Rate of Pedestrian Signal Phase Actuation as a Proxy Measurement of Pedestrian Demand

Christopher M. Day, Hiromal Premachandra, and Darcy M. Bullock

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Abstract

There is a need for more and higher quality data on pedestrian demand patterns for a number of applications in planning, transportation engineering, public health, and other areas. It is particularly desirable to better characterize the influence of daily, weekly, and annual variations; the impact of weather and special events; and the effects of changes in pedestrian phasing. This paper proposes using the rate of pedestrian phase actuation as a proxy measure for quantifying the relative demand for pedestrian service at a signalized intersection. Although this performance measure does not by itself provide a pedestrian count, it can be used as a surrogate to characterize how pedestrian volumes vary due to operating conditions. The methodology could be used at locations where actuated pedestrian phases are in use.

This paper documents findings from over a year of data collection at a signalized intersection on a college campus. The effects of daily/weekly/annual variations, special events, weather (temperature and precipitation), seasonal changes in activity patterns, and changes in pedestrian signal phasing are documented. A Tobit model is used to account for the influences of these variables and understand how they co-influence pedestrian activity. The implementation of an exclusive pedestrian phase is associated with a 9% increase in pedestrian phase actuation at the intersection. This change is associated with a decrease in user cost relative to performing midblock crossings. The modeled impact of snowfall events adds further insight by showing that as the user cost of making midblock crossings increases, pedestrian activity at the intersection increases.

Research Questions

- Does signal event data provide useful information on long-term trends in pedestrian activity?
  - Use rate of actuation of the pedestrian phase as a proxy measure of pedestrian activity
- Can we measure induced demand from signal event data?
  - How does the rate pedestrian phase actuation change?
  - What is increase in the rate of pedestrian phase actuation after the implementation of an exclusive pedestrian phase?

Study Intersection

Crossing Northwestern at the Median

Pedestrian Signal Phase Configuration

- Fully-actuated vehicle operations with recall to phases 2/6 (no fixed cycle length)
- Ped buttons for phases 4 & 8 actuate the exclusive phase
- Ped buttons for phases 2 & 6 actuate conventional phase

Before

After

Exclusive Ped Phase Parameters

4 sec Walk Phase

22 sec Clearance Phase

Summary of Data Collected

Category	Subcategory	Number of Samples	Percentage of Total
Pedestrian Phase Type	Traditional Phases	1,790	17%
	Exclusive Phases	8,688	83%
	No Precipitation	9,431	90%
Weather (Precipitation)	Rain (Non-frozen precip.)	753	7%
	Snow (Frozen precip.)	294	3%
Time of Day	0600-2200	6,984	67%
	Other	3,494	33%
Day of Week	Weekdays	7,406	71%
	Weekends	3,072	29%
Month of Year	January	832	8%
	February	672	6%
	March	1,334	13%
	April	816	8%
	May	744	7%
	June	720	7%
	July	744	7%
	August	744	7%
	September	720	7%
	October	744	7%
	November	1,256	12%
	December	1,152	11%
Academic Year	Academic Year	6,536	62%
	Summer Break	2,568	25%
	Other Breaks	1,374	13%
Special Events	Football game	160	2%
	Basketball game	156	2%
	Other	24	<1%
Total Number of 1-hour Samples		10,478	100%

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Data Collection Periods

Observations From Data

Conclusions

- Pedestrian phase actuation rate demonstrated as a potential proxy measure for pedestrian utilization
  - Observations are consistent with expectations of behavior
  - Quantification of relative levels of demand is benefit of observation
- Could be coupled with direct measurements of pedestrian activity to estimate an annual profile of pedestrian utilization

Model Findings

- 10,478 observations
- Maddala's Pseudo- $R^2 = 0.550$
- Impact of variables mostly follow intuitive expectations
- Implementation of the pedestrian phase is associated with a **9.4% increase** in pedestrian calls for the movement
- The relative effect of snowfall is to **increase** actuation of the pedestrian signal, because of difficulty in making midblock crossings

Tobit Model Specification and Variable Descriptive Statistics

Variable	Pedestrian phase configuration (1 = exclusive, 0 = conventional)	Weekend (1 = true, 0 = false)	Breaks during academic year (1 = true, 0 = false)	Summer Break (1 = true, 0 = false)	Month of August (1 = true, 0 = false)	AM peak hours 0600-1000 (1 = true, 0 = false)	Lunchtime hours 1100-1300 (1 = true, 0 = false)	PM peak hours 1500-1800 (1 = true, 0 = false)	Weekend nights 2200-0200 (1 = true, 0 = false)	Temperature (degrees F)	Rain (1 = true, 0 = false)	Snow (1 = true, 0 = false)	Football Game (1 = true, 0 = false)	Basketball Game (1 = true, 0 = false)
Mean	0.842	0.293	0.131	0.245	0.071	0.667	0.083	0.125	0.049	49.6	0.072	0.028	0.015	0.015
St. Dev.	0.365	0.455	0.338	0.430	0.257	0.471	0.277	0.331	0.216	129.2	0.258	0.162	0.123	0.121
Coefficient	0.0938	-0.236	-0.269	-0.381	0.147	0.431	0.191	0.179	0.305	0.00333	-0.0563	0.0394	0.272	0.147
t-value*	13.182	-41.252	-33.845	-53.024	15.281	69.470	22.938	25.029	23.667	19.028	-6.240	2.694	14.659	7.913
P-value*	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.007	< 0.001	< 0.001

*The constant term in the Tobit regression model had a coefficient of -0.177, a t-value of -18.094, and a P-value of less than 0.01.