



TRAFFIC SAFETY COMMISSION

Kitsap Transit HOV Enforcement Program

2023 Report

Prepared by Kitsap Transit

Note: The contents of the report are solely the responsibility of the authors and do not necessarily reflect the views of the Washington Traffic Safety Commission.

Under SB 5689 (2022), Section 201(1)

Submitted by Washington Traffic Safety
Commission Shelly Baldwin, Director
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INTRODUCTION

The Washington State Legislature provided language in the State Transportation Budget to allow for the Washington Traffic Safety Commission to oversee a demonstration project, coordinated with a public transportation benefit area and the Department of Transportation (WSDOT), to test the feasibility and accuracy of the use of automated enforcement technology for high occupancy vehicle (HOV) lane compliance.

Kitsap Transit had led this demonstration project effort for potential photo enforcement of HOV lanes. The goal of this project is to determine the viability of systems involving sophisticated hardware and powerful software algorithms to automatically identify the occupancy of passenger vehicles in HOV lanes.

Vehicle Occupancy Detection (VOD) technology is being tested extensively worldwide but has not been implemented to be used for actual end-to-end enforcement in many locations yet. VOD technology is a novel piece in the transportation industry, and we are finding that vendors are still dialing in their processes, image quality, and transaction handling.

In the United States, the use of VOD technology along State owned Right-of-Way has been approached cautiously. From our research, we have found that funding for vehicle occupancy detection has been granted through 'Fair Travel' programs. The purpose of implementing a Fair Travel Program is to have the ability to charge single occupant vehicles a full priced toll when claiming to have a 2+ occupancy while traveling in a dynamically priced HOV toll lane.

Currently as it is written into legislation, photo-enforced toll systems can issue a notice of a civil penalty for non-payment of tolls, however only law enforcement officers have the ability to issue infractions to vehicles using HOV lanes illegally at the time of violation, per [RCW 46.63.160](#).

PURPOSE FOR THE PROGRAM

The objective of the project is to develop and test the performance of systems to automatically detect certain violations within HOV lanes, such as insufficient vehicle occupancy. The end product of the research is to quantify the performance of systems across different lighting and prevailing traffic conditions, as well as assess the integration of the system into a comprehensive HOV monitoring tool and explore its deployment for law enforcement activities within such facilities.

The preferred project outcomes will assist the State Troopers in detecting violators of the HOV lanes. By using infrared (IR) and visible range cameras, the system will alert the State Troopers who will be in a safe location about possible violators and potentially, provide the ability to enforce via the IR or camera system. The project involves system identification and short-term deployments.

The benefits of this work can be summarized into:

1. Significant improvements in the enforcement of HOV lanes;
2. Safer working conditions for State Troopers;
3. Improved traffic flow due to fewer HOV lane violations; and
4. Creation of data (velocities, number of vehicle occupants, etc.) that could support infrastructure decisions of significant magnitude (i.e., if the particular HOV implementation is the one that makes the most sense, given its usage, how the HOV traffic patterns interact with the traffic flow in the other lanes, counts of near~ misses when neighboring lanes have significantly slower traffic). Potential users are State Police, traffic engineers, and planners from entities like Kitsap Transit, the Federal Highway Administration (FHWA) and City and State Departments of Transportation (DOTs). Users could even benefit from knowing the traffic patterns at a particular HOV site. The benefits will be measured based on metrics that compare the collected data to the ground-truth.

STAKEHOLDER ENGAGEMENT

Over the course of the year, Kitsap Transit, WSDOT, WSP and local City Officials for both Poulsbo and Bremerton held monthly meetings targeting the review of the current HOV enforcement technology, the impact that it may have within the community, pilot study planning, and performance metric evaluations.

WORK ACCOMPLISHED TO DATE

- Identified and Selected Systems to Pilot
 - o To understand the baseline performance specifications and operational requirements, the Kitsap Transit team conducted an industry scan to seek out candidates to pilot their technology along SR-304. Though more companies soliciting this technology exist, through this scan, Kitsap Transit identified three vendors that met the qualifications and were willing to conduct a pilot.
- Comparative Matrix Creation of Vendor Systems
 - o As these vendors aim to achieve the same objective of vehicle occupancy detection (VOD) enforcement, each one has a slightly different approach to achieving these goals. To better understand these vendors as a side-by-side comparison, a vendor matrix was generated highlighting company details, current and past deployments, ways that the enforcement were being utilized, software capabilities, hardware required, and the type of performance metrics tracked.
- Deployment Review
 - o The main corridor of interest was along SR-304 in Bremerton where many challenges had presented themselves for Washington State Patrol. HOV enforcement issues have been on-going due to a limited and dangerous working environment to pull vehicles over along this corridor. The current lane configuration and limited shoulder widths for

enforcement results in a high frequency of single occupant vehicles (SOV) utilizing this HOV lane inappropriately.

- Taking a further look into the primary corridor of interest, the lack of appropriately placed infrastructure resulted in a challenge for these vendors to deploy equipment effectively and cost efficiently without needing to update existing inventory within the Right-of-Way (ROW).
 - To accommodate the proof-of-concept study, a new location was identified in Poulsbo, WA along SR-305 where appropriate infrastructure was in place to install the equipment and provide an adequate supply of power.
 - After lengthy discussions of overall project costs nearing \$100,000 per vendor, and due to budgetary constraints, the Kitsap Transit Stakeholders decided against a pilot program. With the approval of other agencies, Kitsap Transit had decided to evaluate programs that were already active in the United States to save costs.
- Pilot Program Research
- Kitsap Transit met with multiple transit agencies and DOTs that have either conducted a pilot program or have implemented this type of technology within their ROW for a proof of concept. Through these discussions, Kitsap Transit was able to understand current projects each agency was involved with, successes and challenges each one of these programs were experiencing, feedback of vendors within the industry and why they went the direction they did with each vendor.
 - Kitsap Transit Stakeholders were invited to conduct site visits at each pilot location to get a complete tour of the end-to-end product. Currently, there isn't an active program to showcase their results.

WHAT WE'VE LEARNED

Hardware required – While vendors will have minor variations on what's required, all will have similar requirements (power supply, fiber/communications, minimum width/space, etc.). A standard deployment requires a frontal camera to capture the front seats, a lateral camera to capture the back seats, and rear mounted Automated License Plate Recognition (ALPR) to identify the vehicle. Depending on the vendor and the current infrastructure in place, a custom housing could be made available or multiple poles would be required for installation of cameras. If appropriate infrastructure is in place, such as a tolling gantry, this can be used for installation.

Manual Verification – Is being utilized frequently by VOD vendors as this increases the accuracy of overall enforcement, eliminating false negatives and positives. If the system's confidence in its evaluation for a given vehicle is below a specified threshold, the images are routed to a human reviewer for validation before they are processed any further in our workflow. Results from initial testing periods showed that the automated processing system can accurately identify single-occupant vehicles ~94% of the time and it's estimated that this rate could be increased to 99.9% when augmented by manual human review.

Police Officer involvement – Through the traditional police officer approach, it has been found that on average one law enforcement officer issues one ticket every hour and doesn't allow for large scale

enforcement. Not only has this type of enforcement proven to be a challenge to catch most violators, but it has also shown to create delays and slowdowns from the natural curiosity of passing drivers when violators are being ticketed; with a dynamic toll system, these type of traffic delays will increase rates to utilize HOT lanes.

Some agencies have had difficulty matching Occupancy Detection System (ODS) transactions to roadside toll collection system (RTCS) transactions. In this case, entities have used a common trigger zone to avoid issues with transaction matching later. One of the key challenges in integrating multiple systems is ensuring precise synchronization of timestamps between them. This is essential for accurate violation identification, as any temporal discrepancy between systems can result in erroneous attribution of violations to the wrong drivers.

Dual lane enforcement - is achievable, but at a cost of reduced accuracy. Challenges are seen from side mounted cameras being masked by inside lane traffic flow and outside lane enforcement becomes more difficult during peak hour congestion. Overhead cameras attached to a gantry can only view the front row of vehicles accurately. Not seeing in the back row can provide an opportunity for missed passengers.

System costs - It can be difficult to determine the exact cost of the system without knowing site specific details. However, based on our discussions with multiple vendors, costs can vary between \$200,000 to \$500,000 per year per location, depending on factors such as whether edge computing and automated enforcement are used, the number of lanes involved, and whether a proprietary system specific to the jurisdiction is being developed, which could be an additional one-time fee upwards of \$1 million.

FUTURE WORK

If there is any future work to be conducted, Kitsap Transit will work closely with the WSDOT Tolling Division to aid with any research or reporting necessary if a pilot program is pushed forth.

Within the United States, there are multiple agencies conducting pilot programs with various vehicle occupancy detection vendors that are currently being setup to start in 2023. Once these pilot programs are underway, site visits to further understand the technology and the information it is reporting may be beneficial for key stakeholders involved.