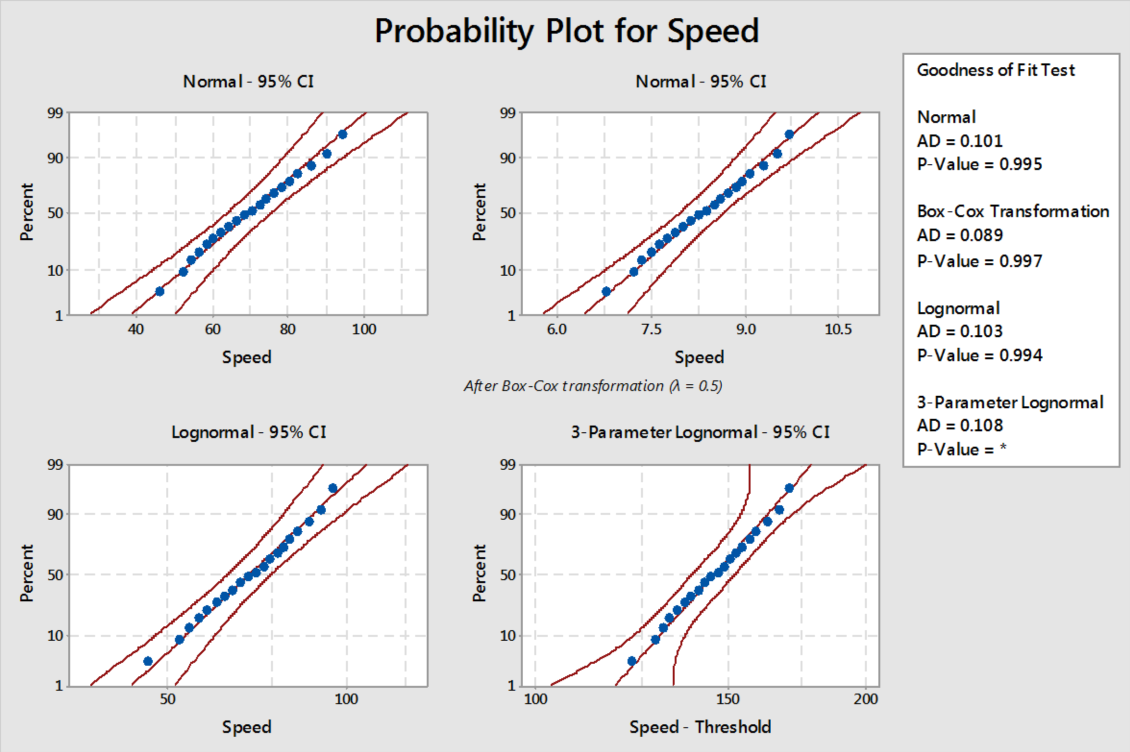


Fig. 3. Best Fitting curves for Speed intervals

Table 3. Summary Speed Distributions Table

Interval	Distributions	Best distribution
Speed 0-200	with the exception of the exponential and two-parameter exponential distributions, all tested distributions fit the data.	Normal distribution and the logistic distribution fit the data the best.
Speed 200-400	with the exception of the exponential and two-parameter exponential distributions, all tested distributions fit the data.	Normal distribution and the logistic distribution fit the data the best.
Speed 400-600	with the exception of the exponential and two-parameter exponential distributions, all tested distributions fit the data.	
Speed 600-800	with the exception of the exponential and two-parameter exponential distributions, all tested distributions fit the data.	Normal distribution and the logistic distribution fit the data the best.
Speed 800-1000	with the exception of the exponential and two-parameter exponential distributions, all tested distributions fit the data.	Normal distribution and the logistic distribution fit the data the best.
Speed 1000-1200	with the exception of the exponential and two-parameter exponential distributions, all tested distributions fit the data.	Normal 3-parameter loglogistic

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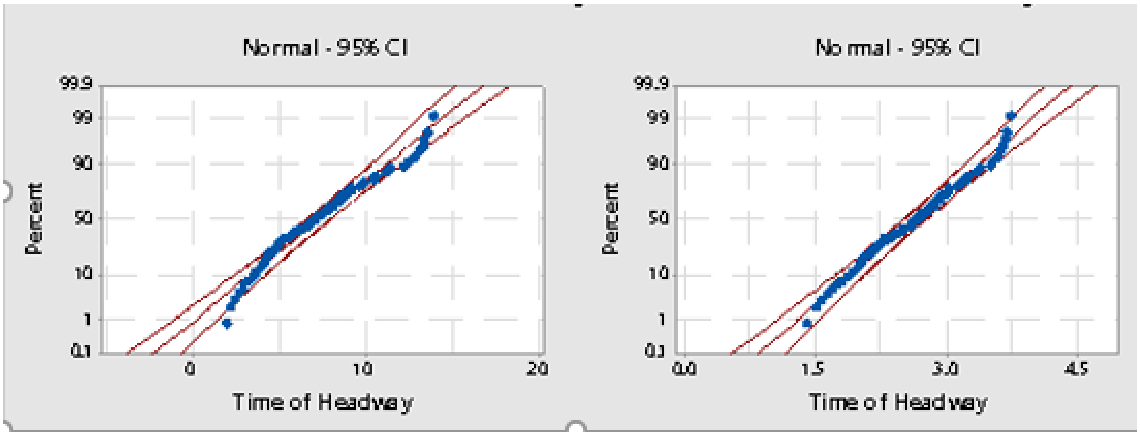

Combined intervals for Headway group 2 (800-1200)

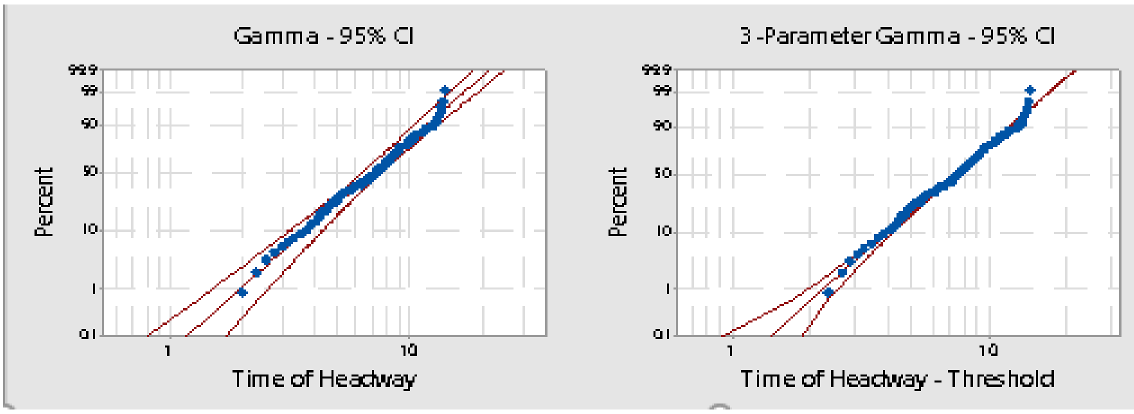

Fig. 4. Best Fitting curves for Combined Headway intervals

Combined intervals for Speed group 1 (0-1200)

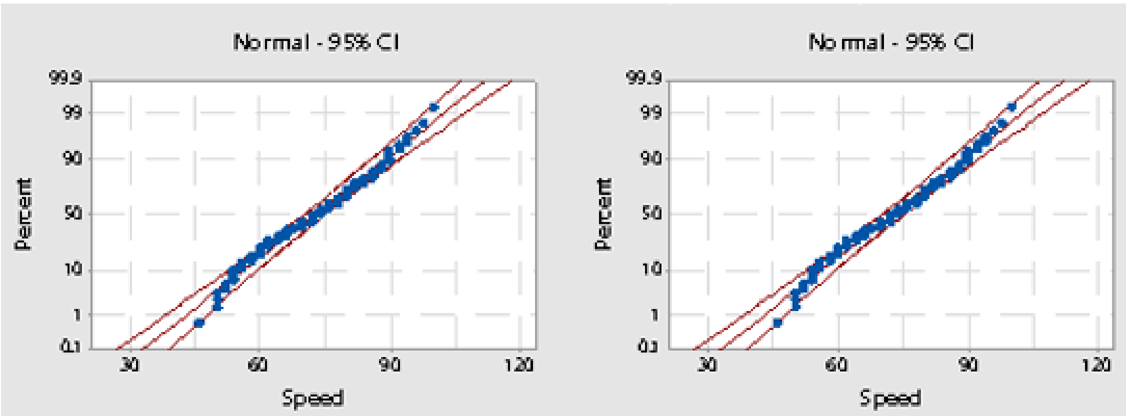

Fig. 5. Best Fitting curves for Combined Speed intervals

Table 4. Combined Headway Intervals Summary

Headway group 1 (0-800)	The normal distribution, Box-Cox transformation of the normal distribution, the three-parameter lognormal distribution, and the three-parameter Gamma	The normal distribution, Box-Cox transformation
Headway group 2 (800-1200)	The three-parameter lognormal distribution, the three-parameter Weibull distribution, and the three-parameter Gamma distribution	The three-parameter Gamma distribution fit the headway data of Group 2 more than the other tested distributions.

Table 5. Combined Speed Intervals Summary

Speed group 1 (0-1200)	the normal distribution, Box-Cox transformation of the normal distribution, the three-Parameter lognormal distribution, and the three-parameter Gamma distribution	