Evaluation of Coordinated Ramp Metering (CRM) Implemented by Caltrans

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Image Source: https://mtc.ca.gov/sites/default/files/4.3c4-RampMetering.pdf.

Coordinated ramp metering (CRM) is a critical component of creating smart freeway corridors for managing traffic congestion and improving safety. CRM uses an algorithm that considers real-time traffic volumes on freeway mainline and ramps and then adjusts the metering rates on the ramps accordingly for optimal flow along the entire corridor. This research examined the recent Coordinated Ramp Metering implementations on Interstate 80 (I-80) in the Bay Area and State Route 99 (SR-99, SR99) in Sacramento. Unlike previous research, it looked at travel time reliability measures, efficiency measures, and before-and-after safety evaluation using the Empirical Bayes (EB) approach. As such, the evaluation represents the most complete before-and-after evaluation of CRM systems.

Study Methods

This study used the ratio of vehicle-miles traveled (VMT) and vehicle-hours traveled (VHT) for the corridor segments as measures of system efficiency. The ratio essentially measures average speed for the corridor. Travel time reliability measures used in this study are based on how much additional time compared to the average travel time travelers need to plan for reaching their destination. Most of the research on before-after evaluations of Ramp Metering compares measures collected in the "before" period to the "after" period. In this study, we contend that this simple comparison is not an appropriate approach since measures may change due to a variety of factors, not just CRM implementation. For instance, the measures of reliability, efficiency, and safety may change due to an increase in demand. Hence, in

this study, we establish the counterfactual (what would have happened on the study corridors without CRM) using control corridors from the same Caltrans district as the CRM corridors. For the safety analysis, we used the well-established Empirical Bayes approach for establishing the counterfactual count of crashes that would have occurred without the CRM systems.

The CRM systems implemented by Caltrans District 3 and District 4 are effective in improving system efficiency. The travel time reliability measures don't show similar improvements.

Findings
The CRM systems in Districts 3 and 4 have led to significant improvements in terms of system efficiency. However, travel time reliability indicators don't show consistent improvement. Estimation of safety improvements requires additional crash data collected over the next two years to be compared with the counterfactual estimates provided here.

Policy Recommendations
The existing CRM algorithms aim to improve system efficiency in terms of average speeds and are effective at doing that. If travel time reliability is an important agency goal, these algorithms may need to be updated to specifically address travel time reliability.

About the Principal Investigator
Anurag Pande PhD is a Professor of Civil Engineering at California Polytechnic State University, San Luis Obispo. His research interests include before-after evaluations of traffic operations and safety.

To Learn More
For more details about the study, download the full report at transweb.sjsu.edu/research/1812.

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