HiRUC
HAWAII ROAD USAGE CHARGE DEMONSTRATION

DEPARTMENT OF TRANSPORTATION
STATE OF HAWAII

Cost of Odometer Reading Analysis

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Milestone

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Definitions & Abbreviations

TERM/ABBREVIATION	DEFINITION/DESCRIPTION
FHWA	Federal Highway Administration
OBD-II	on-board diagnostic
PMVI	periodic motor vehicle inspections
RUC	road usage charge

1. Introduction

As Hawaii and other states explore replacing the state gas tax with a distance-based road usage charge (RUC), one of the key issues to address is the cost of administering a RUC program. Economists and tax policy experts recognize the gas tax as one of the most cost-effective methods of collecting revenue. Elected officials, in turn, appreciate the simplicity, invisibility, and low cost of the gas tax for generating revenue to invest in the upkeep and repair of public roads and bridges.

Despite unfavorable administrative cost comparisons to the gas tax it would replace, RUC functions more like a vehicle registration fee than a gas tax. Like vehicle registration fees, RUC would be collected from individual vehicle owners, perhaps even at the same time as registration. The amount of the fee would vary based on characteristics of the vehicle – in this case, the number of miles the vehicle traveled over a defined period of time, not unlike vehicle fees commonly found in other states that are based on other characteristics such as weight, value, or age.

Given these similarities, the key difference between RUC and other vehicles fees that potentially contributes to the high cost of collection is the need to collect miles driven data from individual vehicles. Collecting miles driven data in an accurate, reliable, unintrusive way that respects privacy of the vehicle owner and does not unduly burden either the vehicle owner or the state government has stood as one of the central challenges of RUC research for the past two decades. Although much progress has been made, more work remains. Hawaii's status as a state with periodic vehicle inspections and no land borders with other jurisdictions offered an opportunity to test a surprisingly novel method of collecting miles driven data from vehicle owners, indeed one that is already in existence: by having a certified inspector look at the odometer once per year and record the number in a database owned by the state.

This paper explores the history of miles driven data collection efforts, the range of costs associated with the various methods tested over the past two decades, and estimates the range of costs for collecting miles driven data from odometer readings taken in Hawaii's periodic vehicle inspections.

2. Background

Since the first explorations of RUC began in Oregon in 2001, states have experimented with numerous methods of collecting miles driven data. These successive attempts have resulted in gradual improvements in accuracy, reliability, cost, and user experience, with enhanced understanding of how to protect driver privacy along the way.

- **Oregon road user fee pilot program, 2006-2007.** Oregon's first trial of RUC featured custom-built devices in several hundred vehicles, each manufactured by a state university engineering lab for the express purpose of recording miles driven and transmitting the data to the state via point-of-sale systems at select retail fueling station gas pumps equipped with radio transmitters. Each vehicle received several pieces of hardware including a GPS antenna fixed to the roof of the vehicle, an in-vehicle computer, and a screen to display miles driven and charges incurred, along with cables to connect all three devices. The devices cost several hundred dollars apiece to build in materials costs alone. Although successful as a proof of concept, the cost of collecting mileage data using such equipment would not scale economically. In Hawaii, RUC, as a gas tax replacement, would generate less than $100 per vehicle per year (approximately $70 per vehicle on average). With devices alone costing several hundred dollars, this method of reporting miles driven would not create any initial positive cash flow. Ongoing operational costs of a statewide pay-at-the-pump were estimated to be low, at $1.6 million per year, similar in magnitude to the fuel tax itself.
- **Minnesota road user fee trial, 2010-2011.** Minnesota improved on the technology by reducing the number of devices from three to two. The Minnesota test featured a device plugged in to participating vehicles' on-board diagnostic (OBD-II) ports along with a dedicated Android smartphone with custom software. Putting aside accuracy issues with the test, the equipment again cost hundreds of dollars per vehicle.
- **Oregon road usage charge pilot program, 2012-2013.** Oregon's second RUC trial saw vastly improved equipment, with plug-in devices as the only hardware required to report miles driven remotely, with no cables, no equipment requiring hard-wiring into the vehicle's onboard computer, and smartphones optional. At a cost of approximately $100, the bigger challenge facing the approach tested in Oregon's second pilot was the ongoing operating cost of the plug-in devices, which could range to as high as $20 per month. Oregon has sought to share cost of operating plug-in devices with private sector account managers by allowing them to offer value-added services to participants, which can generate direct or indirect revenue. The cost of OBD-II devices and their ongoing operations has declined in recent years, but still the cost of collecting miles driven data using this technology remains high. In Oregon, at 40% of revenue collected, commercial account managers take in around $70 per vehicle on average per year. Utah's figures are undisclosed. The HiRUC project team estimates the raw cost of devices, including hardware, communications costs and data management, at between approximately $5 to $10 per month, or in the high tens of dollars per year. This is based on device costs of $100-150 amortized over 48-72 months ($1.40 to $3.10 per month); telecommunications costs of $2-4 per month; and data management costs of $2-3 per month.

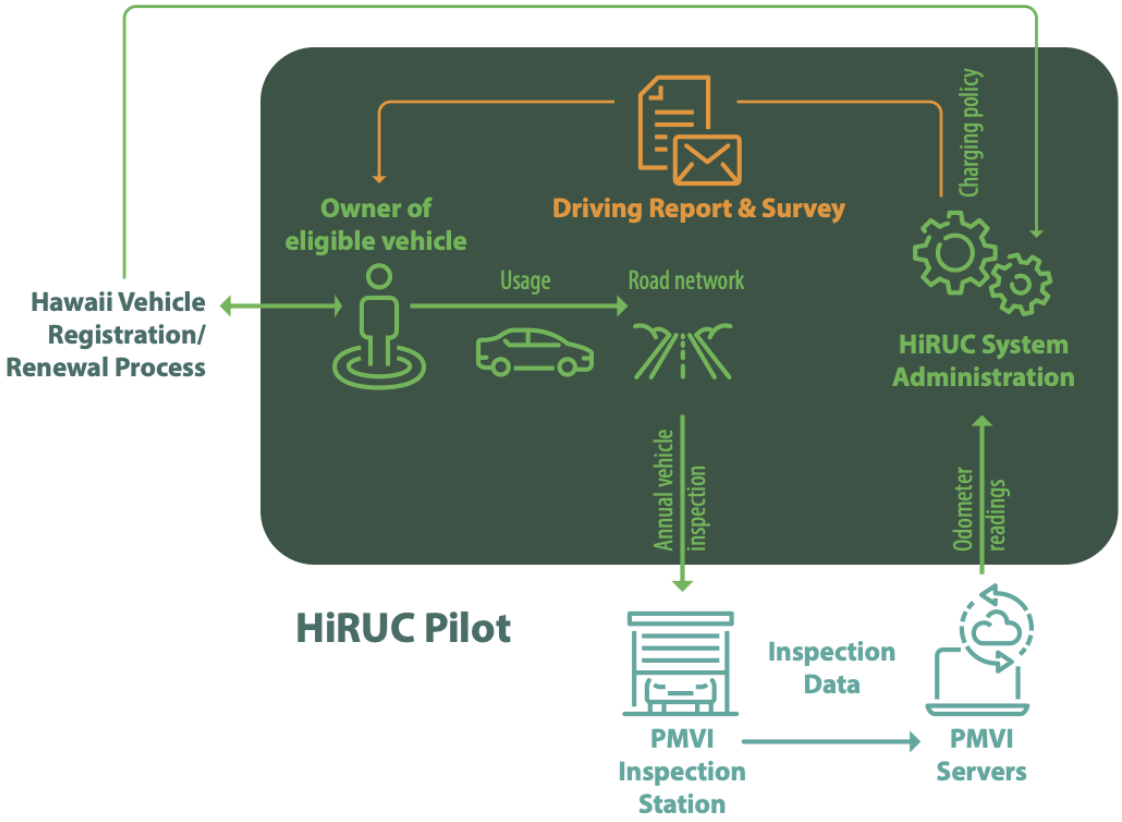
- **California road charge pilot program, 2016-2017.** California expanded the range of technologies tested to include not just OBD-II devices but also standalone smartphone applications (including an odometer image capture application), in-vehicle telematics, and manual odometer reading by a certified inspector. Native automaker telematics proved as costly or more costly than OBD-II technology because of the limited availability and high fixed costs of setting up data connections. With no hardware required, telematics remains a long-term priority for continued exploration and development due to its promise as a low-cost reporting method. Standalone smartphone apps that used the phone itself to estimate and track distance traveled by location performed well at low cost, low double digits per year per vehicle. These apps were distinct from the odometer image capture method. They suffered performance challenges such as battery drain and known logical flaws that could not connect miles recorded by a phone to a particular vehicle. The odometer image capture method was only appealing to a limited number of participants in the California pilot. Meanwhile, visual odometer reading by certified inspectors proved costly because of the lack of any existing infrastructure or program to collect such data. The pilot saw a limited number of inspectors available to inspect odometer readings, at high per-unit costs.

As a central function that must be carried out for a RUC program to succeed, finding efficient ways of collecting miles driven data remains a challenge. OBD-II devices continue to be a preferred method in existing programs, as a reliable but moderately costly approach. And telematics continues to hold long term promise as the method of the future, provided the auto industry, government, and data aggregator partners can agree on approaches for creating viable, low-cost architectures.

Hawaii's RUC pilot, HiRUC, presented a novel opportunity to explore the viability of an existing miles driven data collection approach: statewide periodic motor vehicle inspections (PMVI). Seventeen states have such periodic inspections, typically for safety purposes, and most of them, including Hawaii, already collect odometer data with each inspection. Hawaii, like other states, stores odometer readings in a state-owned, contractor-managed database. However, the data are currently not deployed for any functional purpose. HiRUC was the first application of the data.

Figure 1 depicts how the odometer readings being collected as part of the PMVI process was used in Part 1 - Driving Report of the HiRUC Demonstration. On an annual basis, vehicle owners take their vehicles to a certified PMVI inspection station, where the vehicle's odometer reading is captured as part of the vehicle's annual safety inspection. The PMVI inspection station transmits vehicle inspection data, including VIN, odometer reading, the date of the inspection, and whether the vehicle passed or failed inspection to PMVI's servers. The demonstration used this odometer reading data combined with periodic snapshots of data from the vehicle registry, applied the road usage charging policies to create *Driving Reports* with the miles driven between the last two vehicle inspections, gas taxes paid during the period, and the road usage charge amount. *Driving Reports* were mailed to the address listed in the vehicle's registration record.

Figure 1: Use of Odometer Readings for the HiRUC Driving Report Demonstration



PMVI embodies nearly all of the desired characteristics of a miles driven data collection program: simple, familiar, unintrusive, protective of privacy, and low-cost to driver and state alike. PMVI-collected odometer data do have some accuracy and reliability challenges that were discovered and documented in the HiRUC pilot, but for the large majority of vehicles, it represents an accurate, reliable reporting method. Given these promising characteristics, Hawaii Department of Transportation (HDOT) and the Federal Highway Administration (FHWA) expressed strong interest in exploring inspection-based odometer readings as the basis for a RUC.

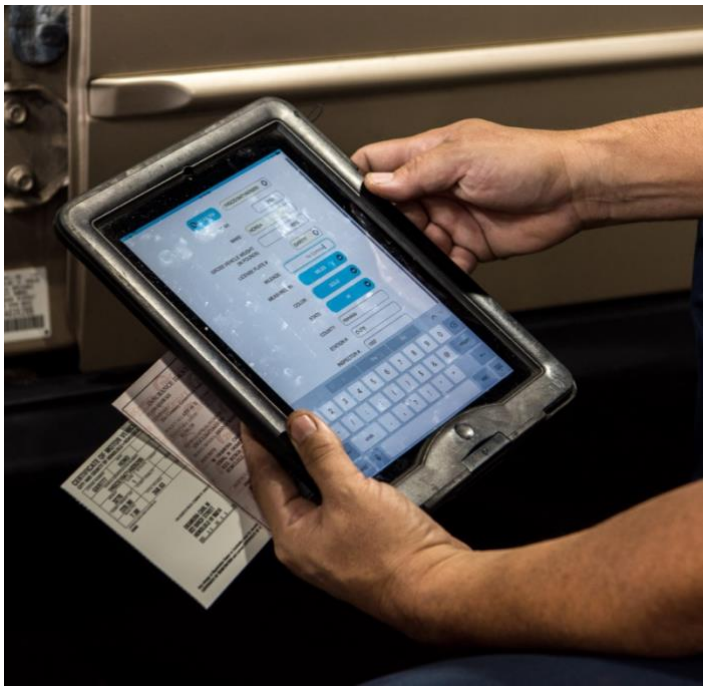
3. Cost of Odometer Reading

There are several ways to calculate the cost of collecting miles driven data using PMVI or any similar inspection-based odometer data collection approach. First is a marginal cost calculation: what is the marginal cost of collecting the necessary data and accessing it for purposes of a RUC program? Second is an actual cost calculation: what is the actual cost to PMVI inspectors of collecting and reporting odometer data to the state? Third is a total cost calculation: imagining there were not PMVI program, what would it take to reconstitute the program?

3.1. Marginal Cost of Collecting Odometer Data through Existing Vehicle Inspections

The marginal cost of collecting odometer data from vehicles for purposes of a RUC program is zero or near zero. Hawaii already requires vehicle owners to receive an annual inspection for any vehicle older than two years. As part of the inspection, inspectors must record the odometer reading by keying it into a custom application on an iPad that communicates the odometer value, along with other vehicle, owner, and inspection data, to servers owned by the contractor who operates the information technology for the state inspection program. The state owns the underlying data collected and housed in the PMVI database.

There are often issues with individual data entries. For example, inspectors sometimes make data entry mistakes when keying in the odometer value, either because they misread the odometer itself or because they type it in incorrectly. These challenges can be improved by adding quality control procedures to the inspection process and/or inserting additional technology, such as odometer image capture applications, into the custom iPad application used by inspectors to capture odometer readings automatically. Either of these changes would result in additional cost to inspectors that could be passed on either to the state or to customers. An odometer image application would cost less than $2 per image per vehicle to administer at scale. We estimate that additional quality control for improving accuracy of odometer data reported could add up to several minutes per inspection along with a minimal amount of time spent reviewing selected images off-site. Based on average wages rates of automotive service technicians in Hawaii ($25.73 in urban Honolulu), three additional minutes of work would cost approximately $1.30 in Honolulu. Figuring additional costs for overhead at a multiplier of about 2, additional QC would cost less than $3.00.



In summary, the marginal cost of collecting odometer mileage data using the current PMVI program is $0. Additional enhancements to the program to improve the quality of data entered into the program would cost up to $5 per year per vehicle at the high end, a cost that could be borne by customers, the state, or shared.

3.2. Actual Cost of Collecting Odometer Data through Existing Vehicle Inspections

The actual cost of collecting odometer data reflects the share of costs of the PMVI inspection process attributable to collecting odometer data. A typical vehicle inspection takes approximately 15 minutes or less. The portion dedicated to noting the odometer can be as short as a few seconds, time enough for the inspector to visually note the reading and either key it in directly to the iPad, or write it down on a notepad (or an arm or hand) before keying it into the iPad later. Assuming 15 seconds and using the wage rates and overheads calculated above, the actual cost of collecting odometer data for a typical inspection station is about $0.10 per vehicle per year. The PMVI inspectors also collect customer charges to cover their costs as well as the costs to the state and the state's contractor for administering the PMVI program, including the information technology and hardware such as the iPad, software, database, and cloud hosting. The pass-through costs to the state amount to approximately $3.40 per vehicle per year, but this includes a significant amount of data other than odometer reading. Presuming the odometer reading accounts for 5 percent of the data collected and transmitted, the additional program and IT costs add another $0.17 per vehicle, for a grand total of approximately $0.27 per vehicle per year.

3.3. Total Cost of Collecting Odometer Data by a Vehicle Inspector

Supposing a state did not have an inspection program and wanted to establish one for purposes of collecting odometer mileage for a RUC program, the cost associated would be higher. The state would not be able to leverage existing processes and would have to incur entirely new costs. Presumably a state in such a circumstance would leverage private auto service stations as the agents to collect data and, like Hawaii's PMVI program, license auto mechanics and service technicians to collect and report the data on their behalf. Hawaii's PMVI inspectors charge $25 per inspection, per state law, of which $3.40 goes to support the PMVI program and IT, leaving $21.60 for the PMVI inspector to cover their costs. An odometer-only program would be significantly less costly to both service stations and the state than an inspection program.

Presuming a typical inspector takes 15 minutes for a PMVI inspection, at the urban Honolulu average wage and an overhead multiplier of 2, the cost is approximately $13, leaving less than $9 for profit. For an odometer-only inspection, we can reasonably presume the length of time would be significantly shorter, about 5 minutes, reducing the cost to about $4.30 per inspection. The state would still need to cover costs of IT, such as iPads, software, database, and cloud hosting, which may still well reach up to $1.70 per vehicle to cover the costs of the IT contractor. The state's costs, however, would be significantly lower, as the need for the safety management portion of the program would not exist. Under this scenario, the total cost of manual odometer collection would be around $6 per vehicle per year.

3.4. Additional Considerations

The HiRUC Demonstration showed that the vehicle inspection mileage reporting method is significantly lower cost than the more technology intensive methods of reporting, but also preferred by Hawaii residents due to convenience and the ability to protect privacy. The demonstration also showed that using the vehicle inspection for mileage reporting could cover over 90 percent of vehicles in a RUC program in Hawaii. The remaining vehicles may fall into one of several categories of special circumstances where additional mileage reporting methods may be needed. These include:

- No vehicle inspection required the renewal year after it is first registered and thus no mileage data to base a road usage charge on
- No vehicle inspection required when a vehicle is retired or leaves the state (although odometer reading is required on the transfer of title)
- Audit situation due to random selection or data discrepancies
- Vehicles that travel many miles on non-public roads, and the owner wishes to record and claim those miles as an offset against RUC owed, presuming state policy allows for such offsets
- Owners and businesses requiring more frequent reporting and payment than annually

Possible ways to handle these special circumstances include manual odometer readings provided by the vehicle owner, smartphone image capture, fleet management systems, and use of plug-in-devices. The cost of manually provided odometer readings or image capture through a mobile website or app is under $2 per instance. Fleet management systems and plug-in-devices are significantly more expensive (as mentioned in Section 2), but the cost of collecting for those that choose to use these alternative methods of reporting could be the vehicle owner's responsibility, not born by the state. As demonstrated in the fleet pilot, the state would simply be responsible for providing an interface to accept the data provided by fleet management systems and plug-in-devices. For those that simply need more frequent payments, additional odometer readings may not be necessary.

An additional benefit of inspection-based reporting is the independent, visual true-up of the odometer reading by a certified vehicle inspector. This decreases the opportunity for fraud, which thereby decreases the overall cost of operations of a RUC program.

3.5. Extending Cost of Collecting Inspection-Based Odometer Data Beyond Hawaii

As shown in Table 1, the cost of collecting mileage driven data from a manual odometer inspection-based program, using a third-party inspector, ranges depending on the existing conditions (i.e., whether the state can leverage existing odometer data, as Hawaii can) and whether the state wishes to apply additional quality controls to the data to improve accuracy and reliability. The "high end" of costs portrayed in the table presumes a cushion of $1-2 per reading to account for regional variations beyond Hawaii, which represents between 20-50% of the calculated costs. All scenarios point to an inspection-based approach for collecting miles driven data at less than $10 per reading per vehicle, and when leveraging an existing program, more likely closer to $0.

Table 1: Cost of Collecting Inspection-Based Odometer Data (cost per reading)

	EXISTING LEVEL OF QC	ENHANCED QC	HIGH END OF COSTS
Marginal Cost Method	$0	$2	$4
Actual Cost Method	$0.27	$2-3	$5
Total Cost Method	$6	$8-9	$10

For the sake of comparison, Table 2 illustrates the estimated range of costs of common methods of mileage data collection other than inspection-based odometer reporting.

Table 2: Range of Annual Mileage Data Collection Costs per Vehicle

	LOW END OF COSTS	MID RANGE	HIGH END OF COSTS
Inspection-based odometer reporting	$0	$5	$10
Annual odometer image capture	$1	$3	$5
Quarterly odometer image capture	$3	$9	$15
Plug-in device	$50	$80	$110

4. Next Steps

Collecting miles driven data is not the only essential function of a RUC program. Other data must be collected or at least identified by joining data to the state vehicle registry. These other data include vehicle owner name and address, vehicle identifiers (e.g., vehicle identification number or VIN; vehicle make, model, and year; and/or vehicle license plate). In addition, a RUC program may need to record the gallons of fuel consumed or miles per gallon rating of a vehicle in order to calculate or estimate any fuel tax refunds offered as an offset to any RUC collected. Most of these additional data items are straightforward to identify and connect to individual vehicles through existing vehicle registries.

More importantly, ensuring an accurate but convenient method of collection can fulfill the promise of a reliable, trusted RUC program that generates needed revenue for investing in state roads and bridges. The HiRUC program demonstrated the viability of odometer-based RUC on a wide scale, but also identified some gaps and data accuracy challenges to address in a live program. Applying enhancements to these areas could be well worth the investment given the low marginal cost of collecting RUC with such enhancements, as low as $2 per reading or lower.

As Hawaii continues towards implementation of a RUC, the cost estimates in this paper can help to inform policy decisions, rulemaking, and system design. This data may also benefit other states looking at comparing costs of various mileage reporting methods for a RUC, particularly those that have a vehicle-inspection or emissions-inspection in place that could be leveraged.