The Effect of Transit Signal Priority on Bus Rapid Transit Headway Adherence

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Abstract

We report the results of an experiment to evaluate the impact of transit signal priority (TSP) systems on headway adherence for a bus rapid transit (BRT) system in Provo and Orem, Utah. The system will grant TSP if the bus is running behind its unpublished schedule; the research question is whether TSP has an effect on the headway between vehicles, which is what users perceive.

1. Questions

Transit signal priority (TSP) allows traffic signals to flexibly accommodate transit vehicles. This may involve extending a green phase until the vehicle passes, triggering an early green if there is a vehicle waiting at the light, or even running specific transit-only phases. TSP helps transit vehicles maintain on-time performance (Liu et al., 2018), but often TSP will only engage at a signal if the vehicle is running behind its schedule, thus minimizing automobile delay when the bus is otherwise on schedule (Ni et al., 2020).

In 2018, the Utah Transit Authority (UTA) launched the Utah Valley Express (UVX) Bus Rapid Transit (BRT) system in Provo and Orem, Utah. The system connects two commuter rail stations, two major universities (Brigham Young and Utah Valley), and commercial districts in Orem and Provo. UVX has TSP on X of the X traffic signals along its route. The TSP is triggered when a vehicle is behind its schedule; however, the system does not publish a schedule and rather attempts to maintain a specific headway (6 minutes in the peak period).

The research questions are therefore:

- Does schedule-based TSP improve headway adherence for rapid transit systems?
- Is there an average improvement, or is there a reduction only in extreme delay?
- Is there an improvement difference by time of day or for particular portions of a rapid transit route?

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2. Methods

UTA provided timepoint data for all trips on the UVX system for the entirety of 2019. We calculated the headway between successive UVX trips at each stop, as well as the cumulative dwell time of all stations along the route. Because the UVX route loops around south Provo and stops at the Provo FrontRunner station twice, this created some minor difficulties in data processing, and we removed the timepoints on this portion of the route. We also limit our analysis to the period between 7 AM and 8 PM.

```
## # A tibble: 4 x 5
##   tperiod threshold start      end            n
##     <int> <fct>     <date>     <date>     <int>
## 1       0 5 min     2019-05-02 2019-06-06 43801
## 2       0 2 min     2019-06-10 2019-08-29 70934
## 3       0 No TSP    2019-07-15 2019-07-25 16312
## 4       0 Always    2019-07-30 2019-08-08 16422
```

From January through June 6, the system operated with a 5-minute TSP threshold,. with TSP granted only if the vehicle was five or more minutes behind its scheduled timepoint. After August 12, the system switched to a 2-minute TSP threshold. During the summer, the TSP system was configured as follows for this experiment:

- May 2 through June 6, 2019: 5 minute threshold
- June 10 through July 12 and after August 12: 2 minute threshold
- July 15 through July 26: no TSP
- July 30 through August 9: TSP always activated

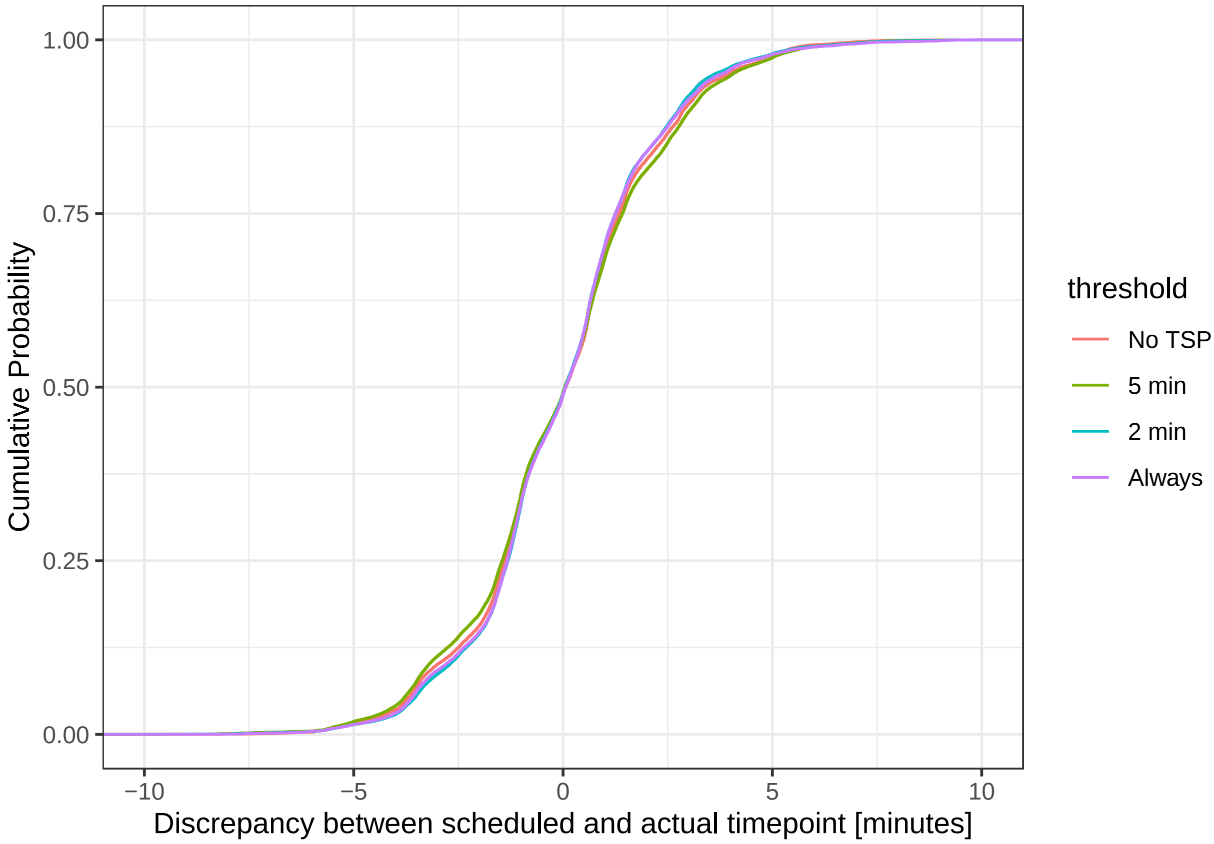
We discarded trips from January through April and September through December because the additional university passenger demand could interfere in the experiment and there were no tests of the "None" or "Always" TSP thresholds during the school year.

To evaluate the effect of changing TSP threshold on headway adherence, we consider two tests:

1. A student's T-test of the mean headway deviation among trips during different threshold periods. This is conducted with the `t.test()` function in R (R Core Team, 2021).
2. A Kolmogorov-Smirnov test of the distribution of headway deviations, conducted with the `ks.test()` function in R.

The data is pooled with We consider

3. Findings



References

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