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Research Note

HIGHWAY OPERATING SPEEDS OF GTS AND PRIVATE BUS DRIVERS

by

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C O N T E N T S

A N N E X U R E

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INTRODUCTION:

The vehicle operating speeds are an important variable for road safety, operating costs, etc. The factors that determine the operating speed include type of vehicle, smoothness of road, conditions of traffic and training and attitudes of drivers. The technical capabilities of the vehicle set maximum limits to speed. This is restricted by the conditions of the road and of traffic. The vehicles would do better on smooth roads than on rought. Congestion also restricts speeds and so do the slow moving vehicles. However, in a given set of physical characteristics, i.e. vehicle, road, traffic, etc. the speeds will be determined by drivers' attitudes and behaviour which in their turn are conditioned by their training and experience.

2. To make the road travel safe, training of drivers, better working and service conditions are emphasised particularly for public service vehicles where more than 50 persons are housed in one vehicle. There are differences in training, working and service conditions between public and private sectors. Whether there are differences in speeds or in other words whether the differences in training and working conditions are related to highway operating speeds is the subject of examination of this paper.

SCOPE AND COVERAGE:

3. This investigation covers speeds of GTS and Private Bus Drivers only. Also the observations include only free moving vehicles. The vehicles interrupted or obstructed on the observation track are not included. The main assumptions about the two groups of Drivers are now described.

4. The Government Transport Service (GTS) is a large organization. Their vehicles are more standardized; they have only a few makes of vehicles. Besides, their fleet is more or less of similar age and size. They have arrangements for training of Drivers. Being a large organization, the management worker relations are impersonal. The operating schedules are fixed. Rest and working hours are pre-determined and in-accordance with the law. There is no immediate profit motive and rather no incentives for racing for passengers. Therefore, much more uniformity can be expected in their operating speeds.

5. On the other hand, the road passenger transport in private sector is characterised by individual ownership and also multiple ownerships of single vehicles. In such circumstances, there will naturally be vehicles of different type, size and age with varying speed capabilities. The drivers would also be of different age, education and experience. The service conditions of drivers concerning working and rest hours would also be different. Also the profit motive would lead to rush-up or slowing down of vehicles. In such circumstances, one would expect less uniformity and more variation in operating speeds.

6. The above assumptions are in-line with the general belief that GTS buses do not indulge in racing and overspeeding and operate at more safe and stable speeds than private buses.

7. Accordingly, the questions formulated for examination are whether there are any differences in operating speeds of GTS and Private Buses and whether the speeds of GTS buses are more uniform than others or whether the variations in speed of private buses are more than for GTS buses, either as a result of training and service conditions or for other reasons. The results would improve our understanding of operating conditions and focus attention on areas of further research.

METHODOLOGY:

8. In order to test the above hypothesis we have examined variances 'within' and 'between' the two groups of drivers. The methodology used follows the simple procedure of description analysis of data in terms of means and variances. This is followed by more rigorous tests of significance of t statistic and F ratios, which are supplemented by X^2 test as well. The results thus obtained have been used to draw inferences.

THE DATA:

9. The data was obtained by observing by speeds of Private and Government Buses on the G.T. Road between Lahore and Gujranwala for two hours between 11.00 A.M. to 1.00 P.M. in May, 1978. Speeds of 112 buses in both directions including 70 private and 42 Government were observed. The Government buses are distinguishable by their colour and design.

10. The measurement of speed was done manually with the help of a stop watch. A distance of 352 feet was marked on the road and an observer was placed in between the marked lines. He recorded time in seconds (upto one decimal point) taken by buses to traverse this distance. This was converted into speed in miles per hour. Although this method is not as precise as would be with mechanical or electronic instruments, but it gives a fair iea of speed ranges. However, as the same method is used for all vehicles, the relative speeds are not effected. The original data is reproduced in Table 1.

LIMITATIONS:

11. As the observations are confined to the same time and place, the effects of road and traffic conditions are uniform on all vehicles. The variations that are observed can therefore be ascribed to other factors including driver training, working and service conditions.

12. A question may arise here that vehicle speeds are not the only result or effect of training and service conditions. There are other indicators as well which may include observance of traffic rules such as keeping to lane, correct stopping, turning and overtaking movements, proper use of lights and indicators etc. There is no doubt that these are also important aspects. Their study would be justified on its own merits and would lend the further support for policy decisions. This exercise is however confined to investigation of operating speeds not only as on effect of training and service conditions but also for its importance for raod safety and operating costs.

THE RESULTS:

13. A brief view of the environment in which the survey was undertaken is given below:

ROAD AND TRAFFIC:

14. The site where observations were made was located on the G.T. Road between Lahore and Gujranwala. The width of the road at this site is 25'. It is among the bussiest sections. The volume of traffic during two hours of observation was as below :

VOLUME OF TRAFFIC

Type of Vehicle	11.00 A.M. 12.00 Noon	12.00 Noon 1.00 P.M.	Average
Animal Drawn	8	3	6
Pedal Cycles	2	2	2
Motor Cycles	10	3	7
Cars	93	89	91
Wagons	20	19	19
Buses	75	69	72
Trucks	41	25	33
Other	2	4	3
	251	214	233

15. It would be seen that during two hour observations, 144 buses passed the survey site in both directions. As bunching in traffic is usual, it is often not possible for one observer to record speed of 100% vehicles. For this reason, the speed of 112 buses could only be recorded. This provided 77.7% coverage.

16. As the overall traffic figures do not make any distinction between Government and Private Buses, it is not possible to determine raios of coverage for Government and Private Buses separately. Even if there is some difference in ratios it would not affect the results.

AVERAGE SPEEDS:

17. The average speed of Government and Private Buses has worked out as below:

Average Speeds

Govt. Buses	(x_1)	43.81 M.P.H.
Private Buses	(x_2)	43.44 M.P.H.

At priori, the difference appears very small. It cannot be said to be the result of service conditions and training of drivers of GTS Buses. It should however be added that averages can conceal large variations in composition. Consider for example the life of two types of machines, x and y, in years is as below:

$x = 2, 10, 3 \quad \bar{x} = 5 \quad (x - \bar{x})^2 = 38$

$y = 4, 5, 6 \quad \bar{y} = 5 \quad (x - \bar{x})^2 = 2$

Both the machines have an average life of 5 years but there is considerable difference in variances which are 38 for x and only 2 for y. There are greater chances of machine x failing early or having longer life. Whereas machines of type y are of consistent quality with stable life span. This is a case of uniform means and different variances. Similarly, it is not difficult to percieve a series having similar variances and means widely apart.

18. Therefore, to find out if two series are different from each other, both their means and distributions need be looked into.

SPEED DISTRIBUTIONS:

19. The distribution of Government and Private Vehicles by speed is set below:

DISTRIBUTION OF BUSES BY SPEED

Speed Range (M.P.H.)	Nos		Percentage	
	Private	Govt.	Private	Govt.
47.5-52.5	11	11	15.7	26.2
42.5-47.5	36	16	51.4	38.1
37.5-42.5	17	11	24.3	26.2
32.5-37.5	6	4	8.6	9.5
	70	42	100.0	100.0

20. It would be seen that in the higher speed category of 47.5 - 52.5 miles per hour, private buses are 15.7% as against 26.2% Government Buses. The proportion of Govt. Buses is also higher in the lower speed category of 32.5 to 37.5 miles per hour; 9.5% Government against 8.6% private. In the middle two categories ranging from 37.5 to 47.5 MPH, Private Buses are 75.7% and Government Buses 64.3%. It is obvious that more Government buses were operating faster and slower than private buses.

21. What is the explanation of greater variation in the speeds of Government Vehicles against our expectation of more uniformity in their behaviour? One possible reasons may be that government vehicles are virtually exempt from police checking and thus freely exceed speed limits. Some element of truth is possible in this assertion, but the more plausible reason appears to be the fact that the life of vehicles in the public sector is less than in the Private Sector and their maintenance standard is also very poor. The ratio of new buses in the fleet is the inverse proportion of life. Therefore, the Governemtn fleet consists of relatively more new buses on the one hand and more poorly maintained on the other. If so, the result would be higher speeds for new vehicle and lower fore older vehicles. More plausibly, the difference could be entirely due to sampling variations. Therefore, before passing any judgement, we should wait for more rigorous analysis that follows in subsequent paragraphs.

22. Incidentally, it may also be noted in passing that speed limit on highways is 4- MPH. The distribution of buses by speed indicates that two third of the vehicles were operating at speeds of 42.5 MPH and over. The proportion of private buses exceeding the speed limit is 67.1% as compared to 64.3% for Government Vehicles. It would be recalled that the proportion of Government buses in the highest speed class was higher than private buses: 26.2% as against 15.7% for private buses. In the second speed class of 42.5-47.5 MPH, the proportion of private buses is higher (51.4%) than Government Buses (38.1%).

This makes the overall proportion of Government Buses in the two speed classes combined less than private buses. Nevertheless, it will be observed that less Government vehicles violate speed limits, but their violations are more severe. On the other hand, more private buses violate speed limits, but their violations are less severe. However, the data is not sufficient to firm up such a conclusion.

TESTS OF SIGNIFICANCE:

23. As indicated before, means and variances alone are not sufficient to indicate differences. A measure is needed to take into account both the means and variances simultaneously. This is provided by statistical tests of significance i.e. t Test and F Ratio.

t Test:

24. The rationale of 't' test is the mathematical truism that if successive samples are drawn from a given universe, their means and variances will differ from each other and will follow a set pattern which is explained by t distribution. More precisely, the ratios of differences between smaple and population means (or pairs of sample means) to standard error of such differences form t distribution. The t distribution thus gives the range over which such differnces can vary due to sampling. This can be used as a test to find if two sample means come from the same universe or significantly differ from each other. If the calculated value of t statistic is within the range indicated by t distribution, one can draw the inference that the difference between the two means is "not significant" and they come from the same universe.

25. The application of t test to our data made in Annexure-II gives a value of:

t = 0.47 whereas its theoretical value at 5% significance level with 83 degrees of freedom is 1.99.

26. This means that the difference between the spedds of Private and Government Buses is far within the possible range of variation due to sampling alone. Hence we conclude that there is no statistically significant difference between the speeds of Private and GTS Buses.

F RATIO:

27. This is a more simple and versatile test to examine the variance of two sample distributions. As in the case of t test, the F distribution is based on mathematical truism that if successive pairs of samples are drawn from a given universe and the variances of both the samples computed, the ratio of larger variance to the smaller will vary from sample to sample and will form F distribution.

28. Among its various properties, the F distribution indicates the range of variation of the ratio of variances of sucdessive pairs of samples drawn for a universe. If the calculated value of the F ratio is less than its theoretical value, the difference in two distributions is regarded as "Not Significant".

29. The value of F ratio calculated in Annexure-II indicates :

$F_{(70,42)} = 1.38 < 1.56$ at 5% significance level.

Adopting the same hypothesis and the decision criteria as used before for t test, it is concluded that there is no difference between the distribution of speeds of private and government vehicles. The difference that exists is due to sampling variation.

30. It would be recalled that while doing the simple analysis it was found that mean speeds were quite near to each other while the speeddistributions were somewhat different. The results of statistical tests have shown similar trend. The t statistics, measuring the difference of means, is far inside the limits of variations due to sampling than the F ratio is not so large, however. This does not contradict the fact of this variation being due to sampling alone.

CONCLUSION:

31. The average speed of GTS buses was found slightly higher than private buses but the difference was not significant, less than 0.4 MPH. However, it appeared from the relative speed distributions that there is greater variation in the speed of GTS buses than private buses. Nevertheless, vigorous statistical tests, t statistic and F ratio, indicated the difference in mean speeds and speed distributions are not significantly different from each other statistically.

32. From the above results one can draw the inference that either there is no difference in training and service conditions of GTS and Private Drivers or the differences if any do not effect operating speeds. It is possible that drivers of GTS and Private buses may be equally trained and experienced, but it is difficult

to accept that there is no difference in working and service conditions because of differences in size and ownership of organizations if not for any other reason. It is however plausible that differences in working and service conditions do not have significant effect on operating speeds which are determined by road and traffic conditions and vehicles have to move in the stream. There was therefore no significant difference in the speeds of two groups of drivers. This suggests need for further research on factors affecting vehicles operating speeds and also on effects of training, working and service conditions on driver behaviour. This study has however amply demonstrated that differences in speeds of GTS and Private buses are statistically not significant.

ANNEXURE-I

OBSERVATIONS OF OPERATING SPEEDS

(MILES PER HOUR)

PRIVATE BUSES:

46.2	48.0	38.7	35.3	42.9	48.0	40.0
44.4	44.4	38.7	40.0	44.4	46.2	47.1
43.6	41.4	40.0	42.9	38.7	46.2	46.1
50.0	41.4	40.0	46.2	44.4	40,0	48.0
46.2	42.9	48.0	38.7	40.0	44.4	34.3
44.4	51.1	41.4	50.0	46.2	42.9	44.4
34.3	35.3	44.4	44.4	42.9	45.3	37.5
48.0	44.4	46.2	46.2	48.0	41.4	46.2
40.0	44.4	42.9	50.0	44.4	46.2	40.0
46.2	37.5	42.9	44.4	38.7	46.2	44.4

GOVERNMENT BUSES:

41.4	41.4	48.0	50.0	44.4	38.7	44.4
46.2	44.4	38.7	42.9	41.4	48.0	46.2
44.4	36.4	33.4	40.0	46.2	46.2	48.0
48.0	44.4	37.5	44.4	46.2	48.0	42.9
46.2	48.0	33.3	46.2	41.4	98.0	41.4
40.0	41.4	42.9	48.0	48.0	52.2	40.7

Annexure-II

Test of Significance

t Test:

For comparison of two sample means where population mean and standard deviation are not known.

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\hat{\sigma}_{\bar{x}_1 - \bar{x}_2}}$$

Where

$$\hat{\sigma}_{\bar{x}_1 - \bar{x}_2} = \hat{\sigma}\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$$

and

$$\hat{\sigma} = \frac{\Sigma (X_1 - \bar{X}_1)^2 + \Sigma (X_2 - \bar{X}_2)^2}{n_1 + n_2 - 2}$$

If sample variance differ significantly, the degree of freedom are obtained by:

$$d.f = \frac{(s_1^2/n_1 + s_2^2/n_2)^2}{\frac{(s_1^2/n_1)^2}{n_1 + 1} + \frac{(s_2^2/n_2)^2}{n_2 + 1}}$$

To test the significance of the difference between the two means, we set-up the Null and Alternate Hypothesis and decision criteria as below:

Null Hypothesis	$H_o = \bar{X}_1 = \bar{X}_2$
Alternate Hypothesis	$H_2 = \bar{X}_1 \neq \bar{X}_2$
Decision Criteria	Reject H_o and Accept H_1 if $t \geq 1.99$ at 5% significance level with 83 degrees of freedom.

Annexure II (Continued)

From Data in Table 1 we obtain:

Private Buses (x_1)	Govt. Buses (x_2)
$n = 70$	$n = 42$
$\bar{x} = 43.44$	$\bar{x} = 43.81$
$\Sigma (x_1 - \bar{x}_1)^2 = 1032$	$\Sigma (x_2 - \bar{x}_2)^2 = 749$

$$\hat{\sigma} = \frac{\Sigma (x_1 - \bar{x}_1)^2 + \Sigma (x_2 - \bar{x}_2)^2}{n_1 + n_2 - 2}$$

$$= \frac{\sqrt{1032 + 749}}{110} = 4.024$$

$$\hat{\sigma}_{\bar{x}_1 - \bar{x}_2} = \hat{\sigma}\sqrt{\frac{1}{n_1} + \frac{1}{n_2}} = 4.024\sqrt{\frac{1}{70} + \frac{1}{42}}$$

$$= 0.785$$

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\hat{\sigma}_{\bar{x}_1 - \bar{x}_2}} = \frac{|43.44 - 43.81|}{0.785} = 0.47$$

$$d.f = \frac{s_1^2/n_1 + s_2^2/n_2}{\frac{(s_1^2/n_1)^2}{n_1 + 1} + \frac{(s_2^2/n_2)^2}{n_2 + 1}} - 2$$

$$= \frac{(14.7/70 + 17.8/42)^2}{\frac{(14.7/70)^2}{71} + \frac{(17.8/42)^2}{43}} - 2 = 82$$

$t = 0.47 < 1.99$ at 5% Sig. level:
Not Sig.

F ratio:

$$F = \frac{\text{Large Variance}}{\text{Smaller Variance}}$$

from the statistics obtained for t test we obtain:

$$S_1^2 = \frac{\Sigma (x_1 - \bar{x}_1)^2}{n} = \frac{1032}{70} = 14.7$$

$$S_1^2 = \frac{\Sigma (x_2 - \bar{x}_2)^2}{n} = \frac{749}{42} = 17.8$$

$$F_{(70,42)} = \frac{s_2^2}{s_1^2} = \frac{17.8}{14.7}$$

= 1.21 Not Significant at 5% level.