Statistical Analysis of Vehicle Delay Measurements Considering Different Time Durations in Dhaka City

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Abstract

Vehicle delay is one of the significant parameters for signalized crossing points. Additionally, these estimations ought to likewise be made very touchy. In the event that the examinations are made without video-camera, regardless of whether any little issue in regards to vehicle records, field perception ought to be repeated. Peak hours are characterized as an hour that traffic volume is the most elevated.This investigation plans to get a solid examination approach identified with the estimation of the vehicle delay in less time. The average delay observation values are viewed as three times the time as fifteen minutes, thirty minutes, and hourly. To examine the impact of observation periods on the consequences of delay, statistical tests are applied. Vehicle delay observation values acquired from Farmgate Intersection in Dhaka, Bangladesh is utilized in these statistical tests. Kolmogorov-Smirnov and Wilcoxon Signed Rank Test are utilized for the assessment of the methodologies. Because of the statistical analyses, however, thirty-minute delay observation results are the foremost closed to hourly (peak hour) delay observation results, fifteen-minute delay observation results don't seem to be closed to hourly (peak hour) delay observation results. Thus, it is presumed that the utilization of thirty-minute delay observation rather than hourly delay observation is demonstrated.

Keywords: *Intersection; Kolmogorov-Smirnov test; Signalized intersection; Wilcoxon signed rank test; Vehicle delay.*

1. Introduction

Delay is the waste of time approaching the vehicle to the intersection because of the other cars, the intersection's geometric properties, and the control structures such as traffic signs and traffic lights. Vehicle delay is an important parameter of success when approaching signalized intersections. This parameter was used to assess the service level and to test the function of signalized intersections (Webster, 1958). In the field, to estimate the real observation values, calculating the delay should also be very responsive. It also takes a long time for such measurements. For several decades different measurement methods have been developed by transportation researchers for the exact prediction of vehicle delay (Akcelik, 1981). The study of delay observation takes a long time and this is a difficult task. On the other hand, obtaining closer values should be made as accurately as possible. These measurements may be taken by a video camera as well as by at least two observers. They make observations at peak hours. The observation time is usually one hour when the traffic levels are the greatest. In the field experiments, each vehicle was separately considered (TRB, 1985). At the end of this, the delay value for each vehicle was obtained. Since inaccurate delay measurements can lead to the assignment of the erroneous signal length for each approach to the intersection and inappropriate design, these measurements should be made very sensitive (Ban et al., 2009 This condition creates a loss of time as well as more labor. It takes a long time to calculate the interval, as well as a complicated and tiring operation, a current method that is more reliable than the others, requires less time, and is closer to real observation.

2. Literature Review

The vehicle delay at the signalized intersection consists of three parts, called the delays in stopping, accelerating, and decelerating (Dion et al., 2004). The stopping delay displays the time to process that the vehicle takes at an indicated intersection due to stopping within the red or green signal span. Figure 1 shows a vehicle's trajectory diagram near a signalized approach to the intersection. In Figure 1 also indicates deceleration delay (A), stopping delay (B), acceleration delay (C) For measuring the delay at signalized intersections, transportation researchers have done several studies for many years (Akgungor, 2004). The 1985 Highway Capacity Manual delay formula was examined and a calibration process was improved (Akcelik, 1981). Field experiments and samples for delay measurements were discussed in the Materials and Methods portion (Murat, 2006). In addition, Delay analysis, sample cases of average delays, and Farmgate Intersection comparisons of delay observations were added. As the results of the statistical tests were demonstrated in the Results part, in the Discussion part, the results were evaluated considering Kolmogorov-Smirnov and Wilcoxon Signed Rank Tests, and some recommendations were presented for the measurement of the delay.

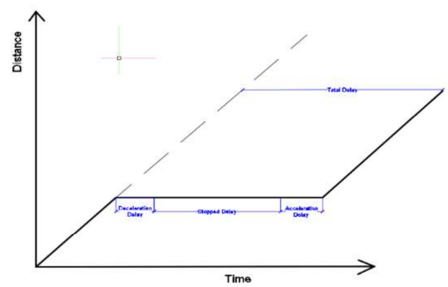

Figure 1. Components of Vehicle Delay.

3. Methodology

Delay observation studies are dispensed within the field as described within the following terms:

i. Determination of point 1 of reference and point 2 of reference: When point 1 of reference is chosen because the center point of the intersection, point 2 of reference is taken because the point behind the traffic signal hundred meters apart.

ii. Observers or Video Cameras: Minimum of two observers or a video-camera is needed for an intersection approach when the delay observation is generated. Observers must be located between indicator 1 and indicator 2. Thus, both entry time (at point of reference 2) of the vehicle to the intersection and exit time of (at indicator 1) the vehicle from the intersection may be accurately recorded. If the video camera is employed rather than observers, it's needed that video camera must be placed on location covering both reference point 1 and reference point 2. The locations of observers or video-camera and reference points at an intersection are depicted in Figure 2.

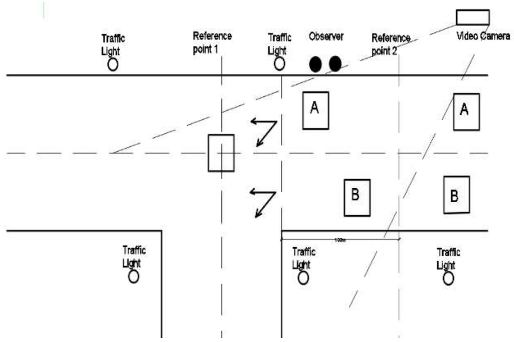

Figure 2. The Locations of Observers, Video-Camera and Reference Points at an Intersection.

In the following equation, the vehicle delay is computed:
t_{exit}: The vehicle's departure time from the intersection-Reference Point 1 (sec.)
t_{entry}: Vehicle entry time to the intersection-Reference Point 2 (sec.)
Vehicle Delay = $t_{exit} - t_{entry}$ ………… (1)
Sample cases for calculating delays are given in Table 1.

Table 1: Sample Cases for Delay Calculation

t_{exit} (Sec.)	**t_{entry} (Sec.)**	**Vehicle Delay (Sec.)**
3	64	62
23	66	45
29	69	42
30	72	44
34	75	43
40	77	39
42	79	39
46	85	41

3.1 Analysis

In this study, vehicle delay observation values were obtained from the Farmgate Intersection in Dhaka, Bangladesh. Observations were made at between 08:00 and 09:00, between 12:00 and 13:00, and also between 17:00 and 18:00 by video-cameras as an hourly. Besides, Observations carries with it two days of the week including daily within the weekday and at the weekend. Each vehicle was examined individually. the typical vehicle delay was calculated for every lane.
The average vehicle delay supported the lane was calculated within the following equations (Equation 2, Equation 3);

$$\text{Average Vehicle Delay for an hour} = \frac{[\sum_{n=1}^{k}(\text{texit} - \text{tentry})_n]}{k} \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

$$\text{Average Vehicle Delay for thirty minutes} = \frac{[\sum_{n=1}^{z}(\text{texit} - \text{tentry})_n]}{z} \quad \ldots\ldots\ldots.. \quad (3)$$

Where,
k : the full number of vehicles on the lane for an hour (veh.)
z : the entire number of vehicles on the lane for thirty minutes (veh.)

This study was applied on six different time periods and on three approaches (eight lanes) at the Farmgate intersection. The sample cases of average delays are given in Table 2. Fifteen-minutes delay observation results aren't given within the table due to not near real delay values (deviations are quite 15%). Each thirty minutes delay observation results and hourly delay observation results are given in Table 2.

Table 2: Sample Cases of Average Delays at Farmgate Intersection

Approach Name	Time Period	Lane	Average Delay (sec./veh.) 0 – 60 min.	Average Delay (sec./veh.) 0 – 30 min.	Average Delay (sec./veh.) 30 – 60 min.
A1	Weekday 17:00–18:00	Left	42.61	33.89	40.21
		Middle	26.64	25.45	27.95
		Right	29.22	30.66	28.75
A2	Weekend 12:00–13:00	Left	41.87	44.12	38.65
		Middle	29.45	28.23	29.56
		Right	35.66	36.45	34.21
A3	Weekday 8:00– 9:00	Left	53.56	58.23	57.45
		Right	57.55	58.23	58.91
A4	Weekend 8:00– 9:00	Left	59.61	61.23	61.77
		Right	62.45	63.45	63.88
A5	Weekend 17:00–18:00	Left	68.23	74.23	69.45
		Middle	70.56	68.23	72.58
		Right	19.23	16.89	18.66
A6	Weekend 12:00–13:00	Left	63.54	61.55	65.39
		Middle	56.23	52.45	58.21
		Right	21.56	22.23	24.56

Forty-eight sample cases were examined and evaluated in this work. The first thirty minutes observation results and second thirty minutes observation results were compared with hourly observation results and the First thirty minutes observation results and the second thirty minutes observation results were compared with each other. The comparison of the results can be seen in Figure 3(a-c).

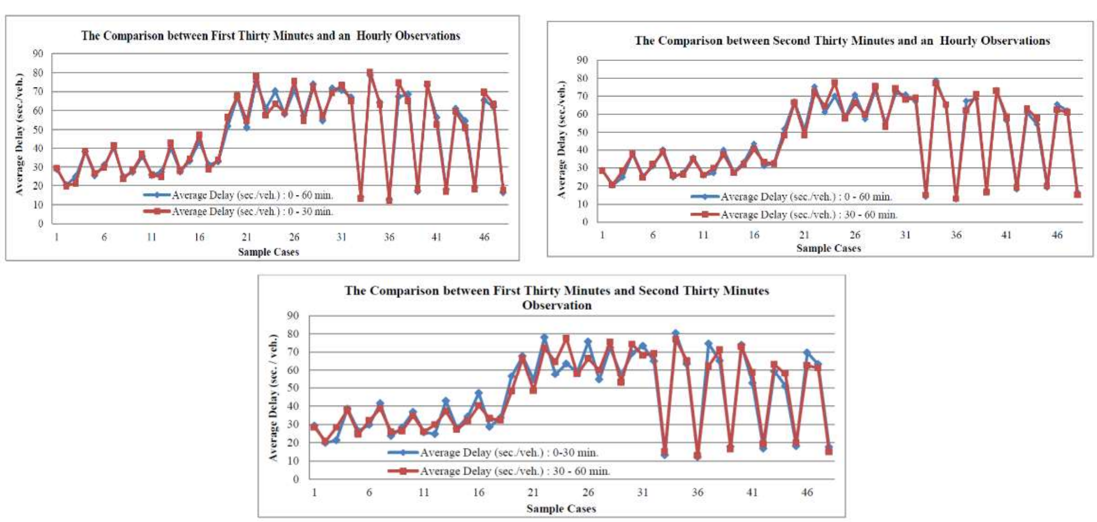

Figure 3: The Comparison between-(a) First Thirty Minutes and an Hourly Observations. (b) Second Thirty Minutes and an Hourly Observations. (c) First Thirty Minutes and Second Thirty Minutes Observations.

3.2. Statistical Tests

As shown in Figure 3(a-c), it can simply be understood that the calculation of vehicle delays is very close to each other despite different time durations. Considering the Kolmogorov-Smirnov and Wilcoxon Signed Rank Examination, these correlations are statistically analyzed by using SPSS (Statistical Product and Service Solutions), a software package used for statistical analysis. Kolmogorov-Smirnov test used for test of the normality in the statistics is one of the most useful and general nonparametric methods for comparing two samples. H_0 and H_a hypotheses of this test can be written in the following:
H_0: Distributions of the information are suitable for normal distribution.
H_a: Distrubutions of the info don't seem to be suitable for normal distribution.
If the significant value is that the greater 0.05, H_0 hypothesis is accepted. Thus, it will be said that data are suitable for normal distributions. If a significant value is less than 0.05, H_0 hypothesis is rejected (Kalayci, 2006). Wilcoxon Signed Rank Test may be a non-parametric statistical hypothesis test used when comparing two related samples or matched samples.

4. Results

Vehicle delay calculations were statistically examined in this work, taking into account various time durations. Firstly, on hourly and thirty-minute delay measurements, the Kolmogorov-Smirnov distribution function test was applied.

Table 3: Results of the Kolmogorov-Smirnov Distribution Function Test

	Kolmogorov-Smirnov		
	Statistics	df.	Sig.
An Hourly Observation Values (0-60 min.)	0.131	50	0.047
Thirty Minutes Observation Values (0-30 min.)	0.145	50	0.028
Thirty Minutes Observation Values (30-60 min.)	0.163	50	0.009

Table 4: Results of the Wilcoxon Signed Rank Test

	Wilcoxon Signed Rank Test - Test Statistics[a]		
	First Thirty Minutes - An Hour	Second Thirty Minutes - An Hour	First Thirty Minutes - Second Thirty Minutes
Z	-.235[b]	-.215[b]	.205[b]
Asymp. Sig. (2-tailed)	.822	.838	.846

a. Wilcoxon Signed Ranks Test
b. Based on Negative Ranks

5. Discussions & Conclusions

An appropriate and time-saving method for calculating vehicle delay is sought in this report. One of the keys aims of this research was to save time and labor for observation. To get an effective, productive, and true observation process, on the other hand. For this reason, instead of hourly observations, time intervals of fifteen minutes and thirty minutes are taken into account and confirmation of these time periods is investigated. The Kolmogorov-Smirnov distribution function test and the Wilcoxon Signed Rank Test are used for the quest stage of validation. As can be seen in Table 3., the important values are less than 0.05 for various time lengths. As seen in Table 4, it is assumed that substantial variations do not exist between two data sets for three comparisons due to significant values greater than 0.05, and these data sets resemble each other. As a result, considering the Wilcoxon Signed Rank Test, the use of thirty-minute delay observation instead of hourly delay observation is confirmed. New techniques and innovations, such as plate recognition, may be used for future automated vehicle delay measurement. For pursuing vehicle headways and saturation flow measurements at a signalized intersection, similar investigations should be carried out.

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