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Minnesota User Based Fee Demonstration

Final Report

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The Minnesota Department of Transportation conducted a 12-month Distance Based Fee (DBF) demonstration that utilizes existing technologies embedded within Shared Mobility (SM) fleet vehicles and connected and automated vehicles (CAVs) to automatically calculate and collect the fees. As part of the demonstration, researchers at the Humphrey School of Public Affairs discussed policy considerations and implications of DBFs on privacy, equity, and administration costs, as these are often raised as obstacles to the implementation of a DBF. Researchers also conducted financial analysis, and outreach and education efforts. Lastly, researchers conducted an evaluation of the demonstration based on the administrative and political feasibility, efficiency, adequacy, and equity of DBFs. This research identified the challenges that had to be overcome to implement DBFs and the potential to deploy this model on a broader scale.

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LIST OF ABBREVIATIONS

AMC	Association of Minnesota Counties
BEV	Battery-Electric Vehicle
C2G	Cradle to Grave
C/AV	Connected and Automated Vehicles
CTS	Center for Transportation Studies
DBF	Distance-Based Fee
DOR	Department of Revenue
DPS	Department of Public Safety
EV	Electric Vehicle
FHWA	Federal Highway Administration
FOIA	Freedom of Information Act
GHG	Greenhouse Gas
GSA	Government Services Administration
HD	High Definition
HOT	High Occupancy Travel
ICE	Internal Combustion Engine Vehicle
MnDOT	Minnesota Department of Transportation
MFT	Motor Fuel Tax
MMB	Minnesota Management and Budget
MNIT	Minnesota IT Services
MPG	Miles per Gallon
MVRT	Motor Vehicle Registration Tax
MVST	Motor Vehicle Sales Tax
OEM	Original Equipment Manufacturers
PCU	Passenger Car Units
PHEV	Plug-In Hybrid Vehicle
PII	Personally Identifiable Information
PILI	Personally Identifiable Location Information
RUC	Road Usage Charges
SM	Shared Mobility
STSFA	Surface Transportation System Funding Alternatives
TAC	Technical Advisory Committee
TNC	Transportation Network Companies
VMT	Vehicle Miles Traveled

EXECUTIVE SUMMARY

MnDOT and other transportation agencies that depend upon the motor fuel tax as a revenue source face greater challenges as more vehicles on the road that use little to no gasoline and the number of electric vehicles on the road is expected to grow quickly in the near future. To continue to provide a strong transportation system, these agencies will need new financing tools to supplement the shrinking revenue from the motor fuel tax.

A logical way to backfill lost revenue from the decreasing number of gasoline-powered vehicles is a distance-based fee (DBF), where fees are calculated based on how far one drives, rather than how much gasoline one burns.

This makes a lot of sense. After all, vehicles that do not use gasoline contribute to the deterioration of roads and bridges, so users of those vehicles should pay their fair share for building and maintaining the transportation infrastructure. Moreover, a distance-based fee is flexible enough to work in an uncertain future, since it can be applied to any type of vehicle regardless of its fuel source. Importantly, a distance-based fee maintains the foundational principle of road financing called “user-pays.” This economic principle encourages rational use of scarce and valuable resources, such as roads.

There are challenges associated with distance-based fees that policymakers would need to manage. Among the most significant are that a distance-based fee system should not violate citizens’ privacy rights, be a burdensome logistical hassle for drivers, or cost an excessive amount for the government to collect.

In this demonstration of distance-based fees, MnDOT partnered with shared mobility (SM) fleet operators to provide aggregated travel data from on-board embedded telematics in their vehicles. With shared mobility services, customers essentially rent the use of vehicles for a relatively short amount of time, such as a single trip or a few hours.

These SM fleets have factory-installed “telematics” capabilities, which, among other things, enable reporting of the distance travelled and the time the travel occurred, the core data that are needed for distance-based fee calculations. With the SM fleet operations, privacy of individual driver’s data is ensured because all trip data reported for fee calculation and collection is aggregated. This vehicle telematics platform is likely a model for what most new vehicles will be capable of in years to come. Already, this factory installed technology has become common-place, and industry analysts expect the imbedded technology to soon become universal.

This distance-based fee fleet collection model could scale up as the government could someday decide to charge vehicle fleet owners a fee based on the mileage driven, which is being automatically tracked by each vehicle’s on-board telematics system. Under this model, individual fleet vehicle users would not directly have to manage payment of the fee, as they would if distance based were charged on all individually owned vehicles. Instead, the fleet operator would manage payment of a fee for their entire fleet.

The evaluation of this approach showed that the approach has several important advantages. First, privacy concerns associated with charging a distance-based fee are essentially non-existent. In the study, personal data is collected with the SM providers' security equipment in ways that their customers have already consented to when they initially enrolled. Under this approach, the only data reported to the State tax collectors is the aggregate distance traveled by the vehicles in the overall fleet, not any individual-specific personal information.

Second, under this DBF for fleets approach, drivers do not have to buy or install new electronic equipment and be responsible for reporting distance traveled to tax collectors. In fact, under this approach individual users of fleet vehicles will not have to do anything differently. SM providers may experience an increase in their operating costs due to the customization of existing software, the automation of the data collection process, and additional efforts to comply with the auditing process. These costs, however, tend to decrease as SM providers are more familiar with the information they were required to report.

Third, it is much more difficult for typical users to avoid fees by altering embedded telematics equipment. This is essential to system integrity and revenue collection.

Finally, under this fleet focus, the government only has to collect from a relative handful of fleet operators, not from millions of individual vehicle owners. This makes tax collection and auditing much more efficient and less costly than DBF collection systems that are implemented at the individual level.

Overall, the collection of simulated fees from the companies who volunteered to participate in the study worked relatively smoothly. Downloading distance-traveled information from on-board telematics equipment was proven technically feasible, and relatively simple. Company officials report that the process was relatively straight forward, even at this fledgling stage. The study also identified ways to make the process work even more efficiently. Factors that may improve efficiency in fee collection, for instance, include a licensing process with an incentive, having legislation requiring online filling, adjusting the fee collection schedule according to the scale of implementation, using the existing taxpayer information, and integrating DBF charges with the payment of other taxes or fees companies are subject to. Similarly, administrative and civil penalties may contribute to improving compliance and enforcement under a DBF system.

A Potential Approach for the Future?

While Minnesota's DBF demonstration was conducted with SM fleets, there are many other types of fleets operated by government and corporations. The federal government alone operates a fleet of about 640,000 vehicles, according to the Government Services Administration (GSA). Fleets operated by ride-sharing companies like Uber and Lyft, food-delivery services, package delivery companies, and freight haulers are also very large and are expected to grow in the future.

Implementing a distance-based fee that is collected via imbedded telematics for those millions of future fleet trips would ensure that the users of those vehicles, including current and future vehicles that use little to no gasoline, are paying their fair share for use of roads and bridges, just as current payers of the gasoline tax are doing. And it would do so in a way that addresses major public concerns associated with DBF for all proposals.

If elected officials chose to adopt this telematics-based collection approach in the future, they would need to grapple with additional policy questions. For instance, they would have to set the rate per mile that would be charged. In the MnDOT study, we estimate that it would take a charge of about 2.7 cents per mile to collect an amount that is equivalent to the current motor fuel tax (1.6 cents per mile for the state of Minnesota and 1.1 cents per mile for the federal government), but lawmakers would have to decide the rate they ultimately choose to charge.

While broad use of distance-based fees for individual vehicle owners was not the focus of this model and this study, the increasing availability of factory-installed telematics in vehicles does also make a distance-based fee approach more feasible for application to individual vehicle owners as well, either on a voluntary or mandatory basis. Minnesota Rep. Steve Elkins has introduced a bill to offer electrically powered vehicles a distance-based charge as an optional alternative to a fixed annual fee.

Through this study, we have learned that the telematics approach to collecting distance-based fees is technically feasible, relatively straight-forward to manage, and carries significant advantages over other collection approaches for distance-based fees. This new research identifies a potentially promising path forward for elected officials to explore to ensure that all vehicle users are paying their fair share for the financing of roads and bridges.

CHAPTER 1: INTRODUCTION

States across the country are facing a future where motor vehicles are increasingly fuel-efficient, electric, or powered by other alternative fuels. This reduced reliance on motor fuels will likely result in a reduction of revenues collected from the motor fuel tax. For this reason, many states are pursuing distance-based systems to replace and/or supplement the motor fuel tax system. Distance-based fees (DBFs) are also known as mileage-based user fees (MBUF), road usage charges (RUC), or vehicle miles traveled (VMT) fees.

The Minnesota Department of Transportation ran a DBF demonstration between April 2020 and March 2021 to demonstrate the feasibility of using telematics embedded in modern production motor vehicles to assess DBFs in partnership with shared mobility (SM) providers. These telematics allow users of the SM vehicles to reserve the vehicle and report the miles driven, and for the SM provider to bill their customers accordingly. The telematics are also secure in that users cannot disable or deceive the fee collection technology. The demonstration project also included an autonomous vehicle simulation to understand how a mileage fee might be charged and collected on a self-driving vehicle.

As part of the demonstration, researchers at the Humphrey School of Public Affairs conducted policy research, financial analysis, outreach and education efforts, and an evaluation of the demonstration. This report has five chapters organized as follows.

Chapter 2 discusses policy considerations and implications of DBF's on privacy, social equity, rural and urban equity, modal equity, and collection and administration costs, as these issues often are raised as obstacles to the implementation of a DBF. The results from these conversations will inform general policy.

Chapter 3 lays out a framework for DBF pricing schemes and discusses potential DBF rates. The pricing schemes for DBF conceptually divide the fee into three key components: a baseline fee, efficiency add-ons fees, and other adjustments. The baseline fee is based on the average cost of a mile traveled for vehicles in the state based on motor fuel tax receipts. The baseline fee could be further augmented with efficiency add-ons and other adjustments to account for additional policy considerations, such as environmental or social-equity concerns and vehicle size/weight. Lastly, the rate structure has the potential to catch up with increasing long-term transportation needs, through indexing, periodical updating, or some combination of both.

Chapter 4 presents a summary of outreach and education efforts. This includes the development and execution of three roundtable events and six Technical Advisory Committee (TAC) meetings. This chapter also presents a communications plan developed early in the process to communicate the goals and purposes of Distance Based Fees effectively and adequately to policymakers, national stakeholders, and customers of SM services. The messaging and marketing of DBFs were developed within the constraints of the demonstration.

Lastly, Chapter 5 presents the results of an evaluation conducted to assess the execution of the Minnesota DBF demonstration based on four revenue-evaluation principles of feasibility, efficiency, adequacy, and equity. Overall, the demonstration successfully showcased the potential to collect DBF from SM providers, with the embedded telematics providing a useful platform for conducting all the necessary transactions. The evaluation also notes a number of factors related to the scalability and transferability of a DBF system that could be considered in a future implementation. These include the ease of implementing a DBF on C/AVs, collecting detailed trip data for variable DBF rates, costs of developing a data systems management plan, and the design of a DBF rate to address equity concerns.

CHAPTER 2: POLICY CONSIDERATIONS

This chapter contributes to the discussion on policy considerations and their implications for the Minnesota DBF demonstration. We discuss policy considerations and implications on privacy, social equity, rural and urban equity, modal equity, and collection and administration costs. In terms of privacy, we provide a discussion of the current legal landscape regarding ownership, collection, and sharing of Personally Identifiable Information (PII). In terms of social equity, we explore social equity of transportation funding sources in terms of the benefit received and the ability to pay. In terms of rural and urban equity, we explore the impacts of a DBF system on urban and rural drivers under different scenarios. In terms of modal equity, we discuss the transportation costs imposed by different transportation modes and how they contribute to cover the infrastructure costs they imposed. Lastly, in terms of collection and administration costs, we discuss how the Minnesota demonstration simplifies the collection and administration of DBFs and explore the fees and regulations that apply to shared mobility providers. The results from these conversations will inform general policy.

2.1 PRIVACY CONSIDERATIONS

2.1.1 Synopsis of the Issue

Data privacy is a concern to many individuals. Well-known examples of events that lead to this concern include the 2017 Equifax data breach[1] and the Facebook and Cambridge Analytica scandal, which led to a 66 percent decline in trust among surveyed Facebook users that the social media site was committed to protecting the privacy of their personal information.[2] This, along with other recent data breaches, may have customer trust repercussions for years to come. Consequently, policymakers and automakers have an interest in ensuring that they keep riders' private information secure.

In a transportation context, personally identifiable information is defined as unique data that carries the potential of being used to identify a single individual. Examples of personally identifiable information include full name, telephone number, street address, email address, email password, vehicle registration plate number, driver's license number, credit card numbers, and one's digital identity (Douma & Deckenbach, 2009, pp. 318-319). More specifically, personally identifiable *location* information (PILI) is considered data that could be used to identify an individual (e.g., license plate number) as being at a particular location at a particular time (Garry, Douma, & Simon, 2012, p. 106).

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[1] "Equifax to pay up to $700M in data breach settlement," KARE 11, July 22, 2109. Available at https://www.kare11.com/article/news/nation-world/equifax-to-pay-up-to-600m-in-data-breach-settlement/507-9c9dd21d-b7aa-4d41-8d5f-92e5bfff2621, last accessed March 13, 2020

[2] Weisbaum, H. (2018, April). Trust in Facebook has dropped by 66 percent since the Cambridge Analytica scandal. CBS News. Retrieved from https://www.nbcnews.com/business/consumer/trust-facebook-has-dropped-51-percent-cambridge-analytica-scandal-n867011

Tolling transponders that gather information about the movement of a vehicle on a stretch of road to collect use revenue fall into this category (Douma & Aue, 2011, p. 15). Conversely, anonymous locational information, or non-PILI, cannot be tied back to a specific individual. Examples include information from traffic counters or devices that only detect the presence of vehicles in order to control traffic flows, without identifying the vehicle (Douma & Deckenbach, 2009, pp. 318-319).

These general concerns, along with the general perception that payment of distance-based fees (DBFs) would require government tracking of the location of individual vehicles, and, by extension, the occupants of those vehicles (Congressional Budget Office, 2001), protecting the privacy of PILI is a significant legal (and business) issue. Consequently, it is worth exploring the actual legal landscape to help understand what locational data is protected and what is not, so that those implementing DBF are able to clearly address these concerns when raised by members of the public.

2.1.2 Sources of Privacy Protection

Federal Constitutional Protections

The United States Constitution, specifically Supreme Court case law on the Fourth, Ninth, and Fourteenth Amendments, is a core source of American privacy law. With respect to the transportation context, case law on the Fourth Amendment is the most relevant and has become more protective of privacy as technology has evolved.

- The basic test for whether a person has a protected privacy interest under the Fourth Amendment comes from the 1967 U.S. Supreme Court case, *Katz v. United States*[3]. Under *Katz,* a reasonable expectation of privacy exists when: (i) a person has an expectation of privacy, and (ii) society deems the expectation to be reasonable.
- Regarding protection of one's location on the road, the Court initially interpreted the "societal expectation" prong of the Katz test to mean that privacy protections did not apply. In a 1983 case, *United States v. Knotts*, the Supreme Court stated, "a person traveling in an automobile on public thoroughfares has no reasonable expectation of privacy in his movements from one place to another."[4]
- Rapid technological change, however, may be leading the Court to change this interpretation. In 2010, the Court noted that technology was evolving so rapidly that it was almost impossible for a court to determine the corresponding societal expectation of privacy.[5] Then in 2012, the Court decided a case involving GPS tracking using an analysis framework other than the *Katz* test, though without necessarily rejecting the primacy of *Katz.*[6]

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[3] Katz v. United States, 389 U.S. 347, 361 (1967) (Harlan, J., concurring).
[4] United States v. Knotts, 460 U.S. 276, 281 (1983).
[5] City of Ontario v. Quon, 130 S. Ct. 2619, 2629-30 (2010)
[6] United States v. Jones, 132 S. Ct. 945, 950-53 (2012).

- Two years later, in 2014, the Court indicated a new understanding of "societal expectations. In *Riley v. California*, the Court determined that searching through a cell phone without a warrant was a violation of 4th amendment rights, characterizing cellphones as "minicomputers" filled with massive amounts of private information.[7] The Court's use of the term "minicomputers" left this ruling open to application to a range of technologies—potentially including fleet service applications that store passengers' information.
- Finally, in a 2018 case, *Carpenter v. United States* (2018), the Court held that the government needs a warrant to access a person's cellphone location history.[8] Although the case addressed cellphone location data, the majority made it clear that the ruling applies to "information that can locate people generally, not just [cellphone location data] specifically."[9]

Looking at the changing interpretations of "societal expectations" related to what data is private as technologies allow increasing amounts of data to be collected and stored, it appears to be possible that PILI data collected as part of a DBUF project may be private. However, without a direct ruling stating this, additional measures may be prudent.

Federal Law

Several existing federal laws create privacy protections, albeit in relatively discrete areas (Douma & Deckenbach, 2009, p. 303). Very few of these laws have direct relevance for distance-based user fees. Among those that might, the most relevant are the *Driver's Privacy Protection Act of 1994,* which protects personal information collected by departments of motor vehicles, and *the Privacy Act of 1974,* which regulates how the federal government handles the personally identifiable information it collects.[10] In addition, the Federal Trade Commission, under Section ***5*** of the *Federal Trade Commission Act,* has become active in regulating companies' privacy notices to consumers about how they collect and use consumer data, including locational data.[11]

State Law[12]

Federal law sets the floor of privacy protection upon which States have the ability to build their own privacy regulations. As a result, the extent to which privacy is protected beyond the federal level varies across states. Some state courts have interpreted their state constitutions in a way that expands the privacy rights of their citizens beyond those prescribed by federal constitution. Similarly, some states

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7 Riley v. California, 573 U.S. 373 (U.S. 2014)
8 Carpenter v. United States, 138 U.S. 2206 (U.S. 2018)
9 Ohm, P. (2018, June). The broad reach of Carpenter v. United States. *Just Security*. Retrieved from https://www.justsecurity.org/58520/broad-reach-carpenter-v-united-states/
10 Driver's Privacy Protection Act of 1994, 18 U.S.C. H§ 2721-2725 (2011); Privacy Act of 1974, 5 U.S.C. § 552a (2011).
11 Federal Trade Commission Act, 15 U.S.C. § 45(a) (2011) (prohibiting unfair or deceptive acts or practices in or affecting commerce).
12 This section draws on Douma & Deckenbach, 2009, pp. 307-310

statutorily extend privacy protections beyond those afforded by federal law. But like federal law, state statutes generally approach privacy in a piecemeal, area-by-area fashion.

There are not many state laws specifically addressing privacy and transportation technologies. Most laws only address specific technologies whose use is either controversial with the public, such as automated speed enforcement, or where there is a perceived potential for abuse. State privacy torts, such as intrusion upon solitude, public disclosure of private facts, "false light" publicity, and misappropriation of likeness, provide an additional source of privacy protection. However, these torts do not usually create a cause of action on public streets and have not yet been successfully applied in any cases involving tolling or other ITS technologies.[13]

2.1.3 Implications of Privacy Law for Distance-Based Fees

Federal Constitutional Protections

The tangled and unsettled nature of privacy law in the U.S. means its application to Distance-Based Fees is often jurisdiction, technology, and context-specific. Nevertheless, several principles can be stated: [14]

- The less personally identifiable the information collected; the fewer privacy issues will arise. When the data collected does include personally identifiable information, however, legal issues regarding consent, access, ownership, and protection of information are often triggered.
- When an ITS application collects personally identifiable information about an individual, consent to obtain that data generally should be obtained from that individual. Voluntary consent ("opt-in") is one way in which consent can be given. Voluntary consent generally requires individuals to manifest willingness to have their personal information collected, and they must be informed of some specific aspects of the information being collected. The other form of consent is to imply consent (opt-out). Courts have found implied consent to be sufficient when the government's interests in preventing injury, property damage, and loss of life on roadways are served by the practice. However, presumed or implied consent usually must allow for individuals to opt-out of such programs and requires that members of the public be made reasonably aware of what they are tacitly consenting to.[15]
- Current law typically places much greater restrictions on the collection and use of personally identifiable data by the public sector, than by the private sector.38 Thus, who is collecting and/or using the information gathered by an ITS application often dictates the level of privacy protections triggered.

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[13] See, e.g., Kendra Roseberg, Location Surveillance By GPS: Balancing an Employer's Business Interest with Employee Privacy, 6 WASH J.L. TECII. & ARTS 143, 150-54 (2010).
[14] These principles come from Douma & Deckenbach, 2009, pp. 318-321 except as otherwise noted
[15] This issue was covered in more depth in a report on online privacy (U.S. Department of Commerce Internet Policy Task Force, 2010).

As noted above, if the data is collected by the State or other public entity, there may be legitimate legal privacy concerns as there are few protections against a person's location, unless specifically provided by a state statute.

If participation in a Distance-Based Fee program is voluntary (i.e. "opt-in") the expectation of privacy is diminished significantly. The association of a toll transponder to a vehicle or vehicles instead of a person also creates some anonymity, is a secondary protection regarding legal privacy; travel history details only provide information about the location of the transponder, not about a specific individual.[16]

Similarly, if the data is collected by a private entity rather than the state, then protection is likely further increased. Private entities can restrict data sharing to ways they define through their own privacy policies, to which customers consent to when they enroll. Secondly, these entities can limit the data they share with the state to aggregate data that does not include individual information.

Demonstrations are incorporating these practices to address these privacy concerns. For example, the Reason Foundation analysis of Oregon's demonstration noted that "The state of Oregon's permanent MBUF program uses a one-way system and third-party data collection to keep personal driver data confidential. The state does not have access to a driver's location" (Smet & Feigenbaum, 2019). Similarly, Minnesota's 2011 Mileage-Based User Fee Policy Task Force pointed out that privacy can be addressed in the following ways:

- Not collecting the data through use of pre-paid debit cards
- Limiting data collection through:
- Anonymous user accounts that do not disclose the vehicle ID
- Only collecting odometer readings
- Retaining data in the vehicle (no transmission except for the fee charged)
- Limiting data retention by immediately deleting data after the mileage fee is determined
- Limiting data access by contracting responsibility to a third-party, non-governmental entity
- Protecting the data through sophisticated data encryption[17]

2.2 SOCIAL EQUITY CONSIDERATIONS

Most people believe the tax system needs to be just, fair or equitable. However, it is rather difficult and complicated to devise a tax system that meets these criteria. To devise an equitable tax system some consider taxation based on either benefit received and/or ability to pay. Under the benefit received concept in the transportation field, drivers pay for the benefit they receive from using the

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[16] This case is discussed in greater detail in Douma & Aue, 2011, p. 16.
[17] Other relevant works include the technical report Munnich, Doan, & Schmit (2011) and Munnich, Robinson, & Zhao (2011).

transportation system. Tolls, for instance, are based on benefits received: Drivers get the benefit of using a road and pay a toll for that benefit. On the other hand, the ability to pay concept considers vertical and horizontal equity when determining tax structures. Under vertical equity the proportion of taxes paid increases with the amount of income earned- people with higher income pay more tax. Under horizontal equity, people under similar circumstances should be taxed similarly. Taxation based on the ability to pay is considered progressive, otherwise, it is considered to be regressive. Minnesota good tax policy guide, as developed by the Minnesota Department of Revenue, should strive to be fair and equitable (pay for what you use), transparent and visible, and simple and economical to collect.

Social equity is an old concept but has become a rather important issue in public policy since equal rights movements in the 1960s. All societies have treated people unevenly based upon gender, age, income, and race, among other classifications. Access to health care, education, and wealth has been distributed unevenly. The discussion of social equity in transportation is rather a new phenomenon. Policymakers are starting to wonder whether transportation policies and taxation are treating all people in an equitable manner (not equal). Equal transportation means, for instance, that everybody gets to drive a 4-door sedan, while equitable transportation means that people get to drive a sedan, SUV, Truck, etc. based on the need and purpose of the trip.

It is known that the driving patterns of men and women are different (Bianco & Lawson, 1998). Women more typically engage in trip chaining as they are mostly responsible for caregiving activities such as picking kids up from daycare, grocery shopping, and taking family members to appointments. Due to these different household roles, women's commuting trips are different from men who may just commute from home to work and back. Women also travel more during off-peak hours and travel less after dark. Similarly, a low-income person might have more than one job which requires multiple trips to various workplaces. People of color experience higher unemployment and poverty, which may either result in not owning an automobile or need to drive.

The externalities imposed by transportation such as environmental degradation and traffic congestion also impact populace differently.

The following paragraphs discuss social equity implications of several state and local transportation revenue sources.

Motor Fuel Tax

The State of Oregon enacted the nation's first gasoline tax of one cent per gallon in 1919. Soon other states followed suit. It took till 1932 when President Hoover authorized the creation of national gas tax of one cent per gallon. Federal gas tax has been raised 10 times and now it is 18.4 cents a gallon. Currently the Minnesota motor fuel tax rate is 28.5 cents per gallon. The gas tax was based on the "user pays" concept. Gas prices were rather cheap till early 70s (about 36 cents a gallon) and most cars had very similar fuel economy, concept of user pay nearly held firm. Since the first energy crises of the 70's it has started to change with the introduction of highly gas efficient vehicles and even more so with the introduction of hybrid and electric vehicles. As gas tax is based on the gas use, vehicles with higher miles per gallon (MPG) pay less than vehicles with lower MPG. Various studies have found that low-income households own older and less efficient vehicles,[18] and therefore a higher proportion of their income goes to pay motor fuel taxes compared to high-income households (West, 2005; Bento, Goulder, Jacobsen, & vonHaefen, 2009). The motor fuel tax, therefore, has both horizontal and vertical equity issues and is therefore considered regressive.

Some states across the U.S. have adopted a fee levied on electric and hybrid vehicles to offset the loss in revenues from the motor fuel tax. In Minnesota, the $75 fee is levied on all-electric vehicles on an annual basis. In the country 29, states have levied a similar fee that ranges between $50 and $200. Few states have implemented a differentiated rate for fully electric vehicles and hybrid vehicles, and typically the rate is higher for fully electric vehicles.

Motor Vehicle Sales Tax (MVST)

In Minnesota, the motor vehicle sales tax is imposed on the purchase or acquisition of a motor vehicle. It is based on the total purchase price or fair market value of the vehicle, whichever is higher. The rate of the MVST is 6.5 percent. There is however a minimum of $10 fee if the car is 10 years or older and if the value of the vehicle is less than $3,000. Individuals who purchase a higher value vehicle pay a larger amount in MVST as the ability to purchase an expensive vehicle is assumed to correlate with the ability to pay more MVST. In this regard, the MVST is correlated with the ability to pay and is considered to be a progressive tax.

Vehicle Registration Fee

On passenger automobiles, vehicle registration tax is $10 plus an additional tax equal to 1.25 percent of the base value of the vehicle. The base value means the manufacturer's suggested retail price including destination charges. The vehicle registration fee also will be considered mostly progressive as it increases with the value of the vehicle.

Wheelage Tax

A wheelage tax is a minimum of $10 tax that is levied by the Minnesota counties board of commissioners on vehicles kept in that county. Most of the counties have wheelage tax between $10 to $20. Considering wheelage tax is a fixed fee without any consideration of ability to pay or use of the vehicle, it will be considered a regressive fee.

Local Option Sales Tax

In Minnesota, county boards can implement a 0.5 or 0.25 percent local sales tax in addition to the sales tax to fund transportation or transit capital or operating costs. For example, in Hennepin county, this

[18] According to EPA (2020), real world economy of vehicles has increased 29 percent between 2005 and 2019.

local option sales tax is used to partially fund construction and operating costs of several light rail lines (Hennepin County, 2017b). The local option sales tax is mostly regressive because low-income people pay a higher percentage of the income in sales tax. In Minnesota sales tax is not as regressive because in Minnesota food and most clothing are exempt from sales tax.

High Occupancy Travel (HOT) Lanes

Studies conducted to study HOT lanes also found that higher-income families use HOT lanes more frequently. Sullivan (2000) learned that while there was little variation in use of SR 91 in California among families with income levels between $40,000 and $100,000, families earning more than 100,000 use SR91 twice as frequently. In San Diego, through surveys of I-5 users, researchers found that higher income users (with an annual income of $80,000 or more) used I-5 more frequently. In Minnesota, studies conducted on I-394 MnPASS lanes also found that families with higher-income using MnPASS benefited more than lower-income residents by paying larger tolls and by traveling a longer distance.

Supporters of HOT lanes point out that while HOT lanes provide more direct benefits to higher-income residents, lower-income families benefit by using lanes occasionally when it is important and provides them with some sort of insurance. HOT lanes also provide reliable service to transit and moving some vehicles to HOT lanes reduces congestion in general-purpose lanes.

Transportation Network Companies (TNC)

Uber, Lyft, and many other companies have experienced tremendous growth during the last decade. It seems these companies are everywhere. These companies are in reality the product of dense urban cities. After tremendous financial growth and valuations, these companies went public with IPOs in early 2019. Recently the valuations have experienced a downward slope with losing billions of dollars. There is a serious question about the long-term viability of these companies especially if level 5 self-driving vehicles do not materialize in near future. Clewlow & Mishra (2017) identified serious equity issues with ride hailing companies. For example, only 4 percent of those aged over 65 and older have used ride-hailing services, as compared to 36 percent of those 18 to 29. College-educated, affluent American have adopted ride-hailing services at double the rate of less educated, lower income populations. Also, 29 percent of those who live in more urban neighborhoods of cities have adopted ride-hailing and use them regularly, while only 7 percent of suburban Americans in major cities use them to travel in and around their home regions. Another interesting finding was that among adopters of prior ridesharing services, 65 percent have also used ride-hailing. More than half of them dropped their membership. And 23 percent cites their use of ride-hailing services as the top reason they have dropped carsharing.

In early 2018, a number of companies and public agencies got together to announce that they are going to make cities more equitable, accessible and environmentally friendly by eliminating the personal car and using technology driven solutions. Robin Chase of Zipcar announced that by being successful they mean ride-hailing, Carsharing, cycling, public transit etc. together replacing personal cars. There is however concern that carsharing and ride-hailing may have a negative impact on transit which is mode of transportation for many low-income urban populations.

Fee and licensure of ride-hailing can also create equity issues. Different communities are applying different taxes and license fees. These may vary from annual TNC licensing fee, an annual driver licensing fee to per-trip fee. For example, per trip fee can have more negative impact on women who take multiple and short strips. Safety and security are also major concerns for women users of Ride-hailing services.

Distance-Based Fees (DBFs)

A number of studies have looked at the equity implications of various DBF deployment strategies and reached conflicting results depending upon different assumptions and deployment strategies. In the deployment of a flat rate (that is equivalent to the motor fuel tax), as proposed in the demonstration, a DBF system is likely to be more progressive that the gas tax. Lower income drivers driving old and less fuel-efficient vehicles will pay less than higher income drivers driving more fuel-efficient vehicles. Higher income families will also pay more because there is a positive relationship between income and VMT (Oak Ridge National Laboratory, 2001). Higher income households drive more miles, on average, than lower income households. Higher income families have higher transportation budgets and a greater ability to pay. DBFs can be made more progressive if the rate changes depending on the time of the day and/or congestion because women and low-income populations tend to drive less during peak periods. The exact number of peak period drivers is unknown, but relative to men, a higher proportion of women work in part-time jobs which may give some flexibility in their driving demand, especially reducing their need to drive during peak hours. According to the Bureau of Labor Statistics, women's labor participation rate was 57.1 percent with 24 percent working part-time and men's labor participation rate was 69.1 percent with only 12 percent working part-time in 2018 (BLS).

Tribal Nations

Minnesota is home to 11 reservations and 12 federally recognized sovereign nations. These reservations are different in size, density of population, method of travel, and infrastructure. Some of these nations are rather remote, have many unpaved roads and severe weather conditions can create serious connectivity issues. How revenues are collected and spent in these nations are also different. Ownership of the infrastructure within tribal nations is also in flux. As we try to develop an equitable DBF, we need to fully understand these differences and engage the tribal nations in the decision-making process.

While a significant part of this study is to test the technical viability of DBF through carsharing, as we analyze the data and conduct the study, we should be aware of the equity implications of DBFs, ride-hailing and carsharing. We may consider use of time of day, traffic accounts or low-income travel credit like strategies to overcome some of these equity concerns. Increased cost to collect tax also will be considered regressive as there is no benefit received by the driver.

2.3 RURAL AND URBAN EQUITY CONSIDERATIONS

One concern surrounding distance-based fees as a future source of transportation system funding is whether drivers in rural areas would be disadvantaged relative to their urban counterparts. Given the greater travel distances to work and other destinations in rural areas compared to the shorter travel distances in more densely-populated urban areas, it stands to reason that, all things being equal, rural drivers would be paying more for the miles they traveled with a fixed fee based on vehicle miles traveled (VMT). The question is are all things equal between urban and rural drivers. Recent studies on how rural and urban drivers would be affected by distance-based fees (DBF) show that rural drivers may in fact be better off financially with distance-based fees than under the current gas tax. This could be true under a scenario where miles per gallon (MPG) for all vehicles is averaged and converted to a flat per-mile fee. That assumption has not been tested for long-term sustainability, meaning adequacy of revenue collected to maintain the system.

2.3.1 The Minnesota Distance-Based Fee Demonstration

The current Minnesota Distance-Based Fee demonstration does not directly address the rural/urban equity issue, but future policies will certainly need to address the issue. While there is still debate over how and when a distance-based fee might replace the current motor fuel tax as vehicles become more fuel-efficient and move away from petroleum-based fuels, MnDOT planners are assuming that we will have a motor fuel tax for a long time into the future. In addition, they assume that a distance-based fee will be introduced in stages alongside the motor fuel tax, with policies established to assure that vehicles are not double-taxed for their use of the transportation system.

The long-term vision for the continuation of the motor fuel tax and the introduction of distance-based fees is important in understanding how the two would work together and the implications for rural/urban equity. In the past, the motor fuel tax was a good way of charging drivers for the use of roads in proportion to their use of those roads. The motor fuel tax was and still is a relatively inexpensive way for state and federal governments to collect taxes to pay for road construction, maintenance and operations. However, as vehicles have become more fuel-efficient and electric vehicles begin to replace vehicles that require motor fuel, the motor fuel tax does not reflect the use of roads as equally as it did in the past - some drivers bear a disproportionate share of the cost for funding the transportation system. Research shows that residents of rural areas rely more heavily on light trucks and older, less fuel-efficient vehicles than residents of urban areas, and thus pay a higher share of the motor fuel tax on a per-mile basis than drivers in urban areas (Western Road User Charge Consortium, 2017). Many states attempt to address this inequity by charging a fixed annual fee on electric vehicles, but this does not account for the amount of road usage by these vehicles.

Minnesota's DBF demonstration will pilot a transferable and scalable model that is sustainable and fair. This model represents a migration to DBFs on some vehicles and not a total transformation of the system away from the motor fuel tax in the foreseeable future. The model is designed to have low implementation, operations and enforcement costs, and assumes retention of the motor fuel tax for most fossil-fueled vehicles and that all vehicles should be charged an appropriate and proportionate share for their use of the roads.

2.3.2 Rural/Urban Equity Studies

A 2010 study conducted a quantitative analysis on the impact of switching from 24 cents per gallon fuel tax to a flat 1.2 cents per mile VMT tax using the state of Oregon as an example. Contrary to expectations, the study found that households in rural areas would actually benefit from a change in tax regimes from a fuel tax to a VMT tax. This is due to the fact that on average, rural households own vehicles with lower fuel efficiency even though they drive more miles than urban households (McMullen, Zhang, & Nakahar, 2010).

In 2017 EDR Group completed a study for the Western Road Usage Charge Consortium (RUC West) to assess the financial impacts of moving from a fuel tax to a mileage-based fee system (Western Road User Charge Consortium, 2017). The initial study covered seven states including Arizona, California, Idaho, Montana, Oregon, Utah and Washington. The analysis was later extended to include Colorado, Hawaii, and Texas for a total of ten states.

The project included identifying fuel consumption and vehicle types in use by urban and rural households and determining the mileage driven for all households in each setting. Using estimates of vehicle miles driven by geographic area, vehicle type information from motor vehicle registrations, and gas tax revenue information for each of the participating states, EDR Group determined the "revenue-neutral" equivalent mileage-based road usage fee rates that would be required to replace current gas tax revenues in each state.

The results of the RUC West study show that rural drivers will likely save money under this mileage-based fee, revenue-neutral scenario (see Table 2.1). The study projects that, on average, rural households would pay 1.9-6.3 percent less and urban households would pay 0.3-1.4 percent more state tax in a RUC system than they currently pay in state motor fuel tax. The ranges reflect the differences from state to state. While this analysis does not take into account how future policymakers may decide to address the issue of rural-urban equity in the taxation and distribution of road user revenues, it does indicate that a simple shift from the gas tax to a mileage tax raising the same revenue on a single-fee basis would benefit rural drivers more than urban drivers.

Table 2.1 Percent Savings with RUC

	Urban	Mixed	Rural
Arizona	-0.7%	1.7%	6.1%
California	-0.3%	2.4%	6.3%
Idaho	-1.0%	0.9%	3.1%
Montana	-1.4%	-0.4%	1.9%
Oregon	-1.0%	2.9%	4.8%
Texas	-0.5%	1.6%	3.1%
Utah	-0.6%	3.4%	5.5%
Washington	-1.0%	3.6%	4.8%

***Note**: Positive numbers show a saving with RUC, in the Rural and Mixed columns.* ***Source**: RUC West: Rural Drivers and Communities*

Atkinson (2019) points out that rural drivers are currently paying more in fuel taxes simply because they drive more – 34 percent more miles per year than people in urban areas—and the difference is even greater in rural western states. However, even with this reality, there should be no difference in how switching to road user charges impacts rural drivers.

> "Consider a driver who commutes 50 miles a day from their small town to a big metropolitan area in a car that gets 20 miles per gallon, and assume they pay a combined state/federal gas tax of 45 cents per gallon for a total tax of $1.12 per day. In comparison, a suburban driver who commutes downtown and drives 16 miles a day would pay 36 cents a day in fuel taxes. If the drivers each paid only a fee of 2.25 cents per mile (and paid no fuel taxes), the rural driver would still pay $1.12 per day, with the suburban driver still paying 36 cents. In other words, on average, rural drivers today pay more in fuel taxes than urban drivers—and would continue to pay more under an RUC system."

A 2017 study found that a VMT system that includes congestion pricing would impact urban and higher-income drivers more than rural and lower-income drivers (Langer, Maheshri, & Winston, 2017). Atkinson (2019) argues that this is another reason why a RUC system would be beneficial for rural drivers: It has the potential to enable congestion pricing—and the vast majority of recurring congestion occurs in metropolitan areas. Under a RUC system that uses congestion pricing, urban drivers will pay more than rural drivers, but also benefit from congestion pricing.

2.3.3 Scenarios

Ultimately the impact of future distance-based fees will depend on the decisions of future policymakers. However, we can make some preliminary assessments based on possible scenarios.

1. **Status quo.** Continue the reliance on the motor fuel tax with no new distance-based fees. This will mean that rural drivers will continue to pay more than urban drivers based on their greater annual mileage as well as their reliance on older, less fuel-efficient vehicles.
2. **Flat distance-based fee.** If the motor fuel tax were replaced by a flat distance-based fee in the future, rural drivers may pay less than their urban counterparts depending upon the rates assumed.
3. **Distance-based fee with congestion pricing.** If a distance-based fee was combined with congestion pricing in urban areas, rural drivers would pay less than urban drivers, though the urban drivers would enjoy the benefit of less congestion.
4. **Efficiency and weight equivalence.** Future policymakers may also decide to reward vehicle fuel efficiency. Pricing based on weight class of vehicles might be an alternative and a way to encourage the use of more fuel-efficient vehicles.
5. **Parallel systems.** Continue the motor fuel tax for older cars and trucks, but initiate distance-based fees on vehicles with factory installed telematics, which enable fee collection and reconciliation with the motor fuel tax.

The current Minnesota pilot offers an opportunity to test a system which could build upon in-vehicle technology and shared mobility platform technology. Under this scenario, distance-based fees would be introduced incrementally with policies designed to assure equitable treatment among various user groups. Shared mobility services such as car sharing as well as electric vehicles and autonomous vehicles are likely to be most common in urban areas, and thus would not have an impact on the tax burdens of rural drivers who would continue to pay the motor vehicle tax. However, as more and more vehicles are becoming electrified in both urban and rural settings, rural drivers of electric vehicles too could begin paying distance-based fees.

2.4 MODAL EQUITY CONSIDERATIONS

We examine existing literature on the costs that different modes of transportation impose on the transportation system as well as the charges they pay to cover these costs. In terms of the costs, we consider direct costs, related to the use of roadway facilities and their deterioration, and external costs, which are costs imposed by users of the transportation system on other users and non-users such as congestion and environmental costs. In terms of charges paid, we consider user fees. We limit our assessment to “user fees”, in particular motor fuel taxes, as they are levied directly to the use of the road, just as a distance-based fee would. Additionally, distance-based fees are likely to replace the motor fuel tax in the future. We do not include other transportation revenues generated through vehicle sales, registration, or lease, since fees and taxes are related to the transaction, ownership or usage right, not to the use of the road. It is important to note that much of the existing research is presented either in terms of costs to the system or in terms of revenues generated by a particular mode. There is little research linking the costs imposed by different modes with the revenue they generate through taxes or fees.

The transportation modes included in this report are divided into individual mobility and shared mobility. Individual mobility refers to passenger vehicles (cars, SUVs, passenger trucks/vans) and trucks (single and combo units, and light- and heavy-duty vehicles). Shared mobility includes carpooling and vanpooling as well as ridesourcing services provided by Transportation Network Companies (TNCs) -such as Uber and Lyft-, and carsharing services that provide their customers either one-way trips (Car2Go) or two-way trips (Zipcar and Hourcar). For all transportation modes, we include conversations related to fuel internal combustion engine (ICE) passenger vehicles and electric vehicles, which are divided into two categories: plug-in hybrid electric vehicles (PHEVs) and battery-electric vehicles (BEVs).

2.4.1 Costs Imposed on the Transportation System

Transportation modes impose costs on the transportation system including direct and external costs. Direct costs are those costs directly related to the use of road facilities and road deterioration; while external costs are those costs imposed by users of the transportation system on other users and non-users such as congestion and environmental costs. Private costs such as maintenance and repairs, and depreciation costs are excluded.

One of the most comprehensive reports on transportation costs and benefits is developed by the Victoria Transport Policy Institute (Litman, 2011). Litman estimated twenty-three transportation costs for eleven transportation modes and concluded that the price structure is both inefficient and inequitable. The price structure is inefficient as there is no incentive to limit driving and it does not mitigate/avoid problems such as traffic congestion and pollution, among others. It is inequitable as people must bear significant costs imposed by others.

Table 2.2 presents Litman’s estimated costs per vehicle mile for different transportation modes. Included costs are related to roadway facilities, congestion, and environmental costs for urban (peak and off-peak travel) and rural travel. Roadway facilities refers to road construction and operating expenses not paid by user fees, congestion includes congestion costs imposed on other road users, and environmental costs include air pollution, greenhouse gas (GHG) pollution, and water pollution.

Table 2.2 Per Vehicle Mile Cost Estimates (2007 US Dollar)

Transportation Mode	Average Occupancy	Road Facilities		Congestion		Environmental Costs	
		Urban Peak	Urban Off Peak	Urban Peak	Urban Off-Peak	Urban Peak	Urban Off-Peak
Average Car	1.1	0.026	0.026	0.130	0.020	0.095	0.083
Compact Car	1.1	0.026	0.026	0.130	0.020	0.079	0.069
Electric Car	1.1	0.064	0.064	0.130	0.020	0.028	0.024
Van or Pickup	1.1	0.035	0.035	0.130	0.020	0.152	0.132
Rideshare Passenger	1	0.000	0.000	0.000	0.000	0.002	0.002
Diesel Bus	25	0.048	0.048	0.270	0.040	0.293	0.260
Electric Trolley	30	0.048	0.048	0.270	0.040	0.116	0.100
Motor-cycle	1	0.014	0.014	0.130	0.020	0.129	0.109

Note: *Rideshare passenger costs are defined as the incremental cost of an additional passenger, assuming that the vehicle will be driving anyway.* ***Source:*** *Data from Litman (2011).*

According to the estimates, all transportation modes impose a higher cost on roadway facilities than what is paid through user fees. Roadway facility costs for electric vehicles are higher as they do not pay fuel taxes. Average, compact, electric cars, vans, and light trucks impose about the same congestion costs. Buses and trolleys are considered to impose twice that cost. Per vehicle costs are higher for transit modes, but when comparing passenger costs, personally owned vehicles impose higher costs. Overall, ridesharing tends to have the lowest costs.

Deterioration of the Roadway System

The deterioration of the roadway system, which includes pavements and bridges, is caused by many factors including traffic, pavement materials, the environment, and excessive vehicle weight (Wilde W. J., 2014). Most of the studies on this topic agree road impacts vary with the type of vehicle and its used capacity, the weight distribution per axle, and the type of road.

In terms of private mobility, it is documented that heavy-duty vehicles can cause several times the damage to roads than light-duty vehicles. Wilde summarized that heavier private mobility options, such as vans and pick-up trucks can cause 7 times the amount of damage to roads than private mobility options that are lighter, like sedans and compact cars (see Table 2.3).

Table 2.3 Road Impact by Vehicle Type

Vehicle Type	Number of Axles	ESAL Factor	Passenger Car Equivalents
Cars	2	0.0008	1
Vans/Pickups	2	0.0052	7
Large Pickups/Delivery vans	3	0.0122	15
Large Delivery Trucks	3	0.1303	163
Local Delivery Trucks	2	0.1890	236
Residential Recycling Trucks	2	0.2190	274
Buses	2 or 3	0.6806	851
Residential Trash Trucks	3	1.0230	1,279
Long Haul Semi-Trailers	3-5+	1.1264	1,408

Source: *Data from Wilde (2014)*

Gibby, Kitamura and Zhao (1990) estimated that, on a typical roadway, the average annual maintenance cost per heavy truck is $7.60 per mile per year, and the corresponding cost per passenger car is $0.08. Furthermore, each additional heavy truck will cost an additional $3.73 per mile per year for pavement maintenance, while each additional passenger car increases costs by $0.04 (see Table 2.4). Similarly, Zhao and Wang (2015) estimated that the unit pavement damage costs induced by trucks are in the range of $0.005-$0.04 per ESAL-mile for the Interstate highways and $0.05-$0.61 per ESAL-mile for minor roads. These values depend on the discount rate, pavement structure, and rehabilitation strategy (full reconstruction and milling & overlay). Additionally, heavy trucks can cause even more pavement damage when they are loaded beyond the legal limit. Pais, Amorim and Minhoto (2013) explored the impact of overloaded vehicles on pavement and concluded that overloaded vehicles can increase costs by 100 percent compared to those vehicles loaded at the legal limit.

Table 2.4 Maintenance Costs per Mile of Roadway

	Average Annual Maintenance Cost per mile	Marginal Annual Maintenance Cost per mile (1)
Passenger Car	$0.08	$0.04
Heavy Truck	$7.60	$3.73

Note:** (1) The marginal annual maintenance cost per mile is the maintenance cost imposed by each additional vehicle.* ***Source: *Data from Gibby, Kitamura and Zhao* (1990).

The deterioration of the roadway system caused by shared mobility varies depending on the type of service. Recent literature recognizes that ridesourcing services are more likely to increase vehicle miles traveled (VMT) (Rayle, Dai, Chan, & Cervero, 2016; Schaller, 2017; Henao, 2017; Clewlow & Mishra, 2017). These services contribute to VMT growth by diverting users from walking and biking into a driving mode, as well as by drivers cruising for passengers. Regarding carsharing services, Martin and Shaheen (2016) found that the use of free floating carshare had two types of impact on customers driving behavior and amount of driving. First, a majority of the members used the service for incidental mobility, which increases driving. Second, a smaller number of members used the carsharing service in place of a personal vehicle and/or sold or suppressed purchase of a private auto. The reduction in VMT seen when users delayed or suppressed the purchase of a car far outweighed the addition of VMT by users who used the service for incidental mobility. These authors also found that round trip carsharing leads to a reduction of 28 and 43 percent in VMT per year per household (Shaheen & Cohen, 2018). The changes in VMT observed as a result of shared mobility use are important as roadway damage caused by light-duty vehicles is directly related to the number of miles driven by those vehicles (McMullen, Zhang, & Nakahara, 2010).

It should be noted that these outcomes in VMT reduction and behavior change resulted from both free-floating and a two-way carsharing models. These two types of carsharing serve different purposes and different use cases, but both contribute to a reduction in the negative externalities of privately-owned vehicles. There are currently no free-floating car-share operators in Minnesota, though the City of Saint Paul, along with HOURCAR have proposed a one-way, stationed-based, all-electric service (City of St. Paul, 2019).

Automation and electrification of the shared mobility fleet could also have some impacts on vehicle weight, which impacts transportation infrastructure. According to the Alliance to save energy, automation could add some weight to vehicles due to the equipment required for operations (Information Communication Technologies, Shared Mobility and Automation Technical Committee, 2018). But it can also eliminate the need for vehicle components (such as steering wheels, foot pedals, and transmission control among others) which could reduce vehicle weight. More research in this area is needed to determine the real impact.

Congestion

Congestion costs are a continuing topic of debate in the US. One of the most critical congestion costs is the increased time of travel, that is, time spent in travel that could be devoted to other pursuits, such as earning income or engaging in leisure activities (FHWA, 2008). Other costs include the increase in travel time unreliability; excess fuel usage; increased emissions and environmental damage; higher accident rates and safety costs; higher inventory, maintenance, and operating costs; and loss of productivity (HDR, 2009).

Private mobility is a large contributor to congestion. As Thomson & Bull (2006) describe, different vehicles cause different amounts of congestion. Vehicles receive Passenger Car Units (PCU) ratings based on their disruption to traffic and the amount of road they occupy relative to a passenger vehicle. For instance, a passenger car has a PCU rating of 1, while a bus has a PCU of 3. The congestion caused by a bus is higher than congestion caused by a passenger vehicle, however, when considering the congestion caused per occupant (50 for the bus and 1.5 for the passenger vehicle, on average) each passenger vehicle occupant causes 11 times as much congestion as each bus passenger.

When it comes to shared mobility and congestion, a study in San Francisco found that ridesourcing services increased three factors indicative of congestion: delay, VMT, and speed (San Francisco County Transportation Authority, 2018). Population and employment growth in the area also contributed to an increase in congestion but about 50 percent of the increase can be attributed to ridesourcing services (San Francisco County Transportation Authority, 2018). Another study found that many types of shared mobility, including peer-to-peer, carsharing, and ridesourcing do not contribute to reductions in congestion or carbon emissions (Santos, 2018). In addition, this study suggests that ridesourced vehicles where multiple passengers share a ride with people headed in the same direction have the potential to reduce congestion and carbon emissions. Unfortunately, this mode of shared mobility is the least appealing to customers.

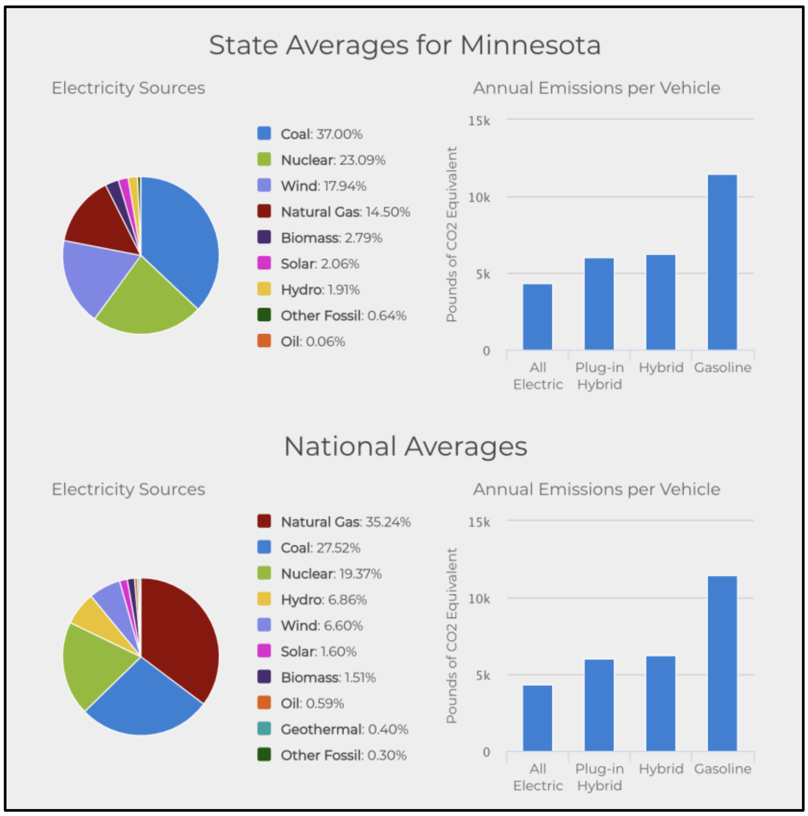
Environmental Cost

Environmental costs include air pollution, greenhouse gas (GHG) emissions, water pollution, and hydrologic impacts, etc. Air pollution refers to emissions from vehicles that can impact human health such as fine particulates, carbon monoxide, and methane among others. GHG emissions such as carbon dioxide and monoxide contribute to climate change. Pollution of water systems comes from run-off that washes lubricants, road salt, automotive chemicals, and particles from tires. Additionally, impervious paved surfaces like roads and parking lots can cause increased runoff and flooding, among other impacts (Litman, 2011).

According to the U.S. Environmental Protection Agency (2019) light-duty vehicles are the largest emitters of GHGs followed by heavy-duty trucks. In 2017, these types of vehicles accounted for 82 percent of total GHG emissions (59 and 23 percent, respectively). Buses and rail together accounted for only 3.15 percent. Per vehicle, those powered by diesel contribute more GHG emissions. Monahan & Friedman (2004) point out that burning a gallon of diesel leads to the release of 17 percent more GHG than does burning a gallon of gasoline. For instance, an average 40-passenger diesel bus must carry a minimum of 7 passengers on board to be more efficient than the average single-occupancy vehicle (U.S. Department of Transportation, 2010).

Among transportation modes, it is estimated that an automobile that gets 20 miles per gallon contributes $0.006 per mile of greenhouse gas externalities (Harford, 2006). When comparing ICE with EVs, EVs are seen as a "greener" transportation choice. The environmental friendliness of BEVs and PHEVs depends on the method used to generate the electricity that fuels the vehicle. For example, in Minnesota, 37 percent of electricity is still generated from coal (Figure 2.1

). This is important considering all types of coal emit more carbon dioxide per million British Thermal Units of energy produced than gasoline does (U.S. Energy Information Administration, 2019). In Minnesota, an EV accounts for 4,303 pounds of carbon dioxide emissions per year, on average, while an ICE vehicle accounts for 11,435 pounds of carbon dioxide emissions per year, on average.



Source: *U.S. Department of Energy (2019)*

Figure 2.1 Summary of Electricity Sources

Additionally, while EVs on the roadway can produce less carbon emissions than ICE vehicles, EVs still have a cradle to grave (C2G) carbon footprint. A cradle to grave carbon footprint refers to the GHG emissions produced from the production, operation, fuel pathways (source and production of fuel), and disposal of vehicles. The literature highlights that the manufacturing impact of EVs is higher compared to the one of ICE vehicles. For Amgad Elgowainy, et al. (2018), there are 26 percent more GHG emissions associated with the manufacturing of BEVs compared to ICE vehicles. According to Del Pero, Delogu, & Pierini (2018), the manufacturing impact of BEVs is higher with respect to the one of ICE vehicles due to the high contribution from the production of battery and electric motor as well as other powertrain components which present a high content of aluminum. EVs appear to involve higher life cycle impacts than ICEs for acidification, human toxicity, particulate matter, photochemical ozone formation and resource depletion. This greater load in the production of BEV is largely compensated by the lower use stage impact, which leads to a 36 percent reduction of total life cycle impact with respect to ICEs. The reason for this is the absence of exhaust emissions during operations as well as the lower environmental burdens involved in the production of electricity compared to the fuel supply chain.

BEVs have the potential to reduce the impact on climate change in comparison with ICEs, but this is true only if the electricity consumed by car is produced from non-fossil energy sources (Del Pero, Delogu, & Pierini, 2018). On the contrary, the use of fossil energy carriers for electricity production can strongly reduce the environmental benefit of BEVs and even lead to an increase in GHG emissions. According to Asaithambi, Treiber, & Kanagaraj (2019), EVs in China produce more CO2 emissions compared to ordinary ICE vehicles whereas than in Germany, the US, and Japan produce less emissions. Current ICE vehicles produce C2G emissions of approximately 450 grams of carbon dioxide equivalents per mile (*gCO2e/*mi) while C2G emissions from HEVs, PHEVs, Hydrogen EVs, and BEVs range from 300-350 gCO2e/mi. In the future, with improvements in vehicle efficiency, ICE vehicles are expected to produce C2G emissions of around 350 gCO2/mi while EVs are anticipated to generate around 250 gCO2e/mi (Amgad Elgowainy, et al., 2018). Overall, the impacts of EVs are highly dependent on vehicle operation energy consumption and the electricity mix used for charging.

Regarding shared mobility, Shaheen and Cohen (2018) found that roundtrip car sharing leads to a reduction of 34-41 percent of GHG emissions. In addition, the electrification and automation of the shared mobility fleet are expected to minimize energy consumption and associated emissions. Greenblatt and Saxena (2015) found that integrating shared and automated technologies could result in decreased U.S. per-mile GHG emissions in 2030 per vehicle deployed of 87–94 percent below current conventionally driven vehicles. These technologies can enable GHG reductions even with an increase in total VMT, average speed, and vehicle size.

When it comes to carpooling, a potential conflict exists between congestion reduction offered by carpooling and vanpooling and the increased emissions these modes might lead to. Concas and Winters (2007) suggest that carpooling dissuades people from combining maintenance and discretionary trips with commuting trips, or trip-chaining. A departure from trip-chaining leads to maintenance and discretionary trips being made outside of the commuting schedule. This discontinuity of trips leads to more “cold starts” of vehicles, which is ultimately more polluting than engaging in the same trip when the vehicle is already warm. A “cold start” is when a vehicle is started after having not run for an hour or more. Trips made under a cold start condition can lead to up to 5 times more pollution.

2.4.2 Charges to Cover the Costs Imposed on the Transportation System

Proceeds from user fees are not sufficient to cover transportation costs and are supplemented through appropriations from the general fund. Bishop-Henchman (2013) found that fuel taxes, tolls, and other local user fees and taxes covered 32 percent of total spending on state and local roads in 2010.[19] This share varied from 59.3 percent in Delaware to 5.2 percent in Alaska. In Minnesota, these transportation special revenues covered 23.6 percent of road spending.[20] Of the total highway funding in the U.S., 23.4 percent comes from general fund appropriations.[21] At the federal level, general funds appropriations make up to 37.5 percent of total highway funding, while at the state level they represent 7.9 percent. In Minnesota, general appropriations to supplement highway funding began in 2018 and accounted for 4 percent of the revenues of the Highway User Tax Distribution Fund (MnDOT, 2020) – the other 96 percent corresponds mainly to revenues from the motor fuel tax, registration tax, and the vehicle sales tax.

Proceeds from the motor fuel tax are projected to continue to decline, due to inflation, improved fuel efficiency and stagnation in driving (Dutzik & Weissman, 2015). Projected increases in fuel efficiency due to technological advances in ICE vehicles and the addition of hybrid electric vehicles will reduce the per-mile fuel tax paid by 25 percent (before inflation) from 2010 to 2030 (Weatherford B. A., 2011). Because of this degradation in revenue-raising capacity of the fuel tax, the Highway Trust Fund is, and will continue to be, underfunded unless the fuel tax is regularly increased, or a different solution is put in place. As Coyle et al (2011) note, while the fuel tax is operationally efficient to collect, from the economic sense it is an inefficient revenue-generating system as it provides weak price signals to users by not charging for the full costs their road use imposes on society. This underpricing leads to over-use of the road, inefficient transportation investments by the government, and sprawling land uses due to the perceived low costs of commuting. In addition, fuel taxes have little impact on demand for vehicle travel as they often go unnoticed by users and do not account for the higher costs imposed by road use during times or within zones of high congestion.

Regarding trucks, the Federal Highway Administration (2000) reported that combination trucks (more than 50,000 and less than 100,000 pounds) paid only 80 percent of the federal-scale costs they imposed on highways via user fees in 2000, with the largest trucks paying only half of their responsibility.

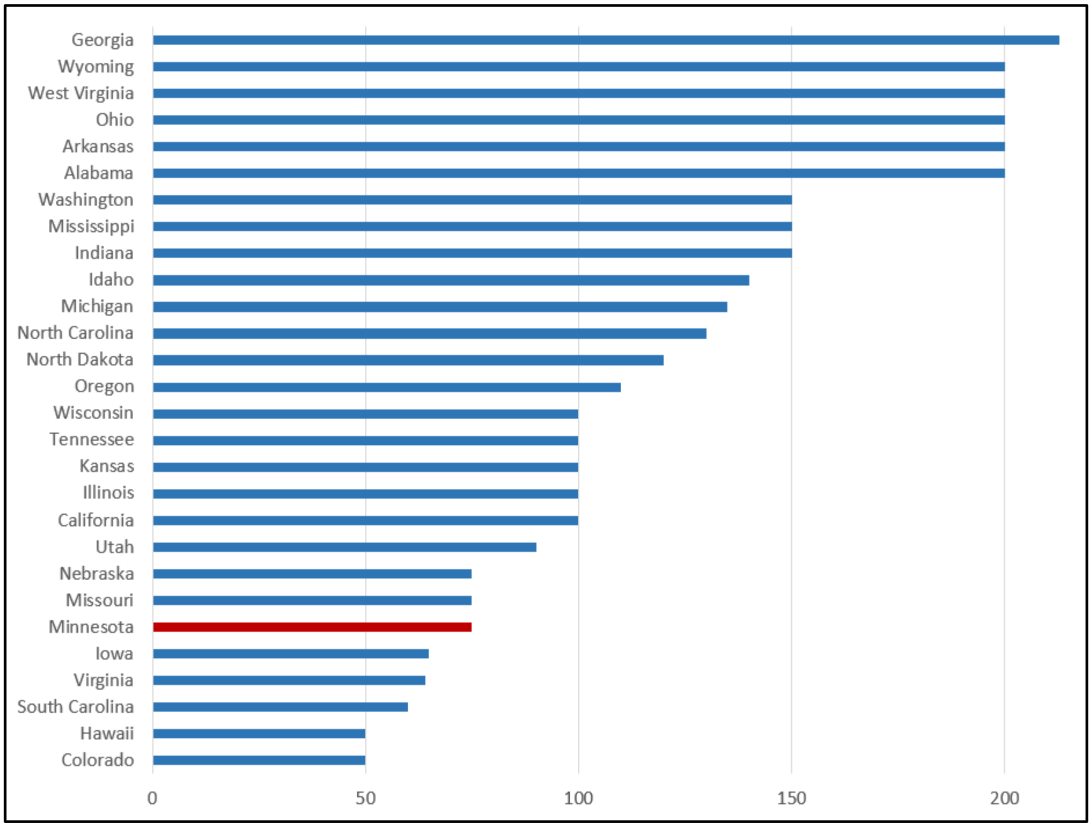
Regarding passenger cars, it is noted that hybrid and electric vehicles contribute less in tax revenue than ICE vehicles. Jenn, Azevedo and Fischbeck (2015) estimated that, under the current funding structure, midsize and compact vehicles (e.g., Toyota Camry and Honda Civic) generate between $2,000 to $4,000

[19] The author defines road spending as motor fuel tax revenue and highway revenue divided by highway spending.
[20] Other sources of roadway funding are from local efforts, mainly through the levy of local property taxes (Zhao, Lari, & Fonseca, 2018).
[21] Information from Batic Institute and AASHTO Center for Excellence. "Transportation Funding and Financing" retrieved from http://www.financingtransportation.org/funding_financing/funding/

in tax revenue over their lifetime, and half of which are accrued from fuel taxes. For less fuel-efficient vehicles (e.g., F-150) revenue generation is between $3,000 to $6,000 over the lifetime of the vehicle. PHEVs (e.g., Chevrolet Volt) and BEVs (e.g., Nissan Leaf) generate substantially less at $1,500-$2,700 and $400–$1,300, respectively.

Some states have adopted an additional registration fee that applies to hybrid and electric vehicles to make up for lost gas tax revenues. This fee typically applies in addition to the standard motor vehicle registration fee. As of October 2018, 20 states have enacted legislation requiring a special registration fee for electric vehicles (see Figure 2.2). Further research is needed to assess the capacity of the fee to cover the costs for the use of the transportation infrastructure. These fees are typically flat fees that do not provide a direct price signal to the users about their road use and other indirect costs. Additionally, these fees need to be adjusted by the legislature to cover the increasing costs of transportation, which has generated resistance in several states. The state of Washington, for instance, attempted to pass legislation in 2019 that would cap vehicle registration fees at $30.[22] This limit on registration fees would cost the state six billion dollars in revenue used for transportation projects over the next six years.

[22] There is an ongoing legal case in the state of Washington on the implementation of Initiative 976 - which would cap the registration fee at $30. News article from The Oregonian "Washington's $30 car tab measure blocked by judge" (Nov 27, 2019) retrieved from https://www.oregonlive.com/news/2019/11/washingtons-30-car-tab-measure-blocked-by-judge.html



Source: *National Conference of State Legislatures (2018). New Fees on Hybrid and Electric Vehicles.*

Figure 2.2 Fees on Electric Vehicles in Different States

In addition to these fees, states like Virginia, California, Florida, Minnesota, and Texas have implemented a form of congestion pricing including high occupancy travel (HOT) lanes and express toll lanes. Studies in these states have found that congestion pricing strategies are successful in changing driving behavior. In Minnesota, in particular, it is found that MnPASS users travel approximately 25 mph faster during peak periods than non-users, with a 3-4 mph speed gain for non-users (FHWA, 2017; Virginia Department of Transportation, 2019). Proceeds from this pricing strategy pay for MnPASS operations and maintenance in the corridor (up to $1 million or 75 percent of the revenue, whichever is less). The remaining proceeds are split between MnDOT costs associated with the operation of the program and infrastructure improvements in the corridor (25 percent), and for bus transit improvements in the corridor (75 percent) (MnDOT, 2019).

Most heavy-duty vehicles are fueled with diesel. At the state level, some states imposed a higher tax on a gallon of diesel than on a gallon of gasoline, some impose the same amount per gallon. At the federal level, the motor fuel tax is higher for diesel than for gasoline (U.S. Energy Information Administration, 2019). The difference in charges could account for (i) higher damage to the transportation infrastructure (heavier vehicles tend to use diesel), and (ii) higher environmental costs imposed by the use of diesel. In Minnesota, particularly, vehicles powered with diesel pay the same amount per gallon in state motor fuel tax than vehicles powered with gasoline.

Lastly, in terms of shared mobility, some states have started to levy fees and taxes on ridesourcing trips (Zhao, Fonseca, & Zeerak, Taxing Ride-Hailing Services: Revenue Usages, Pricing Schemes, and Media Discussions, 2019). Although the majority of localities use these strategies to cover regulatory costs or fill budgets, a few are using the proceeds to improve transportation infrastructure such as Massachusetts, Nevada, and Maryland. In New York (in NYC the fee is part of a congestion pricing strategy) and the District of Columbia, proceeds are used to support transit services. In New Jersey and New York, the fee varies for solo- and shared-trips, and typically shared-trips pay a lower charge. Given the recent adoption of these measures, more research is needed to determine how much of the costs imposed on the systems are recovered through these fees as well as their modal equity implications.

2.5 COLLECTION AND ADMINISTRATION COSTS

Distance-based feeds (DBFs) are expected to be a more reliable and consistent funding source for the roadway system in the future (Coyle, Robinson, Zhao, Munnich, & Lari, From Fuel Taxes to Mileage-Based User Fees: Rationale, Technology, and Transitional Issues., 2011; Weatherford B. A., 2011; Zhao Z. , Guo, Coyle, Robinson, & Munnich, 2015). Given the low administrative cost of the motor fuel tax in the state (about 0.25 percent of the total revenue collected[23]), designing an administratively efficient DBF system is crucial for the state of Minnesota.

A key concern regarding the implementation of a DBF system is its administrative cost. Currently, Oregon was the first state in the U.S. with an operating DBF system that collects revenues from users and the administrative costs are estimated to be around 40 percent of the revenue collected (CalSTA, 2017). And while collection costs are certain to decline with economies of scale as more drivers subscribe, it is not clear how much of that overhead can be reduced. In this section, we discuss the costs of administering a DBF and compare them to the motor fuel tax system, other taxes, and utility systems. In addition, as Shared Mobility (SM) providers are partners on MnDOT's current DBF demonstration, we discuss how this partnership simplifies the collection of a DBF system and review other fees and regulations that apply to these providers.

2.5.1 Administration of a DBF System

The administrative costs of a Distance-Based Fee system are likely to be higher than those of the motor fuel tax system. In terms of the total revenue collected, a state-level DBF system is estimated to cost between 5 and 13 percent of total generated revenue, while the motor fuel tax costs less than 1 percent (Sorensen, Ecola, & Wachs, 2012; Kirk & Levinson, 2016). In terms of vehicle miles traveled, a DBF system is estimated to cost between $1.79 and $65 per 1,000 vehicle miles traveled (VMT) depending

[23] Amount based on administrative expenses of $2.194 million and revenue collection of $878.2 million for FY2020 (MMB, 2021).

on the features of implementation,[24] while the cost of motor fuel tax is $0.10 per 1,000 VMT (Rufolo, 2011).

Administering the motor fuel tax is very efficient and low cost compared to administering other taxes and fees. Table 2.5 shows the administrative costs of several transportation-related taxes and fees collected by Minnesota state agencies and local agencies. The purpose of the taxes and fees presented in the table is to generate revenue except for the MnPASS fee that was designed to manage traffic demand and congestion.[25]

Table 2.5 Administrative Costs of Taxes and Fees at the State and County Level

Collection Level	Tax/Fee	Admin Costs (as percentage of revenue collected)	Notes
State (1)	Motor Fuel Tax	~0.25% for FY2020	Collected by Department of Revenue
	Registration Tax (2)	~1.14% for FY2020	Collected by Department of Public Safety
	Wheelage Tax	Between 0.5% and 0.7% of total revenue or 5-7 cents for every $10	Information based on 5 counties and a $5 wheelage tax. New information to be updated by AMC. Tax added to vehicle registration (Minn. Stat. 163.051), collected by DVS.
	Managed Lanes (MnPASS)	Information for FY2017: I-394 - ~61% (13 years of operation) I-35W - ~58% (8 years of operation) I-35E - ~63% (2 years of operation)	Revenue is used for capital costs and operations and maintenance expenses. Remaining revenue is split equally between MnDOT and the Met Council for highway and transit improvements in that corridor.
Local	Gravel Tax (Aggregate Tax)	County auditor may retain an annual administrative fee of up to 5% of revenue collected	Counties administer and collect the tax (Minnesota Statute 298.75)

Notes:** (1) DOR collects taxes such as the sales tax and local option sales tax among other taxes, but individual costs of collection are not available. (2) Costs include other costs related to registration taxes such as issuing license plates.* ***Sources: *MnDOT* (2018), *Kleman* (2018), *MMB* (2021).

[24] The upper bound of the estimates corresponds to the German system, which is only used for heavy vehicles on specific roads.
[25] The MnPASS fee is automatically set to a level that maximizes lane use while keeping the lane flowing at 50-55mph. MnPASS is a traffic management tool designed to increase person throughput, improve travel time reliability, and increase transit ridership and carpooling.

Administrative costs for the MnPASS Express lanes included in **Error! Reference source not found.** were between 58 and 63 percent in 2017 depending on the corridor. The costs included as administrative costs are operation contracts, enforcement, staff from the Minnesota Department of Transportation -MnDOT and IT services -MNIT, utilities, and miscellaneous equipment and supplies.[26] The administrative costs for the various MnPASS corridors vary widely throughout their lifetimes, but generally decrease rapidly during the first several years of operation. For instance, the I-394 administrative costs have been as low as 29 percent of total revenue in 2009 and as high as 100 percent and 96 percent in 2005 and 2016, respectively. The variation in the administrative to total revenues ratio can be attributed to changes in total revenue due to lane usage as a result of weather and construction events, as well to changes in administrative costs due to increases in operating contracts as a result of system changes (MnDOT, 2018).[27]

Several DBF pilot projects indicate that DBF administrative costs vary widely between 2 and 40 percent of total revenue collected (see Table 2.6). Most of the costs are estimates except for the OReGO program which was launched in 2015 in Oregon and is currently one of the operating DBF systems in the U.S. The state of Utah also has an operating Road Usage Charge program since 2018.

The administrative costs of OReGO are 40 percent of total revenue collected but are expected to decline to less than 10 percent as the number of users participating in the system increases to hundreds of thousands (CalSTA, 2017). Participation in the program is currently voluntary and administrative costs would need to be reduced before making the program mandatory. This could be achieved by offering users the option of a flat annual road usage charge, creating effective compliance mechanisms, and partnering with other states to realize economies of scale. According to OreGO's 2017 report, the program cost $2.3 million to operate between July 2015 and December 2016 and is expected to generate $340 million in revenue between 2015 and 2025. Assuming annual costs of $4.6 million and annual revenues of $34 million, the yearly administrative cost of the program is roughly 13.5 percent of generated revenue (ODOT, 2017).[28]

Similarly, Utah's Road Usage Charge program costs are expected to decrease. Currently, some alternative fuel vehicles are eligible to participate in the program including full EVs and hybrids (plug-in hybrid and gasoline hybrid vehicles). In the first year of the program, the state DOT spent $1,040,000. This cost included start-up efforts such as a communication campaign and development of the commercial account manager. The program collected approximately $42,000 in its first year (Braceras, 2021).

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[26] Other costs such as the costs dedicated to planning future MnPASS corridors as well as capital costs such as equipment installation, lane engineering and construction, and communications about the new lanes are not included in these calculations.

[27] Administrative costs for I-394 and I-35W spiked in 2016 due to an operating system upgrade and "additional up-front expenses under the new enforcement contract (e.g., state trooper academy training costs, vehicle and equipment purchases)."

[28] As of December 2016, the program had 1,103 volunteers (1,238 vehicles).

Table 2.6 Administrative Costs by Project Implemented

Program	Features of Implementation	Administrative costs (as % of revenue collected) (1)	Number of Users
Wyoming (2021)	(pilot) Unknown	**9.4% (est)**	Not Available
Washington (2020)	(pilot) Participants chose between five collection methods and two account managers. No-tech to high-tech collection options. Volunteer basis.	**7 - 13% (est)** 7-8% - Manual 12-13% - Technology based 10% - combination	>2,000
I-95 Corridor Study (2019)	(study) Commercial and State account managers. Assumed that most collection will be through electronic methods.	**8% (est)**	Not Available
Utah Road Usage Charge (2018)	(fully implemented) Account managers. OBD mileage reporting device. Voluntary for electric and hybrid vehicle owners.	TBD	3,500
OReGO (2017)	(fully implemented) Three account managers, including the state. GPS and non-GPS options. Value-added services available. Volunteer basis.	**40%**	>5,000
California Road Charge Pilot Program (2017)	(pilot) Demonstrated six reporting and recording methods through four account managers. Collection methods ranged from no-tech to high-tech. Heavy vehicles were included. Volunteer basis.	**2.5 - 15% (est)** ~2.5% - heavy vehicles ~5% - high tech ~7% - low tech ~15% - state operated	>5,000

Notes: *(1) Reflects costs to the government as opposed to costs incurred by third-party account managers. In some cases, these reflect costs the government pays to third-party account managers for the operation of the DBF system.*

The administrative costs vary widely among pilot projects due to several factors such as the costs included as administrative costs, the technology used, the number of users included in the program, and the agency collecting the charge. First, pilot projects include different costs under what they report as administrative costs. In the I-95 corridor study, for instance, administrative costs consider *"education and outreach, certification and ongoing monitoring of account managers, changes to DMV operations and software to support system enrollment and compliance efforts, payment enforcement and collection activities, and the need for the state to accommodate cash payments"* (I-95 Corridor Coalition, 2019). On the other hand, a pilot conducted in Oregon in 2006 included "*auditing, enforcement and administration, communication lines*" while the 2012-2013 study included "*device communications, data analytics, mapping, data hosting, and account management and billing*" (ODOT, 2013; ODOT, 2007).

Second, administrative costs also vary with the technology used. In the Washington pilot project, the estimated costs of administering a DBF system using a time permit and odometer charge were approximately 7–8 percent of revenue collected. These costs increased to 12–13 percent when using a plug-in mileage metering device. If a combination of both is used, costs would be just under 10 percent of revenue collected. The California pilot project found that manual collection of mileage information could be the most expensive to administer. Currently, California is exploring a pay-at-the-pump collection method in order to replicate current user experience with the fuel tax and to potentially reduce collection costs. Lastly, the I-95 corridor study suggests technology-based collection methods will result in lower administrative costs than manual collection methods (WSTC, 2020; CalSTA, 2017; I-95 Corridor Coalition, 2019).

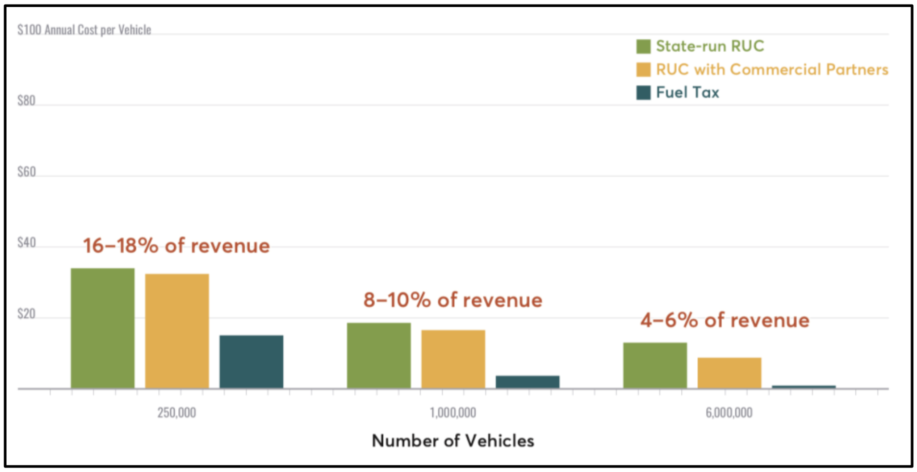
Third, the number of users or vehicles included in the program affects administrative costs. DBF pilot projects provide evidence that DBF administrative costs decrease as the number of vehicles involved in the collection system increases due to economies of scale (WSTC, 2016; ODOT, 2017).

Fourth, administrative costs also depend on the agency in charge of its collection. The pilots in Oregon, California, and Washington estimated a decrease in DBF administrative costs with a commercial partner that centralizes its collection. The commercial partners, for instance, can provide value-added services[29] that offset the costs associated with DBF collection, quickly adapt to evolving technologies, and operate in several jurisdictions (WSTC, 2016; ODOT, 2017; CalSTA, 2017).

Lastly, other research suggests that substantial cost savings could be realized if some administrative costs associated with vehicle registrations and toll collections were integrated into DBF systems. According to the I-95 Corridor Coalition (2012), such integration can reduce the annual administrative cost of a DBF system in the U.S. from $51 to about $40 per vehicle.

Figure 2.3 presents the administrative costs of a DBF system in the Washington Pilot. The costs of a DBF system are estimated for two scenarios, one in which the state collects the fee and the other in which a commercial partner collects it, and compares them to the current motor fuel tax (WSTC, 2020). As mentioned earlier, administrative costs are expected to decrease as the number of vehicles involved in the collection system increases as well as when commercial partners are involved.

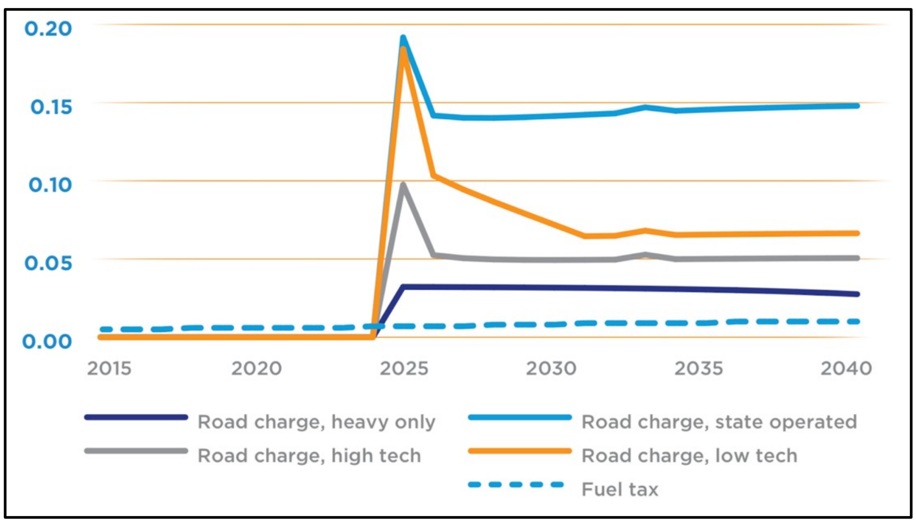
[29] Commercial account managers in Oregon, for instance, allowed volunteers to check their mileage and other driving statistics, and their badges (awarded for certain driving behaviors). They also allowed the driver to set a geographical boundary and receive information when the vehicle leaves it (helpful for drivers with a younger dependent).



Source: *WSTC* (2020, p. 23).

Figure 2.3 Costs of DBF compared to Fuel Tax, at various vehicle volumes (Washington RUC)

Figure 2.4 presents the costs of collection of a DBF under several scenarios in California pilot (CalSTA, 2017). The stabilization of the costs over time assumes that technology and service companies make breakthroughs that increase consumer adoption of in-vehicle services that serve as a platform for the DBF system. Several scenarios developed in the pilot estimated collection costs below 10 percent of total revenue in the long term.



Source*: CalSTA* (2017, p. 71).

Figure 2.4 Costs of DBF under different scenarios over time (California RUC)

The costs of collecting a DBF system could also be compared with the costs of collecting utility fees as both are user fees. Overall, the research in this area is limited, but the costs of collecting a road usage charge are estimated to be more costly compared to utilities such as gas, water, electricity, and telecommunications which have collection costs of 5-10 percent (CalSTA, 2017).

As of 2020, the Minnesota Department of Transportation is running a DBF demonstration in collaboration with Shared Mobility providers. The collaboration with SM providers aims to improve the administrative and political feasibility of a DBF system. There is potential for higher administrative feasibility with the demonstration as it reduces collection points and uses existing in-vehicle technologies. Similarly, there is potential for higher political feasibility since partnering with SM providers could address privacy and data protection concerns (see privacy memo for further information).

Reducing Collection Points

State and federal motor fuel taxes are relatively cheap to administer due to the small number of wholesalers that are billed (DeGood & Madowitz, 2014). DBF costs, in contrast, are higher due to the costly infrastructure to read, store, process, and bill a large number of individual drivers (Duncan & Graham, 2013). By partnering with SM providers, the number of entities that are billed is still larger than collecting the motor fuel tax at the wholesale level, but is likely to be much lower than administering a DBF at the individual driver level.

Minnesota's DBF demonstration reduces collection costs by billing SM providers instead of billing drivers individually. SM providers will process the mileage data of all vehicles in their fleet and report it to the state.

Using Existing Technologies

A Distance-Based Fee system in partnership with SM providers has the potential to reduce or eliminate program start-up costs. Start-up capital costs for a DBF system are the costs related to the technology required to track and transfer VMT data, including the development, purchase, and installation of third-party GPS devices and transponders in vehicles.

Minnesota's DBF demonstration eliminates start-up capital costs by leveraging existing resources. SM providers already have a fleet of vehicles equipped with GPS-enabled tracking and anti-theft technology in order to provide transportation services to their customers. With this existing technology SM providers can determine the location of the vehicle during a reservation, monitor the state of the vehicle, and bill customers for time and mileage use of the vehicle. It is assumed that SM providers have better, cheaper access to technology and data than the state for mileage reporting (WSTC, 2016). In addition, SM providers are in a better position to keep pace with evolving technology (vehicle electrification and automation) as these technologies become necessary to compete in the Shared Mobility market.

Leveraging existing relationships with customers

The nature of shared-mobility services involves sharing information. SM providers offer vehicles with embedded technology to their customers and customers agree to share trip information to be billed for the usage of the vehicle. SM providers have established contracts and privacy policies that help prevent the dissemination or transmission of personal information and its inappropriate use.

Minnesota's DBF demonstration leverages this relationship to address privacy and data protection concerns. There is no need to have additional privacy policies put in place between drivers and the state than what already exists between SM providers at their customers. When reporting mileage in the demonstration, SM providers will report information aggregated at the vehicle level and, therefore, no personally identifiable information (PII) should be disclosed. In addition, SM providers will not report specific vehicle point locations, but rather aggregated per car mileage for the month.

There is potential for the existing relationships between shared mobility providers and their customers to facilitate customer acceptance of DBFs. The SM customer understands that using a SM service is different than using a personally owned vehicle, and because of this are potentially more accepting of business practices and procedures that the SM might have in place, such as collection of certain taxes or fees. The nature of this relationship between customer and SM provider could lead to more acceptance by SM users due to the customer's understanding of SM business practices.

2.5.2 Fees and Regulations that Apply to Shared Mobility Providers

Shared mobility providers are subject to taxes levied on the services they provide, in addition to regular transportation taxes - such as the motor fuel tax, registration taxes, and motor vehicle sales taxes. While there are no taxes levied on ride-sourcing services in Minnesota,[30] there are taxes levied on car-sharing services. These taxes include the sales taxes, the rental motor vehicle tax, and the motor vehicle rental fee.

Car-sharing companies are subject to pay sales taxes, which include the state general tax, a county sales tax, a city sales tax, and a local option sales tax (see Table 2.7). The state general tax applies to all transactions within the state, and additional local sales taxes apply depending on the locality where the trip originated. The final tax rate is applied to the total cost of the reservation, including mileage charges and punitive fees.

Table 2.7 Sales Tax in Minnesota

Tax	Rate
State General Sales Tax	6.875%
County Sales Tax	0.15% (Hennepin)
City Sales Tax	0.50% (Minneapolis, St. Paul) 0.75% (Rochester)
Local Option Sales Tax	0.50% (Hennepin, Ramsey, Olmstead)

[30] For more information on taxes levied on ride-sourcing services across the U.S. see Zhao, Fonseca, & Zeerak (2019).

These companies are also subject to the rental motor vehicle tax of 9.2 percent and the motor vehicle rental fee of 5 percent (Minn. Stat. § 297A.64). The percentages are applied to the sales price. Nonprofit car-sharing operators are exempt from the motor vehicle rental fee.

All these taxes add up to an approximate tax burden of 22 percent for car-sharing operators in the state and become a strong barrier for being competitive in the shared mobility market. This high tax burden, for example, makes it hard for car-sharing services to compete with other SM services such as ride-sourcing services (provided by Transportation Network Companies -TNCs- like Uber and Lyft). These services have been shown to have a negative impact on congestion and greenhouse gas emissions in many cities, while car-sharing services have shown to provide societal benefits of reduced personal car ownership, increased walking and biking without reduced transit use, and reduced parking demand that typical car rental services do not (Schwieterman & Spray, 2016).

Additionally, this high tax burden reduces the supply of transportation services in Minnesota. High taxes are cited as the reason why car-sharing providers have left the Minnesota market. This is important since shared mobility services are critical when other transportation modes cannot meet the needs of a certain trip or certain populations, such as Minnesotans living without personally owned vehicles.

Car-sharing services across the U.S. face tax burdens that are higher than most other segments of the economy (Schwieterman & Spray, 2016). A study considering the 40 largest cities in the country found that eight of these cities levy taxes on car-sharing trips that are 15 percent or higher, with some reaching levels of over 30 percent. Among the 40 cities, Minneapolis was found to have the 10th highest tax rate on one-hour car-sharing reservations and the 2nd highest tax rate on 5-hour reservations (Schwieterman & Spray, 2016).

The rationale for the high tax rates levied on car-sharing services is that these services are the same as traditional car-rental services, which are traditionally subject to high taxes due to their exportability (Schwieterman & Spray, 2016). Car-rental services are typically used by tourists and visitors of a municipality. Therefore, taxes levied on these services are paid by tourists and visitors as opposed to residents (Murray, 2006). This tax exportation makes a tax politically feasible. However, while most traditional car-rental customers are from out of town, most car-sharing customers are local residents and the application of a tax intended to be exportable, like the MVRT, is inappropriate when applied to car-sharing. Car-share providers have testified at the Minnesota state capital for exemption from the 9.2 percent rental vehicle tax, without success (Bakst, 2017). This is in an effort to reduce the tax burden borne by local residents and users of car-sharing services.

2.5.3 Potential Future Benefits of Collaborating with Shared Mobility Providers

Partnering with SM providers offers potential future benefits that can reduce administrative costs. First, shared mobility services are expected to continue growing (Grosse-Ophoff, Hausler, Heineke, & Möller, 2017), which increases the number of vehicles involved in the collection system and, thus, reduces collection costs. Second, the DBF system could be expanded to several SM services, including ride-sourcing, car sharing services, and bike and scooter sharing, to capture more fleets and a larger number of vehicles. This is important as we look towards a potential future where mobility as a service becomes more common (Goodall, Fishman, Bornstein, & Bonthron, 2017). Third, substantial cost savings could be realized with the integration of DBFs and other charges levied on shared mobility services (as I-95 Corridor Coalition, 2012 found) such as the motor fuel tax, registration fees, sales taxes, tolls, and vehicle rental taxes and fees, among others. SM providers already include a process for sales tax remittance within their internal operations. Integrating a DBF payment into these existing internal operations could ease the collection process and the costs associated with it. Lastly, SM providers can also operate in multiple states allowing for easy interoperability of the DBF system. SM provider operation in other jurisdictions facilitates the charge of out-of-state VMTs (WSTC, 2016).

CHAPTER 3: RATE SETTING AND FINANCIAL ANALYSIS

In this chapter, we lay out a framework for DBF pricing schemes and discuss potential DBF rates. We consider pricing schemes for DBF that conceptually divide the fee into three key components: a baseline fee, efficiency add-ons fees, and other adjustments. The baseline fee is such that, in the short run, DBF revenues equal those from the current motor fuel tax levied by the State of Minnesota. In this way, the pricing scheme would ease a transition from the motor fuel tax system to the DBF system. In the long run, the rate structure has the potential to catch up with increasing long-term transportation needs, through indexing, periodical updating, or some combination of both. The baseline fee could be further augmented with efficiency add-ons and other adjustments to account for additional policy considerations, such as environmental or social-equity concerns and vehicle size/weight. To illustrate some of these issues, we conduct financial analysis with data from shared mobility partners and provide examples of multiple rate-setting options. Actual pricing decisions -regarding how the baseline rate is selected, what efficient add-ons to incorporate, and what additional adjustments to put in place- are ultimately made by policymakers.

3.1 PRICING SCHEME FOR DBF: AN INITIAL APPROACH

The proposed framework for DBF pricing aims to ease the transition from the motor fuel tax system to the DBF system and includes three components: a baseline fee, efficiency add-ons fees, and other adjustments. The baseline fee is designed so that, in the short term, it generates the same amount of DBF revenues as the current motor fuel tax. In the long run, the rate structure has the potential to catch up with long-term transportation needs, through indexing, periodical updating, or some combination of both. The baseline fee could be further augmented with efficiency add-ons and other adjustments to account for additional policy considerations.

3.1.1 Baseline Rate

As a starting point, the DBF baseline rate is based on the average cost of a mile of travel for vehicles in the state based on MFT receipts. We set the baseline rate by computing the charge per mile traveled that generates the same revenue as the motor fuel tax, while covering the costs of administering the system. In some states, these revenues not only include the motor fuel tax paid for every gallon of fuel purchased, but also the proceeds from a fee levied on electric vehicles (EVs)-and hybrid vehicles- that account for the loss in motor fuel tax revenue. In addition to generating the same revenue, this baseline rate should also account for the of costs administering the DBF system. Revenues from other taxes such as sales taxes and registration taxes are not considered in this calculation since these revenue streams depend on the value of the vehicle (due to vehicle ownership), while motor fuel taxes reflect in a way the use of the roadway system (user fee).

The DBF baseline rate is equal to the total annual MFT revenues plus DBF administrative costs divided by total annual VMT:

$$DBF_t = \frac{MFT\ revenues_t + AdminCost_t}{VMT_t}$$

In the formula for the state of Minnesota, *MFT revenues* stands for the total motor fuel tax proceeds[31] and the proceeds from the $75 annual surcharge levied on fully electric vehicles;[32] *AdminCosts* is the additional cost of administering the DBF system; and VMT refers to total vehicle miles traveled in the state. All of them considered in a given year (t).

This report presents two methods to calculate the baseline DBF rate. First, assuming all VMT contribute the same amount of MFT revenue regardless of the vehicle type (light vs heavy vehicles). Second, assuming a different contribution on MFT revenue from miles traveled by different types of vehicles. This method is more realistic as heavy vehicles use much more fuel per mile than light vehicles, and therefore, pay more motor fuel tax per mile. However, given that detailed data is not available for the calculations, several assumptions have to be considered.

Method I: All VMT contribute the same MFT revenue

Table 3.1 presents annual MFT revenues, annual VMT, and annual revenues from the EV fee in the State of Minnesota, as well as the calculations for baseline DBF rates between 2015 and 2019. The calculations of the baseline DBF rate in the table consider DBF administrative costs similar to the costs of administering the current motor fuel tax system, which are 0.25 percent of the total revenue collected in Minnesota (MMB, 2021).[33] This is a conservative assumption but implies a lower bound of the DBF rate.

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[31] The state of Minnesota has a motor fuel tax rate of 28.5 cents per gallon of fuel regardless of the type of fuel. This tax was last raised in 2008. In 2019 the House File 1555 failed to pass the Senate. The bill proposed a 20-cent gas increase phased in over four years and could have indexed the gas tax for inflation on an annual basis after the completion of the phase-in. In Minnesota, the administrative costs of the motor fuel tax are paid out of motor fuel tax revenues.
[32] The fee was effective on January 1, 2018. In 2019 the Senate File 1093 proposed a $200 annual surcharge for all-electric vehicles and a $100 annual surcharge for plug-in hybrid electric vehicles. The bill failed to pass.
[33] Amount based on administrative expenses of $2.194 million and revenue collection of $878.2 million for FY2020.

Table 3.1 Baseline DBF rate for the State of Minnesota – Method I

Year	VMT (1)	MFT (thousands) (2)	EV fee (thousands) (3)	Admin. Costs (thousands) (4)	DBF (¢/VMT)
2015	58,124,883,776	$888,000	-	$2,238	¢1.532
2016	58,856,547,322	$899,000	-	$2,265	¢1.531
2017	59,970,745,402	$911,000	-	$2,296	¢1.523
2018	60,438,313,272	$926,000	$196	$2,334	¢1.536
2019	60,730,981,154	$938,000	$399	$2,364	¢1.549

Notes: *(1) 2015 VMT calculated by authors as the 2014-2016 average. (2) Gross revenues. (3) Calculated by authors as the number of electric vehicles registered multiplied by $75. (4) Calculations assuming DBF administrative costs similar to the costs of the MFT system.* ***Source:*** *Author's calculations. Data from the Minnesota Transportation Finance Database, MnDOT, and Drive Electric Minnesota.*

The literature estimates the costs of administering a DBF system to be higher than the costs of administering the motor fuel tax. Table 3.2presents the DBF rate for 2019 considering different administrative costs for the DBF system including the baseline administrative costs of 0.25 percent (the current costs of collecting the MFT in Minnesota) and the cost of administering a DBF system estimated by several pilot programs implemented across the U.S., which are estimated to be between 5 and 15 percent of revenue collected (CalSTA, 2017; ODOT, 2017; WSTC, 2020).

Table 3.2 Baseline DBF rate considering Different Administration Costs

Admin Costs (% of MFT revenue collected)	0.25%	5%	10%	15%
Admin Costs (in thousands)	$2,364	$46,900	$93,800	$140,700
DBF (cents per mile)	1.549	1.622	1.700	1.777

Overall, calculations for 2019 show that, on average, all vehicles in Minnesota contributed 1.55 cents per VMT through the motor fuel tax. In addition, if the administrative costs of a DBF system were 10 percent of the total revenues collected, the baseline rate would increase to 1.7 cents per VMT. These rates are similar to the estimated rates initially used in the pilots explored in Oregon (¢1.5 in 2015), California (¢1.8 in 2017), and Colorado (¢1.2 in 2017).[34]

[34] As of 2021, the OReGO program charges ¢1.8 per VMT and the Utah Road Usage Charge charges ¢1.5 per VMT. These two programs are actually collecting revenues from the DBF system.

Method II: VMT contribute different MFT revenue depending on the type of vehicle

This second method to calculate the baseline DBF rate takes into consideration that heavy vehicles use much more fuel per mile than light vehicles, and therefore, contribute more per mile in motor fuel tax. However, detailed data regarding the gallons of fuel consumed and the amount of VMT driven by heavy and light vehicles is limited, and several assumptions are made to calculate the baseline DBF rate. First, heavy vehicles' VMT represents around 8 percent of total VMT driven in the Trunk Highway (TH) route system (MnDOT, 2020).[35] Researchers, with the help of MnDOT staff, assumed that total VMT driven by heavy vehicles in the non-Trunk Highway system[36] was around 4 percent – half the percentage driven in the TH system. These percentages are similar to national trends estimates (FHWA, 2019). Second, there is no information regarding the motor fuel tax contributed by vehicle type. Therefore, it is assumed that light vehicles contribute motor fuel tax paid for the gallons of gasoline consumed, and heavy vehicles contribute motor fuel tax paid for the gallons of special fuels consumed.[37] According to this assumption, of the total revenues from the motor fuel tax, around 80 percent are contributed by light vehicles and 20 percent by heavy vehicles (DOR, 2021).

Table 3.3 presents annual MFT revenues and annual VMT by vehicle type, as well as the calculations for baseline DBF rates between 2016 and 2019. The calculations of the baseline DBF rate in the table consider administrative costs similar to the costs of administering the current motor fuel tax system.

Table 3.3 Baseline DBF rate for the State of Minnesota – Method II

	Light Vehicles			Heavy Vehicles		
Year	**VMT**	**MFT (1) (2)**	**DBF (¢/VMT)**	**VMT**	**MFT (1)**	**DBF (¢/VMT)**
2016	55,070,990,370	$720,621,953	1.31	3,785,556,953	$180,643,527	4.77
2017	56,149,884,399	$730,240,933	1.30	3,820,861,003	$183,054,787	4.79
2018	56,594,880,703	$742,461,203	1.31	3,843,432,569	$186,068,861	4.84
2019	56,708,570,730	$752,283,946	1.33	4,022,410,424	$188,480,120	4.69

Notes: *(1) The amount includes DBF administrative costs similar to the current costs of the MFT system. (2) The amount includes revenues from the EV fee, calculated by authors as the number of electric vehicles registered multiplied by $75.* ***Source:*** *Author's calculations. Data from the Minnesota Transportation Finance Database, MnDOT, DOR, and Drive Electric Minnesota.*

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[35] VMT in the Trunk Highway system account for around 60 percent of total VMT. The Trunk Highway route system includes interstates, U.S. highways, and MN highways (for these last two routes it includes both numbered and non-numbered roads).
[36] VMT in the non-Trunk Highway system account for around 40 percent of total VMT. Non-Trunk Highway routes include county state-aid highways, municipal state-aid streets, county roads, municipal streets, township roads, state forest and park roads, and Indian Reservation roads.
[37] Special fuels refer to diesel **Invalid source specified.**. In Minnesota, the tax rate for diesel fuel is 28.5 cents per gallon **Invalid source specified.**.

Table 3.4 presents the DBF rate for 2019 for light vehicles considering different administrative costs for the DBF system.

Table 3.4 Baseline DBF rate for Light Vehicles considering Different Administration Costs

Admin Costs (% of MFT revenue collected)	0.25%	5%	10%	15%
Admin Costs (in thousands)	$1,875	$37,500	$74,999	$112,499
DBF (cents per mile)	1.327	1.389	1.456	1.522

Although the baseline rate is designed to be equivalent to the MFT, users will experience a change in their tax payments. Under a scenario where the two systems are in place and the motor fuel tax is credited for DBF payment, users of fuel-efficient, hybrid, and electric vehicles will experience an increase in their tax payments, while users of less fuel-efficient vehicles might experience a potential reduction their tax payments. In the long-term, when only a DBF is charged, users' tax payments will depend on their VMT regardless of their fuel consumption.

A flat baseline fee per mile traveled may ease the transition from the motor fuel tax system to the DBF system. According to other pilots implemented across the U.S., a flat fee per mile is simple for drivers to understand and easy to implement. These characteristics also make the system easy to comply with, and facilitate collection, audit, and enforcement from state agencies, further reducing administrative costs. However, the flat fee concept raises significant equity concerns as it creates winners and losers.

A flat charge per mile traveled also raises several efficiency and environmental equity concerns. On one hand, a flat rate assumes that all vehicle miles traveled cause the same impacts, but they may differ in terms of vehicle type (such as light-duty vs heavy-duty vehicles), vehicle occupancy, and time of travel (peak vs non-peak hours) among others. On the other hand, the rate does not reflect the environmental impacts of the vehicle's power source (fuel vs electricity). To address these limitations, the baseline rate could be augmented with efficiency add-ons and other adjustments. These adjustments are discussed in the next subsections.

3.1.2 Efficiency Add-Ons

The DBF rate could be adjusted to account for the impact of different vehicle types on the roadway system as well as to address congestion problems. This subsection discusses vehicle-dependent surcharges and congestion fees to address these impacts.

Vehicle-dependent surcharges and congestion fees may promote an efficient use of the roadway system. However, future research would be needed to assess the benefits and costs of their implementation, as well as the trade-offs that may exist. For instance, as more variables are needed for the design of the DBF rate, more detailed data would be needed from the vehicle. Individual users may benefit from a more accurate payment for their use of the roadway system, but it may bring up data protection and privacy concerns. In addition, additional data points might increase the costs for the government agency that collects, audits, and enforces the DBF system.

Vehicle-Dependent Surcharge – The deterioration of the roadway system is caused by many factors including traffic, pavement materials, the environment, and vehicle weight (Wilde W. J., 2014). Vehicle weight could be an appropriate measure to adjust the baseline rate and there are several ways to account for it including the weight of the vehicle, the weight of the vehicle with occupants or loads (e.g., maximum capacity, average occupancy weight, etc.), and the distribution of weight across axles among others. In addition, these could be considered by groups of vehicles (e.g., light-duty & heavy-duty vehicles) or by vehicle categories (sedans, SUVs, pickups, vans, buses, and types of trucks).

To illustrate the vehicle dependent surcharge for the state of Minnesota, we consider the Equivalent Single Axle Load (ESAL) factors and the pavement damage costs as follows:

$$DBF_{VD} = ESAL\ factor * pavement\ damage\ costs$$

The ESAL is a measure of the damage to the pavement incurred by vehicle loads. In particular, it establishes a pavement damage relationship for axles carrying different loads (Peterson, 2011; Wilde W. J., 2014).[38] In addition, we used the estimates of Zhao & Wang (2015) for the pavement damage costs. The authors estimate that these costs vary between \$0.005 to \$0.04 per ESAL-mile. We used an average of \$0.03 for the calculations. Table 3.5 provides the ESAL factor by vehicle type and the vehicle-dependent surcharge.

[38] Peterson (2011) provides estimates of the ESAL factor for concrete and asphalt pavements for the 13 types of vehicles in Minnesota. These estimates are similar to those provided by Wilde (2014). These authors, however, differ in the ESAL factor assigned to passenger cars and van/picks. We consider this difference in our calculations.

Table 3.5 Comparison of Vehicle Impacts to the Roadway System by Vehicle Type

Vehicle Type		ESAL Factor			Vehicle Dependent Surcharge (¢/VMT)
		Concrete	Asphalt	Average	
1	Motorcycle	0.0007	0.0007	0.0007	0.00
2	Car	0.0007	0.0007	0.0007	0.00
3	Van/Pickup	0.0052	0.0052	0.0052	0.02
4	Bus, truck with trailer	0.74	0.57	0.66	1.97
5	2 axle single unit	0.24	0.25	0.25	0.74
6	3 axle single unit	0.90	0.61	0.76	2.27
7	4+ axle single unit	0.90	0.61	0.76	2.27
8	3 & 4 axle semi	0.61	0.60	0.61	1.82
9	5 axle semi	1.64	0.99	1.32	3.95
10	6+ axle semi	0.83	0.69	0.76	2.28
11, 12, 13	Twin Trailer Semi	3.06	3.15	3.11	9.32

Notes: *Author's calculations.* ***Source:*** *ESAL Factor from Peterson (2011) and Wilde (2014).*

The higher the impact of the vehicle on the roadway system, the higher the vehicle-dependent surcharge needed to cover the damage to the transportation infrastructure. Motorcycles and passenger vehicles are selected as the base category and would not pay the vehicle-dependent surcharge. Vans and pickups would pay an additional fee of ¢0.02 per mile traveled to account for the additional roadway damage they impose on the system. This means that in total, per mile traveled, passenger vehicles would contribute the baseline rate, while vans and pickups contribute the baseline rate plus ¢0.02 – which represents a difference of around one percent per mile traveled.

Depending on the implementation of the surcharges, it might be necessary to revise the baseline fee. A lower fee might be in order as surcharges cover more of the infrastructure costs, targeting the payments to the vehicles that do the most damage to roads.

Approaching the vehicle-dependent surcharge in the form presented above may create additional concerns. For instance, all vehicles grouped in each category are assumed to have the same impact on the roadway system regardless of their actual occupancy/load and vehicle class. One example of this is the great variation in vehicles categorized as car or passenger vehicles, which group compact vehicles, sports vehicles, SUVs, and full-size SUVs among others. However, these differences might not be significant enough to require different pricing.

Congestion fee – Congestion creates externalities that are not reflected in travelers' out-of-pocket costs. Costs associated with congestion include the increase in travel time unreliability; excess fuel usage; increased emissions and environmental damage; higher accident rates and safety costs; higher inventory, maintenance, and operating costs; and loss of productivity (HDR, 2009). In order to develop a

DBF system that is efficient and accounts for all costs, the state might consider a congestion-based efficiency adjustment.

Congestion pricing schemes are currently applied in different settings (Federal Highway Administration, 2008). A combination of a baseline DBF rate and congestion pricing may address congestion problems, address rural/urban inequities, and increase the efficiency of road usage. In particular, the congestion fee could vary by time of day or by timeframes (for example, peak and non-peak hours) and be implemented on a limited number of lanes of a roadway (leaving other travel lanes unpriced), or on all lanes of a roadway, or a specific zone. Across the U.S., several states are already familiar with congestion pricing schemes through toll-managed lanes programs, for instance.[39]

3.1.3 Other Adjustments

The DBF rate or the DBF system could be adjusted to address environmental and social impacts. This subsection discusses environmental and income-based adjustments that could be used to address these impacts.

Environmental Adjustment – There is a growing interest regarding the burden of DBFs on owners of alternative-fuel vehicles (e.g., hybrid and electric vehicles). Owners of these vehicles, for instance, contribute relatively less than internal combustion engine (ICE) vehicles through the motor fuel tax. Their contributions, however, could be relatively higher with regards to other roadway funding sources, such as vehicle sales tax or registration fees, due to vehicles' commercial value, which tends to be higher compared to ICE vehicles.

Many focus group participants in several studies indicated their concern about the additional burden of the DBF systems on owners of alternative-fuel vehicles. According to research findings, a DBF system would impose a penalty on those users who cause less environmental damage (Weatherford B. , 2012; Agrawal, Nixon, & Hooper, 2016). Other studies note that a DBF system may discourage ownership of hybrid or other fuel-efficient vehicles rate (Zhang, McMullen, Vallury, & Nakahara, 2009; Weatherford B. , 2012). According to them, it is believed that owners of hybrid or fuel-efficient vehicles would pay more than individuals with fuel-inefficient vehicles. However, this may be addressed by setting DBFs rates so that those with fuel-efficient vehicles pay less (Zhang, McMullen, Vallury, & Nakahara, 2009).

A potential adjustment to the DBF rate includes a transitional tiered rate based on the vehicle powertrain. In this structure, the rates could be lower for electric and hybrid vehicles than for ICE vehicles. The tiered-rate system, in the short term, would account for the environmental benefits of alternative-fuel vehicles. The lower rates for electric and hybrid vehicles could be gradually increased

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[39] In Minnesota, for instance, the E-ZPass (previously called MnPASS) provides travel options to busy weekday commuting hours (6-10 am and 3-7 pm) by providing a dedicated lane that free for high occupancy vehicles (HOV), buses and motorcycles, and requires a fee for single occupant vehicles (SOV). The fee is based on traffic levels, the heavier the traffic, the higher the price. The fee ranges between $0.25 and $8 **Invalid source specified.**.

over a period of time (between 5 and 10 years), considering the increasing adoption of hybrid and electric vehicles. After the transition period, all VMT would be charged at a specific rate regardless of vehicle powertrain.

Other potential adjustments to the DBF system include short-term and long-term adjustments. Short-term adjustments include providing credits or discounts to owners of hybrid and electric vehicles during a transition period (5 to 10 years), which could be gradually reduced considering the increased adoption of these vehicles. Long-term adjustments could include adding a surcharge in addition to the DBF to account for the environmental impact of the vehicle; either a surcharge based on vehicle emissions or type of vehicle, or continue charging the motor fuel tax but at a lower rate.

Income-Based Adjustment – Studies focused on the motor fuel tax system have found that the burden the motor fuel tax imposes on low-income individuals is higher than the burden on high-income individuals (Poterba, 1991; Williams, 2007). For instance, according to Williams (2007), Americans earning less than $10,000 on an annual basis paid 2.5 percent of their income in gas tax, while those earning $150,000 or more paid about 0.2 percent. With the potential of implementing DBF systems, there is growing interest in designing a less regressive and socially equitable system. Two potential adjustments have been discussed. The first is to provide credits or subsidies to low-income drivers. The subsidy could be provided to drivers that already qualify for another income-based program. The second approach is to charge travelers based on their income level, for instance, based on the submission of income tax returns.

3.2 FINANCIAL ANALYSIS

The Minnesota Department of Transportation (MnDOT) partnered with two shared mobility (SM) providers to demonstrate a Distance-Based Fee system in the state of Minnesota. The collaboration with SM providers not only contributes to improving the administrative and political feasibility of a DBF system,[40] but also provides a useful context to study the future of transportation funding.

Vehicles in the SM providers' fleet are different from the average vehicles currently used in the State of Minnesota. SM providers not only have internal combustion engine (ICE) vehicles that are relatively new and therefore more fuel-efficient than the average vehicle in Minnesota,[41] but they also have and are

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[40] With this collaboration there is potential for higher administrative feasibility as SM providers already use existing in-vehicle technologies and reduce collection points. Similarly, there is potential for higher political feasibility since SM providers already have systems or policies in place that could address privacy and data protection concerns.

[41] The current average age of vehicles in Minnesota is 11.8 years **Invalid source specified.**, which relates to an average vehicle fuel-economy of 23.5 **Invalid source specified.**, while the SM providers' fleet has an average vehicle fuel-economy of 31.

adopting alternative energy source vehicles.[42] These factors are particularly relevant as they are closer to what the characteristics of the State fleet will be in the coming years.

This section presents simulations of the SM providers' contributions to the roadway system under the current motor fuel tax system and a hypothetical distance-based fee system at the State level.

Data and Assumptions

Each SM provider shared two datasets for the analysis. The first dataset reported monthly fuel purchases and total gallons of gas purchased linked to fuel cards attached to a vehicle. The second dataset reported the miles traveled of each of SM providers' vehicles, along with some vehicle information such as model, make, and year. Both datasets were monthly and covered data between April 1, 2020, and March 31, 2021. As part of this study, we merged these datasets by pairing gas purchases to specific vehicles whenever possible.

The fleet of shared mobility providers reported VMT and gallons of fuel purchased during the twelve months of the demonstration. VMT correspond to miles traveled during customers' reservations and by SM provider staff to support services offered. To prevent double-counting VMT from reservations that started in one month (t) and ended in the following month (t+1), VMT were capture from reservations that ended in a particular month. As SM providers could not identify the miles driven in Minnesota from those out-of-state, all VMT are assumed to be driven in the state of Minnesota. Similarly, all gallons of fuel purchased were included in the analysis, including some transactions that occurred in Wisconsin (accounting for 0.9 percent of the total gallons reported). Duplicated observations -same transactions reported in two different months- were deleted from the sample to prevent double counting. Outlier observations were also deleted. Overall, the fleet of shared mobility providers reported 529,076 VMT and 17,819 gallons of fuel purchased during the twelve months. Table 3.6 presents VMT and gallons of fuel purchased aggregated per month.

[42] During the demonstration, the fleet included hybrid vehicles. In addition, SM providers may have considered converting their fleet to a fully electric fleet.

Table 3.6 Monthly VMT and Gallons of Fuel Purchased

Month	VMT	Gallons of Fuel
Apr-20	27,018	1,128
May-20	42,885	1,496
Jun-20	49,065	1,436
Jul-20	63,752	1,858
Aug-20	58,079	1,849
Sep-20	56,771	1,440
Oct-20	52,770	1,814
Nov-20	43,427	1,446
Dec-20	42,858	1,501
Jan-21	29,797	1,066
Feb-21	8,466	959
Mar-21	54,187	1,827
Total	**529,076**	**17,819**

With vehicle information provided by SM providers, researchers created new variables to conduct the analysis. In particular, researchers created a variable to capture the vehicle's powertrain. All vehicles in the sample were considered internal combustion engine (ICE) vehicles, except for some Toyota Prius that were considered hybrid (HYB) vehicles and a Chevy Bolt that was considered as an electric vehicle (EV). Table 3.7 presents the VMT and gallons of fuel purchased by vehicle powertrain. ICE vehicles drove 90.9 percent of the VMT and purchased 91.7 percent of fuel gallons. On average, an ICE vehicle drove 7,175 VMT and purchased 243.99 gallons of fuel, while a hybrid vehicle drove 6,037 VMT and purchased 143.92 gallons of fuel.[43]

Table 3.7 VMT and Gallons of Fuel Purchased by Vehicle Powertrain

Vehicle Type	VMT		Gallons of Fuel	
	Value	%	Value	%
ICE	480,733	90.9%	16,347	91.7%
HYB	48,299	9.1%	1,151	6.5%
EV	44	0.0%	-	0.0%
Vehicle not identified (1)	-	0.0%	320	1.8%
Total	**529,076**		**17,819**	

Notes: *(1) A SM provider reported gallons of fuel purchased with spare credit cards, which could not be traced back to a vehicle.*

[43] Usage patterns per vehicle could be observed in Figure 3.10 (the figure presents an outlier that was not included in this analysis).

Revenues from the motor fuel tax system and a hypothetical DBF system are calculated for the financial analysis. Revenues from the motor fuel tax system are calculated using the Minnesota motor fuel tax rate of 28.5 cents per gallon. Similarly, revenues from a hypothetical DBF system are calculated using rates identified in Section 2 under different scenarios. For this financial analysis, all VMT and all gallons of fuel purchased are assumed to be in the State of Minnesota. In a future implementation of a DBF system, however, the VMT and fuel purchases considered for the DBF payment, and a motor fuel tax credit would depend on the policies each state adopts.

3.2.1 Current Contributions through the State Motor Fuel Tax

During the twelve months, SM providers contributed $5,078.37 through the motor fuel tax - on average $423.20 per month (Figure 3.1). Given the miles reported by SM providers, researchers calculated an average motor fuel tax contribution of 0.96 cents per vehicle mile traveled. This contribution differs significantly between ICE and hybrid vehicles. Hybrid vehicles contribute almost half of what ICE vehicles contribute (0.68 and 0.97 cents per mile, respectively).

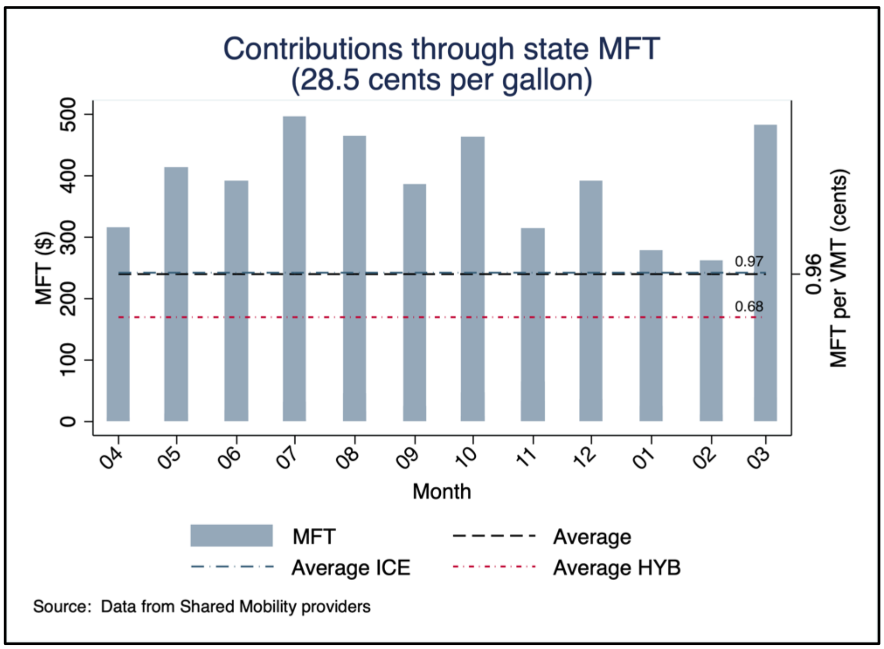

Figure 3.1 Total Contribution through State Motor Fuel Tax

Given fuel purchases and miles traveled by vehicle, it was possible to estimate the average fuel efficiency of ICE and hybrid vehicles. Researchers used these estimates to create hypothetical situations, assess changes in MFT revenues with increasing fuel efficiency, and their implications.

First, researchers assessed what would have happened if the SM providers' fleet were only composed of ICE vehicles or only composed of hybrid vehicles - similar to those used in the demonstration. Figure 3.2 presents the results. To travel the same VMT in a fleet composed of only ICE vehicles, the SM providers would have to use 17.36 percent more gallons than they actually used, and thus would have contributed more through the motor fuel tax (a total of $5,853). On the contrary, if the fleet were only composed of hybrid vehicles, the SM providers would have used 28.7 percent less gallons of fuel to drive the same amount of VMT, and thus their contribution through the motor fuel tax would have been much lower (a total of $3,554).

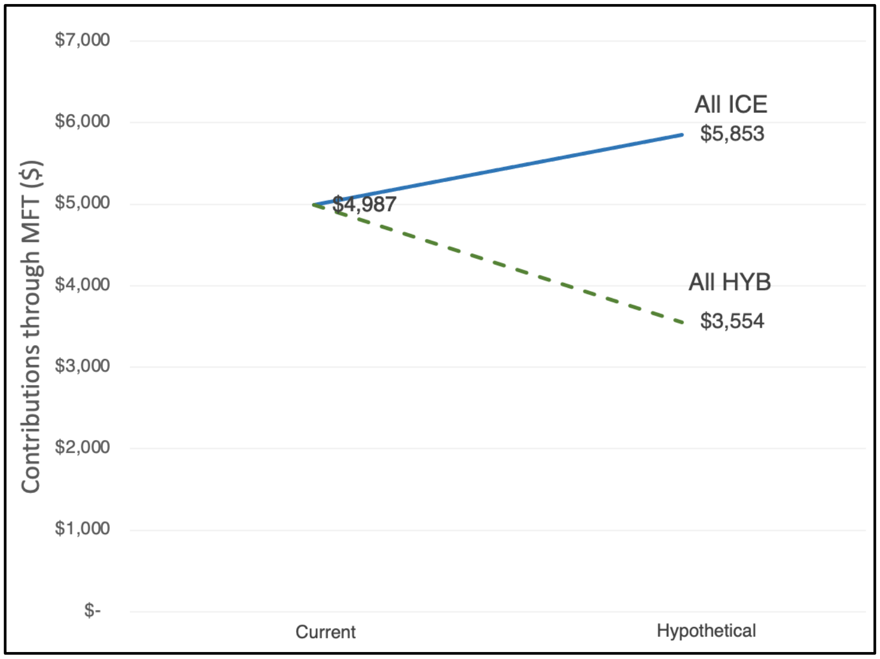

Figure 3.2 Potential SM providers' Contribution with Different Fleet Composition

Second, researchers assessed what would have happened if all vehicles in the state were as efficient as vehicles in the SM providers' fleets. We estimated the gallons of fuel needed to drive the current VMT driven at the state level (60,7 billion VMT) for a fleet of ICE vehicles and hybrid vehicles similar to those in the SM providers' fleet. The results are shown in Figure 3.3. If all the current state VMT would have been driven by a fleet of ICE vehicles, the revenue from the motor fuel tax would have decreased to $534 million, which represents a reduction of 43 percent. Similarly, if all the current state VMT would have been driven by a fleet of hybrid vehicles, the revenue from the motor fuel tax would have decreased to $378 million, which represents a reduction of 59.8 percent compared to current revenues.

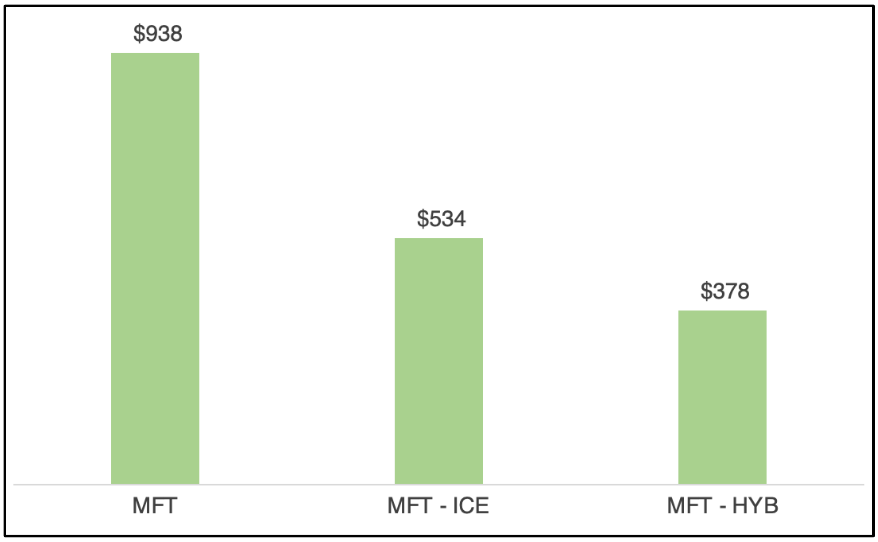

Figure 3.3 Potential MFT with changes in Vehicle Fuel-Economy (in millions)

Third, researchers assessed what would have happened if light vehicles in the state were as efficient as vehicles in the SM providers' fleets. We calculated the gallons of gasoline needed to drive the current VMT driven by light vehicles for a fleet of ICE vehicles and hybrid vehicles similar to those in the SM providers' fleet. For these estimates, we assumed that the MFT contribution of heavy vehicles would remain the same. Figure 3.4 shows the results. Similar to the previous scenario, the total revenues from the motor fuel tax would have decreased but at a lower rate. If the current VMT driven by light vehicles would have been driven by a fleet of ICE vehicles, the revenue from the motor fuel tax would have decreased 39.8 percent, while if the current VMT driven by light vehicles would have been driven by a fleet of hybrid vehicles, the revenue from the motor fuel tax would have decreased by 57.5 percent.

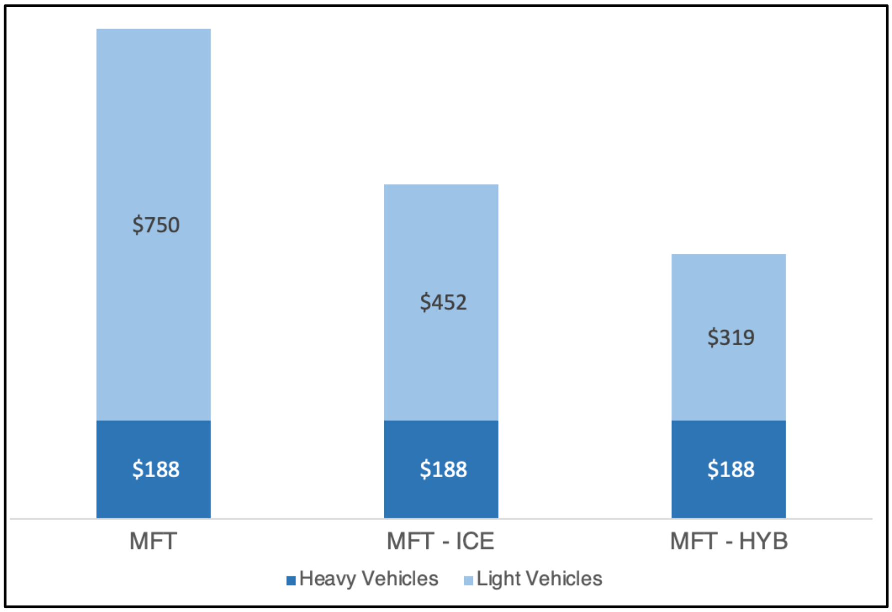

Figure 3.4 Potential MFT with changes in Vehicle Fuel-Economy of Light Vehicles (in millions)

The results shown in Figure 3.3 and Figure 3.4 only present what would have happened to the revenues from the motor fuel tax if VMT were driven by fuel-efficient ICE vehicles or hybrid. The inclusion of a portion of VMT driven by full-electric vehicles would have further reduced motor fuel tax revenues. However, the magnitude of the reduced amount is uncertain as we need to account for the $75 EV fee the EVs contribute to the system. Overall, this analysis highlights the role of increased fuel efficiency in determining the revenues from the current motor fuel tax. The reduction in revenues can be substantial even without hybrid or electric vehicles because of the impact of more fuel-efficient ICE vehicles.

There are several conversations regarding converting the current SM providers' fleet to an all-electric fee in near future. With the available data, researchers considered a fourth scenario to assess the revenues the government would have received if all the vehicles of the fleet would have been fully electric. Figure 3.5 presents the monthly contributions in MFT by SM providers' fleets and what would have been the monthly contributions from an EV fee for all vehicles. Overall, if it was an all-electric fleet, SM providers would have paid less than what they currently contribute to the roadway system through the MFT. On average, every vehicle would have contributed $6.25 every month through the EV fee, while currently contributing $7.42 through the MFT (that is 16 percent less every month).

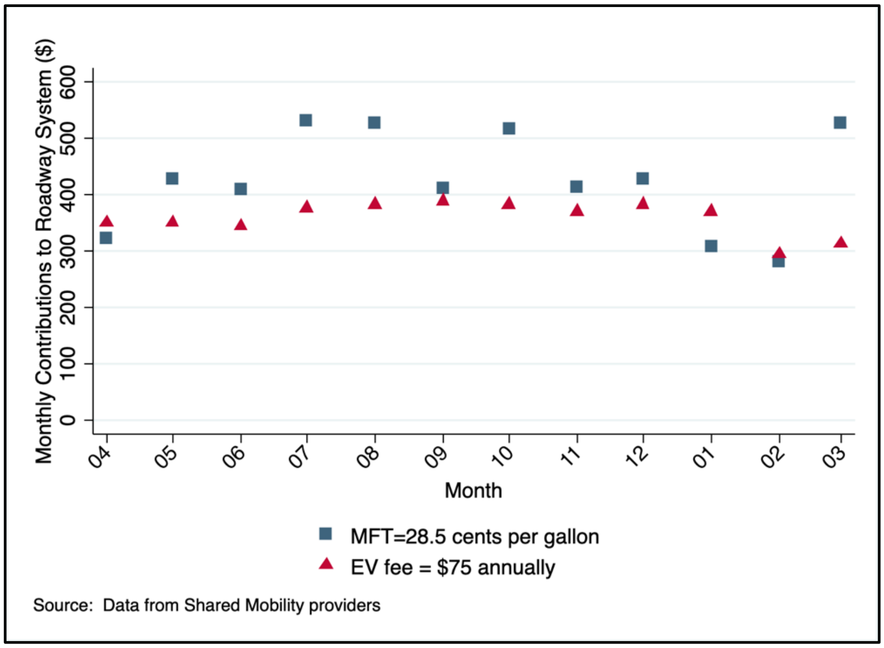

Figure 3.5 MFT Contributions vs Hypothetical Revenues from an All-Electric Fleet

During the twelve months, 62 vehicles reported VMT and fuel purchases.[44] If these vehicles were all-electric, they would not have contributed to the transportation system through the motor fuel tax, but they would have contributed through the $75 EV fee. Table 3.8 presents the results. Overall, these vehicles would have contributed a total of $4,650 in a year, which is 8.4 percent less of what they actually contributed through the MFT. With the current fleet, SM providers paid on average 0.96 cents per VMT. However, if the fleet was all-electric, SM providers would have paid, on average, 0.88 cents per VMT.

[44] A total of 76 vehicles reported information throughout the demonstration, however, some vehicles only appeared for one or two months and then were replaced with other vehicles. For the purposes of the calculation, we used the maximum number of vehicles reported in a month, that is 62 vehicles. Not all vehicles may have been used all months, but SM providers would have paid an annual fee of $75 for each of them.

Table 3.8 Current Revenues vs Hypothetical Revenues from an All-Electric Fleet in a year

Current Scenario		All-EVs Scenario	
Number of vehicles	62	Number of vehicles	62
VMT	529,076	VMT	529,076
Gallons of fuel	17,819	Gallons of fuel	-
MFT revenue	$5,078	MFT revenue	$ -
EV-fee revenue	$ -	EV-fee revenue	$ 4,650
Price per mile (cents per mile)	0.96	Price per mile (cents per mile)	0.88
		Difference in Revenue	-8.4%

These results suggest that the $75 fee EVs pay may be low to offset the loss in MTF revenue. According to the calculations, the EV fee would have to be $81.9 per vehicle (which represents an increase of 9.2 percent) to generate the same amount of revenue these vehicles contribute through the MFT.

3.2.2 A State DBF System with a Baseline Rate

This subsection presents the potential contributions under a DBF system considering the rates identified in Subsection 3.1.1 using the two different methods of calculation. While the first method assumed all VMT contributed the same amount in motor fuel tax, the second method assumed a different contribution from VMT driven by light and heavy vehicles. The data used in this section includes outlier observations as they were included in the revenue reports submitted by SM providers.

Figure 3.6 presents the current contribution of SM providers to the roadway system through the motor fuel tax as well as the potential contributions under a DBF system considering three different administrative costs and assuming that all VMT contribute the same amount in motor fuel tax. The first rate assumes administration costs equivalent to the motor fuel tax system (DBF_1); the second rate assumes administration costs equivalent to 5 percent of the revenue collected (DBF_5); and the third rate considers administration costs equivalent to 15 percent of the revenue collected (DBF_15). Overall, SM providers would have contributed between 60 and 90 percent more in a year under a DBF system compared to their contribution under the MFT. The monthly contribution to the transportation system would have been higher for all months, except for February[45] (month eleventh of the demonstration), when MFT contributions were higher than what they would have to pay under a hypothetical DBF system.

[45] During this month there was an issue in the reporting technology of a vehicle that prevented it from reporting the miles in February. It is possible that all miles traveled by the vehicle were reported in March.

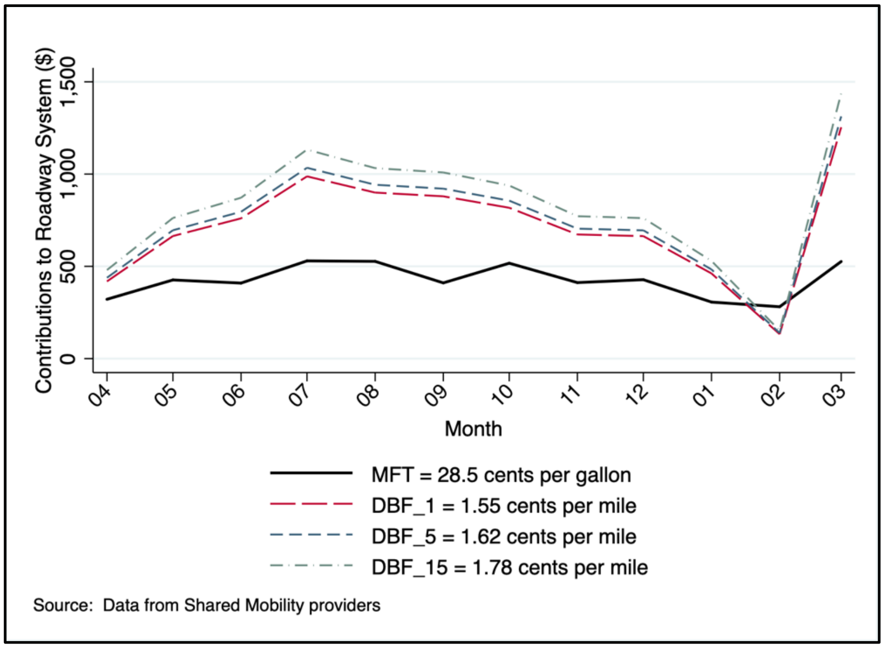

Figure 3.6 Potential Contributions through the MFT and a State DBF System (Method I)

Table 3.9 presents the SM providers' contributions, estimated administrative costs, and the net revenues available for highway purposes using the DBF rates identified by using the first method.

Table 3.9 Hypothetical DBF Revenues – Method I

	MFT	DBF_1 (0.25% costs)	DBF_5 (5% costs)	DBF_10 (10% costs)	DBF_15 (15% costs)
SM Contribution	5,094	8,611	9,017	9,451	9,879
Change (base-MFT)		*69.0%*	*77.0%*	*85.5%*	*93.9%*
-Admin Costs	**13**	**22**	**451**	**945**	**1,482**
Highway Revenue	5,081	8,590	8,566	8,506	8,397
Change (base-MFT)		*69.0%*	*68.5%*	*67.3%*	*65.2%*

The potential contributions under a DBF system with a different rate for light and heavy vehicles are presented in Figure 3.7. Under this scenario, SM providers would have contributed between 40 and 60 percent more in a year under a DBF system compared to their contribution under the MFT.

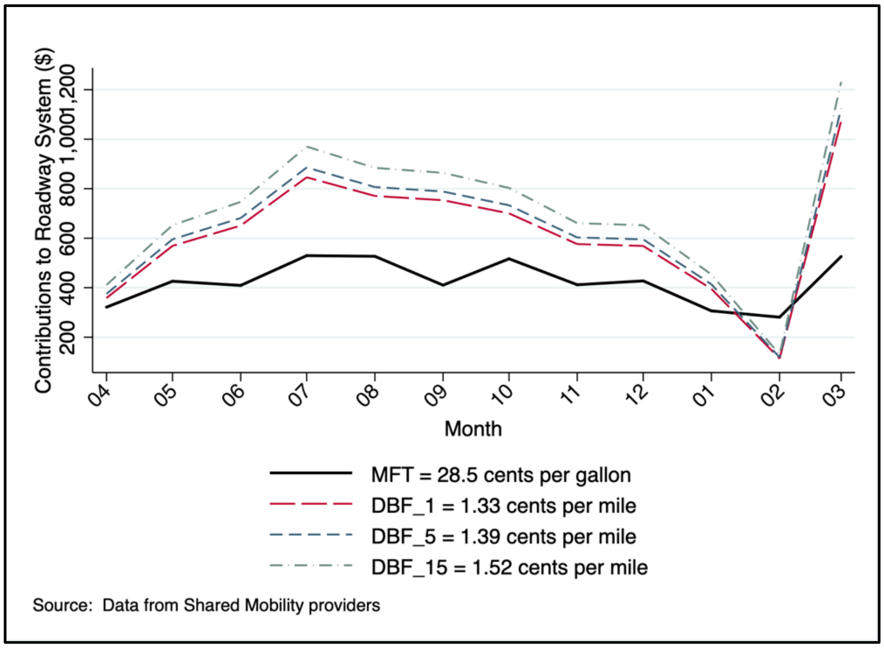

Figure 3.7 Potential Contributions through the MFT and a State DBF System (Method II)

Table 3.10 presents the SM providers' contributions, estimated administrative costs, and the net revenues available for highway purposes using the DBF rates identified by using the second method.

Table 3.10 Hypothetical DBF Revenues – Method II

	MFT	DBF_1 (0.25% costs)	DBF_5 (5% costs)	DBF_10 (10% costs)	DBF_15 (15% costs)
SM Contribution	5,094	7,377	7,722	8,094	8,461
Change (base-MFT)		*44.8%*	*51.6%*	*58.9%*	*66.1%*
-Admin Costs	**13**	**18**	**386**	**809**	**1,269**
Highway Revenue	5,081	7,359	7,336	7,285	7,192
Change (base-MFT)		*44.7%*	*44.3%*	*43.3%*	*41.5%*

Results in Table 3.9 and Table 3.10 show that as administrative costs increase, contributions from SM providers and the actual revenue available for highway purposes increase. However, the actual revenue available for highway purposes increases at a lower rate. The actual revenue available for highway purposes in both scenarios increases the most with the lowest administrative costs, which highlights the importance of having an efficient fee collection system.

3.3 TECHNICAL NOTES: DATA FROM SHARED MOBILITY PROVIDERS

The Minnesota Department of Transportation partnered with two shared mobility (SM) providers to demonstrate a Distance-Based Fee system in the state of Minnesota. Each SM provider shared two datasets for the analysis. The first dataset reports monthly fuel purchases and total gallons of gas purchased linked to fuel cards attached to a vehicle. The second dataset reports the miles traveled of each of SM providers' vehicles, along with some vehicle information such as model, make, and year. Both datasets are monthly and cover data between April 1, 2020, and March 31, 2021. As part of our study, we merge these datasets by pairing gas purchases to specific vehicles whenever possible. This section presents a description and analysis of the monthly data reported by SM providers.

3.3.1 Gallons of Fuel Purchased

We start by analyzing the datasets on fuel purchases. The data contains a total of 1,872 transactions of fuel purchases during the twelve-month demonstration for a total of 17,874.30[46] gallons of fuel, with a monthly average of 1,491.1 gallons.[47]

Most of the fuel gallons correspond to gasoline and were purchased in Minnesota. Of the total gallons reported in the data, 90 percent correspond to unleaded regular, 2.77 percent to unleaded ethanol 10% blend, and 2.36 percent to unleaded plus, among others.[48] Only 4.6 gallons of the total reported are diesel. In addition, almost all fuel gallons were purchased in Minnesota. Only one shared mobility provider (SM-A) reported purchases in Wisconsin, corresponding to 0.9 percent of total gallons reported by that provider. Figure 3.8 shows monthly fuel purchases reported by both SM providers during the demonstration. The fuel information is presented in the month in which the transaction occurred and not in the month in which it was reported.

---

[46] The total amount of gallons used in this report differs from the total amount of gallons reported in the MnDOT website for the DBF demonstration. Several reasons help explain the difference. First, researchers eliminated duplicated transactions. For instance, some fuel purchases made at the end of May appeared in the fuel reports for May and June. A total of 25 transactions were duplicates, accounting for 210.09 gallons of fuel. Second, 131.8 gallons purchased in Wisconsin are included. Third, researchers deleted transactions not related to fuel purchases (2 observations, 2 gallons).
[47] SM provider A and B had an average of 8.2 and 9.0 gallons per purchase, respectively.
[48] Others include future defined, unleaded plus ethanol (5.7%, 7.7%, and 10% blend), unleaded super, super unleaded ethanol (5.7% and 10% blend), unleaded (4 and 5), and E-85 among others.

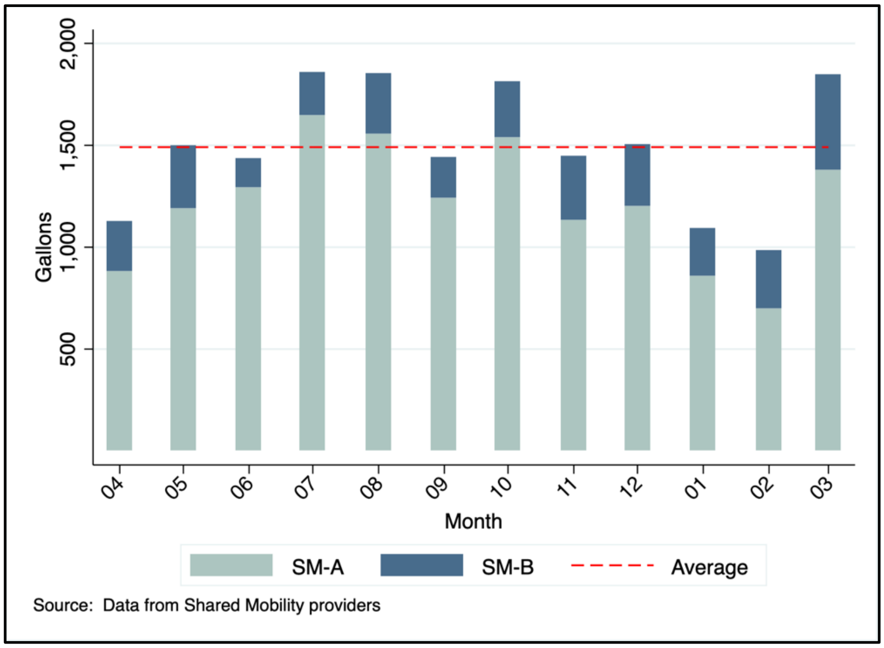

Figure 3.8 Gallons of Fuel Purchased by Shared Mobility Provider

The fuel purchases reported by SM providers do not necessarily represent the total fuel used to power their vehicles. Some situations may create differences in the number of gallons of fuel reported and those actually used. First, SM providers have a fuel card that their customers can use to pay for fuel purchases. However, customers could make fuel purchases for the vehicle out of their pockets and ask for a reimbursement. If a customer fuels the tank of a SM vehicle, the transaction is only included in the data if the customer reports the fuel purchase to the SM provider. Second, there could be problems with the fuel card system/software that prevents the export tool from pulling fuel information from the correct data source. Third, fuel cards could be used to fuel other vehicles outside of the SM provider's fleet. This last situation was not reported by any SM provider during the twelve-month DBF demonstration.

3.3.2 Vehicle Miles Traveled

The second dataset provided by SM providers included vehicle miles traveled. The data contains a total of 76 vehicles each reporting monthly miles traveled during the twelve-month demonstration for a total of 555,919.15 miles, [49] with a monthly average of 46,326 miles and an average of 7,314.73 miles per vehicle on an annual basis.[50] The individual observations for VMT correspond to miles traveled during

[49] The total amount of miles used in this report differs from the total amount of miles reported in the MnDOT website for the DBF demonstration. The difference could be to reporting problems from one of the SM providers in February and March.

[50] SM provider A and B had an average of 7,909.34 and 5,944.52 annual miles per vehicle, respectively.

customers' reservations as well as miles traveled by SM provider staff to support services offered. In order to avoid double-counting VMT of long reservations (2 or more days), the milage information corresponds to VMT of reservations finalized in each month. For instance, if a reservation started at the end of June and finalized at the beginning of July, all the VMT are reported in July.

Figure 3.9 presents monthly VMT reported by each SM provider during the demonstration. MVT show a seasonal pattern – VMT are low during the winter season and start increasing during spring until they reach maximum levels in summer. A couple of caveats are in order. First, the VMT patterns during the last quarter of the demonstration (January-March 2021) are abnormal. The change in reported miles is linked to the transition to a new technology system by one of the SM providers.[51] Second, one vehicle reported more than 20,000 miles in a trip in the last month of the demonstration. Potentially there was an issue in the reporting technology of this vehicle that prevented it from reporting the miles in February and reported all of them in March.[52]

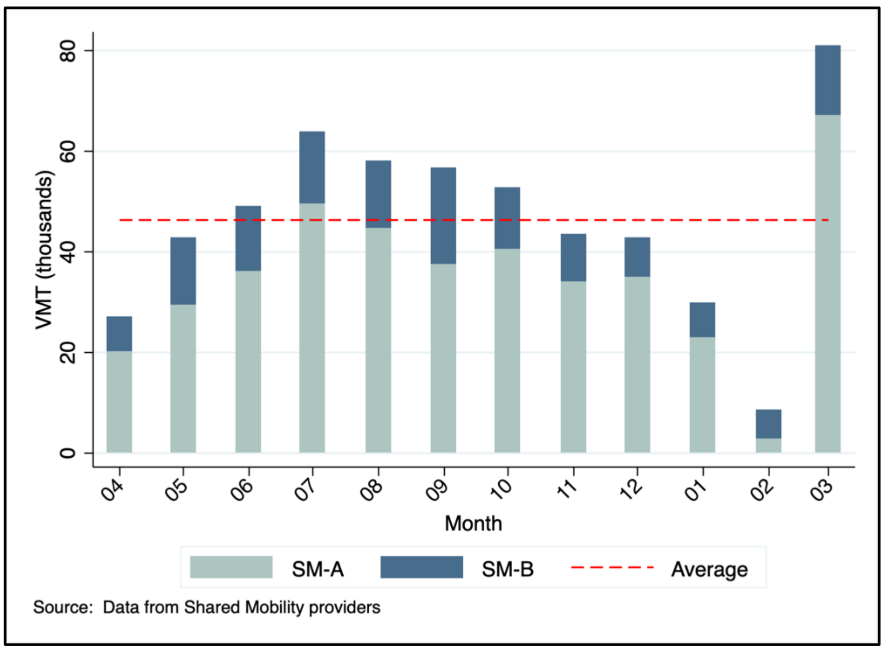

Figure 3.9 Vehicle Miles Traveled by Shared Mobility Provider

[51] The SM provider went offline for one week (January 25th to February 1st) to install the new technology system. During this week, there were not reservations and no miles driven.
[52] The SM provider is still investigating the potential causes of this issue.

3.3.3 Vehicle Miles Traveled and Fuel Purchases

As part of our analysis, we aggregated fuel purchases and VMT at the vehicle level and merged the two data sets described above. In addition, researchers created a variable to represent the vehicle's powertrain. All vehicles in the sample are considered internal combustion engine (ICE) vehicles, except for some Toyota Prius that are considered hybrid (HYB) vehicles and a Chevy Bolt that is considered an electric vehicle (EV).

Figure 3.10 shows the distribution of annual fuel purchased versus VMT by vehicle powertrain by shared mobility provider. Overall, gallons of fuel purchased and VMT are positively associated: The more miles are driven, the more fuel is needed. There are few observations along the Y-axis (fuel purchases with no miles traveled) explained by fuel purchases made with spare fuel cards. Unfortunately, it was not possible to trace purchases made with spare fuel cards back to a specific vehicle. When the monthly data is considered, there are several observations along the Y-axis and X-axis. These appear as some vehicles may be fueled the last days of the month and used during the following month or driven during the last days of the month and fueled the following month. This pattern disappears when annual data is considered as the exact timing of the transactions no longer matters.

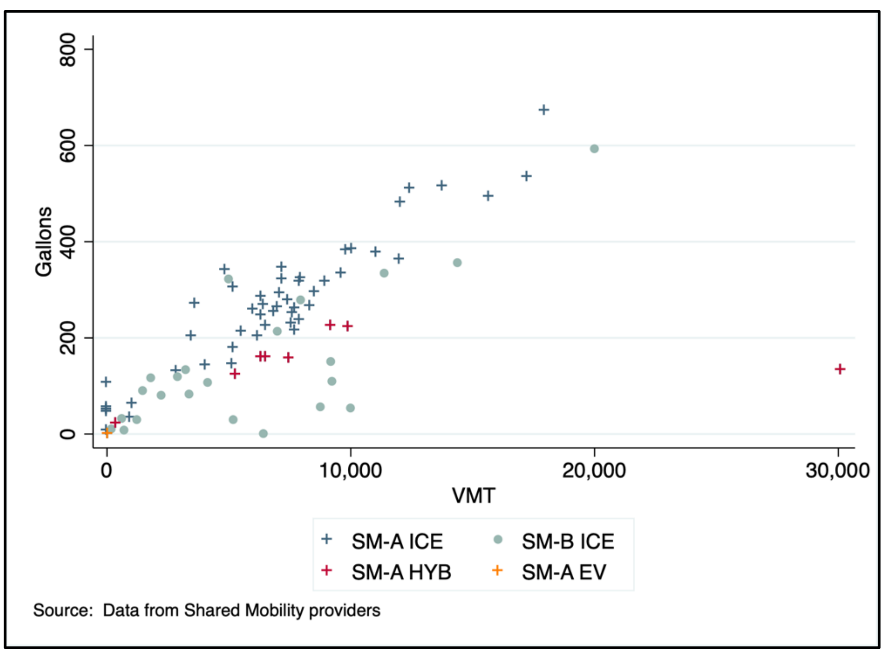

Figure 3.10 VMT and Fuel Purchases by Shared Mobility Provider

Figure 3.10 also shows clear differences between the fuel purchases of ICE and hybrid vehicles. As expected, gallons of fuel purchased are higher for ICE vehicles than for hybrid vehicles for a certain level of VMT. Using data from one of the SM providers (SM-A) and using a simple regression model, we estimate an average difference in fuel efficiency (miles per gallon) of 15.26 (Figure 3.11).

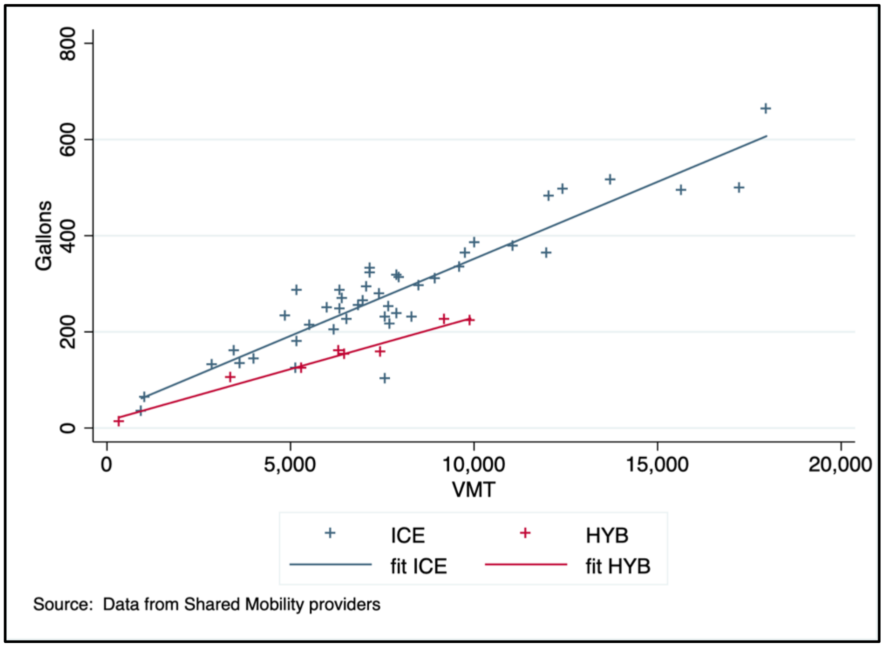

Figure 3.11 VMT and Fuel Purchase by Vehicle Powertrain

The differences in fuel efficiency (miles per gallon) between ICE and hybrid vehicles impact the motor fuel tax revenue that is obtained from each type of vehicle. Using the estimated values for average fuel efficiency, researchers calculated the motor fuel tax revenue ICE and hybrid vehicles generate when traveling a certain amount of vehicle miles. Figure 3.12 presents the results using a tax rate of 28.5 cents per gallon. Overall, hybrid vehicles contribute less through the motor fuel tax than ICE vehicles, and the difference gets larger as more VMT are driven.

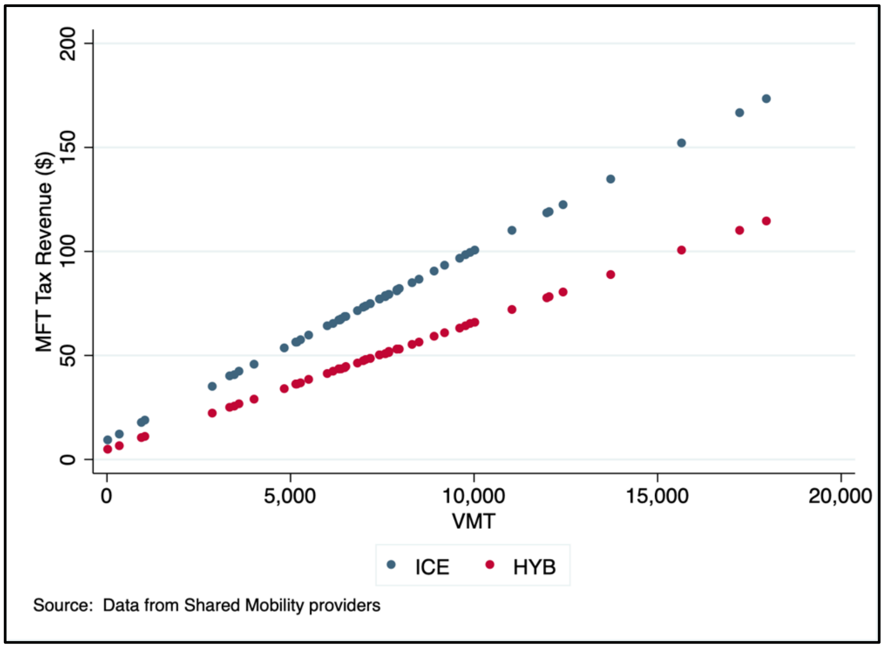

Figure 3.12 Estimated MFT Revenue by Vehicle Powertrain

CHAPTER 4: OUTREACH AND EDUCATION EFFORTS

This chapter presents a summary of outreach and education efforts including roundtable events, Technical Advisory Committee (TAC) meetings, and the communications plan developed for this demonstration.

4.1 ROUNDTABLES

As part of the Minnesota Department of Transportation's Distance-Based User Fee (DBUF) Demonstration, the Humphrey School of Public Affairs developed a roundtable series to "help educate policymakers, stakeholders, interested members of the public, and others that will need to understand the context and importance of this demonstration". There were three roundtable events hosted.

The first event was the "*Transportation in Changing Times*" Roundtable, held on November 18th, 2019, at the Hubert H. Humphrey School of Public Affairs from 3 to 5 p.m. Fifty-three people registered for the event and there were 41 people in attendance (an attendance rate of 77.3 percent). The event featured three panelists with expertise in the topic:

> **Adrian Moore** - Provided the national perspective and the congressional interest in this issue, including the support at the federal level for DBUF.
>
> **Anthony Buckley** - Discussed ongoing issues at the state level with user fees, particularly in the western states. He shared experience from Washington's ambitious DBUF initiative.
>
> **Kenneth Buckeye** - Discussed the Minnesota's perspective and history with Distance-Based User Fees as well as the unique approach Minnesota is taking to move DBUF forward in the state through MNDOT's DBUF Demonstration project.

The second event entitled "*Rethinking Transportation Finance Roundtable: Perspectives on Distance Based Fees in Utah and Minnesota*", was held on November 23rd, 2020, from 3:30 to 4:45 p.m. This was an online event hosted through Zoom. 120 people registered for the event and there were 104 people in attendance (an attendance rate of 86 percent). The event featured three panelists with expertise in the topic:

> **Carlos Braceras** - Executive Director of the Utah Department of Transportation (UDOT) discussed Utah's Road Usage Charge Program. Road usage charge is a user fee based on the number of miles driven instead of the gallons of fuel consumed. Similar to utilities, drivers pay for the amount of

the resource they use. Utah's initial voluntary program focuses on electric and hybrid vehicles. The program launched on January 1, 2020.

Kenneth Buckeye - Program Manager at the Minnesota Department of Transportation (MnDOT) discussed Minnesota's DBF demonstration project.

Rep. Steve Elkins - from the Minnesota House of Representatives, discussed a Distance-Based Fee proposal to be introduced during the 2021 Minnesota State Legislative Session.

The third event entitled "*Rethinking Transportation Finance Roundtable: Where Do We Go From Here*?", was held on June 14th, 2021, from 3:30 to 5:00 p.m. This was an online event hosted through Zoom. A total of 154 people registered for the event and there were 96 people in attendance (an attendance rate of 62 percent). The event featured opening remarks, followed by two panels.

The opening remarks featured two panelists with expertise in the topic:

Commissioner Margaret Anderson Kelliher - Minnesota Department of Transportation, emphasized the importance of this work and the need to find a transportation funding alternative to the fuel tax.

Barbara Rohde - Executive Director, Mileage-Based User Fee Alliance provided an overview of the current state of DBF projects and implementations nationwide.

The first panel entitled "*Minnesota's DBF Demonstration: Where Do We Go From Here?"* featured Kenneth Buckeye (Project Director, MnDOT) as the moderator, and Michael Warren (WSP), Frank Douma (Humphrey School of Public Affairs), and Christopher Berrens (MnDOT) as panelists. The panelist discussed key takeaways and lessons learned during Minnesota's DBF Demonstration project and how they anticipate these lessons will impact future DBF work.

The second panel entitled "*Policy Perspectives on the Transition to Distance-Based Fees"* featured Lee Munnich (Senior Researcher at the Humphrey School) as the moderator, and Susan Binder (Cambridge Systematics, Inc.), Rep. Steve Elkins (Minnesota House of Representatives), and Douglas Shinkle (National Conference of State Legislature - NCSL Transportation Program) as panelist. The panelists, with national perspectives on DBFs, discussed barriers and potential ways forward for more widespread implementation of DBFs.

At the end of the roundtable events, all participants were invited to complete an evaluation form for the event. Table 4.1 presents registration and attendance to all events as well as participation in the evaluation.

Table 4.1 Registration and Attendance to Roundtable Events

	Event 1	Event 2	Event 3	All Events
Registered	53	120	154	327
Attendees	41	104	96	241
Attendance rate	77.4%	86.7%	62.3%	73.7%
Evaluation participants	22	25	30	75
Evaluation response rate	53.7%	24.0%	31.3%	31.1%

The evaluation form included questions regarding the affiliation, familiarity, and favorability towards DBF of participants, as well as an overall evaluation of the roundtable event. Figure 4.1 presents the affiliation of survey respondents for each event. One-third of the respondents for all events were from the public sector, mostly representing the Twin-Cities Seven County Metro Area. The first roundtable had a higher representation of academics, while the second and the third roundtables had more representation of private employees. The second and third roundtable events had participation of people from Greater Minnesota, and other U.S. municipalities outside of the state of Minnesota because they were hosted virtually.

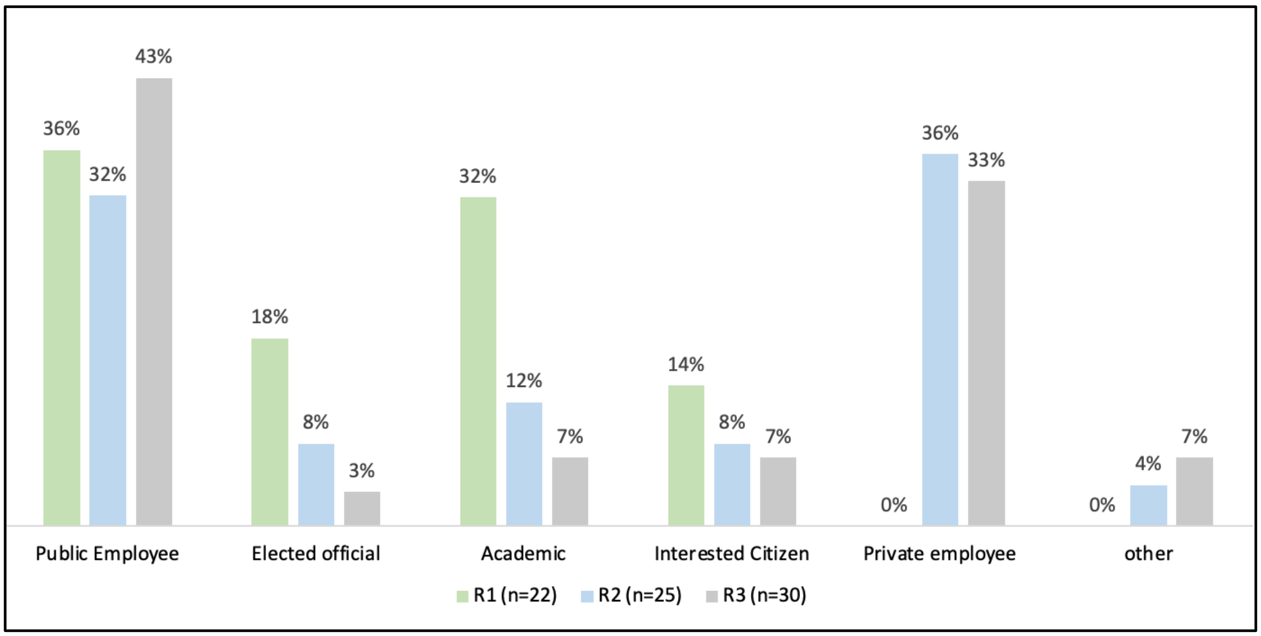

Figure 4.1 Affiliation of Survey Respondents

Notes: *R1: First roundtable; R2: Second roundtable; R3: Third roundtable. Other included consultants and transportation planning professionals.*

Participants were asked about their level of familiarity with Distance-Based Fees in a scale of 1 (very unfamiliar) to 4 (very familiar) before and after the event. Figure 4.2 presents the responses for respondents for the three events. The data suggests that the roundtable events were successful in communicating information about Distance-Based Fees, although majority of respondents were already familiar with the topic.

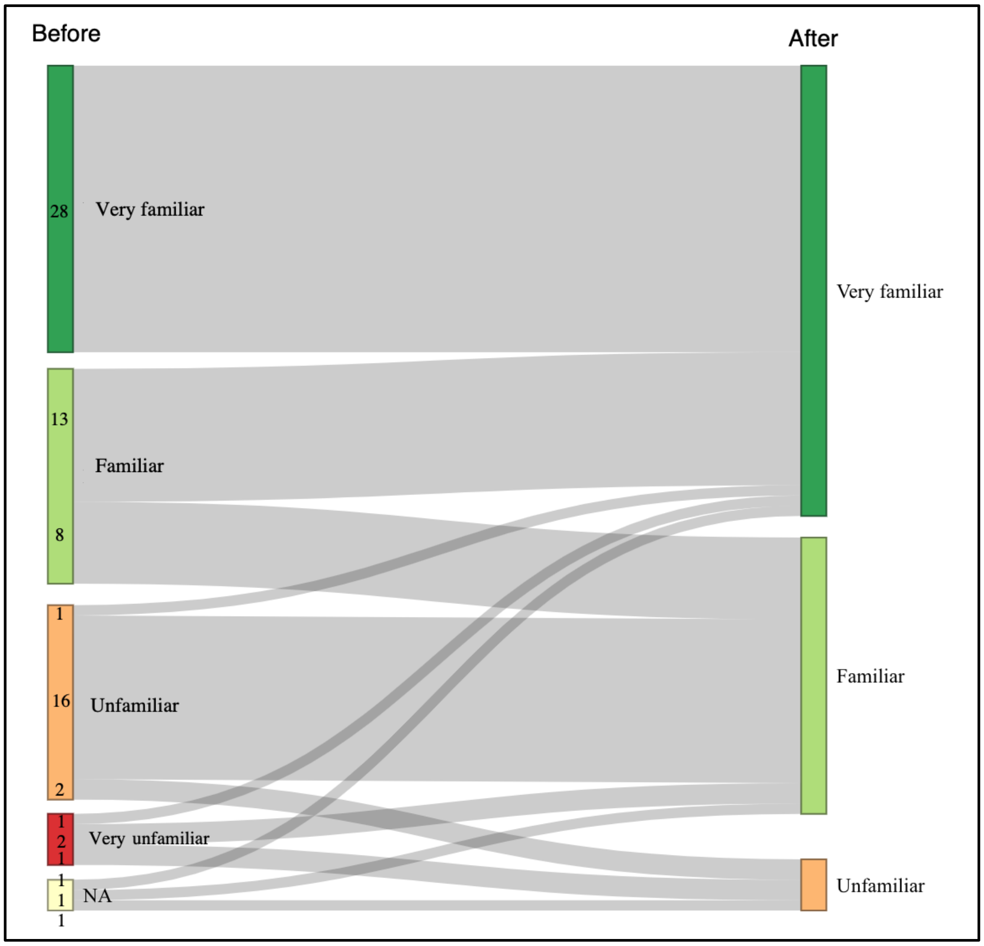

Figure 4.2 Survey Respondents' Ranking of DBF Knowledge Before and After the Roundtables (all events)

Notes: *Contains information for all events. Participants to multiple events may be counted twice as the evaluation forms were anonymous.*

Most respondents ranked their favorability of DBFs as high. Figure 4.3 presents responses aggregated for all three events. This supports further exploration of DBFs as a possible funding source for the transportation system.

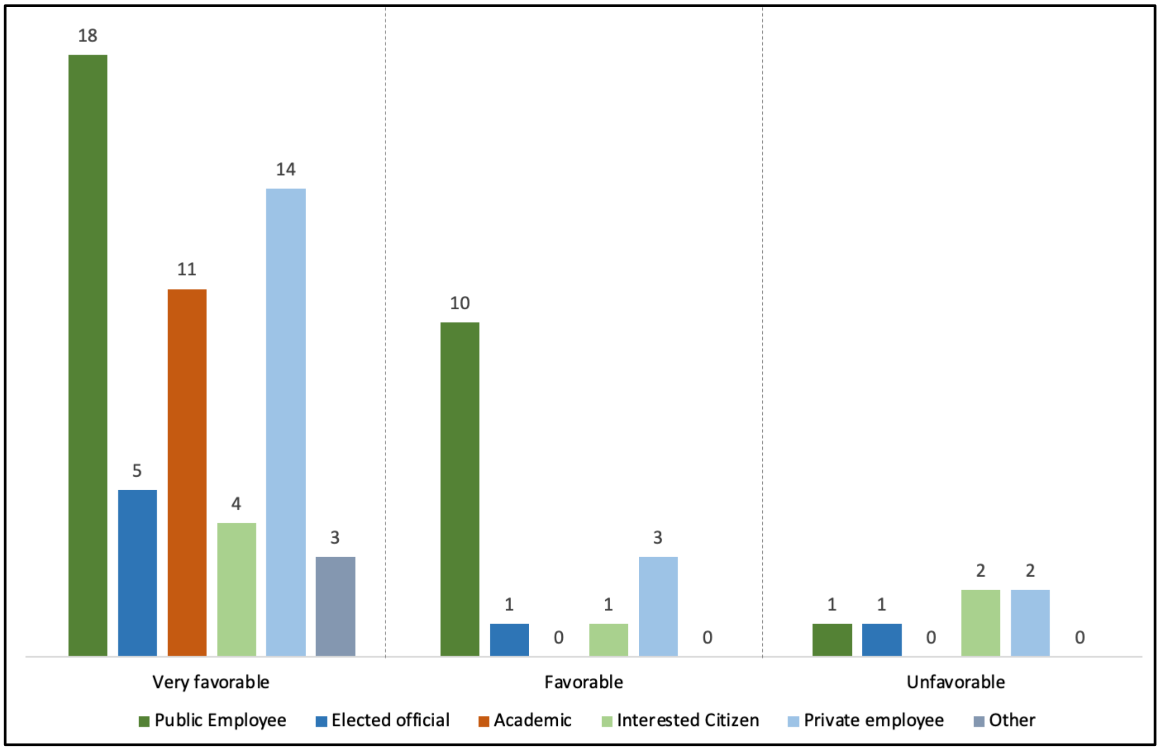

Figure 4.3 Favorability of Respondents toward DBF by Affiliation (all events)

Notes: *The category "very unfavorable" was excluded from the graph because none participants selected it as an option. Participants to multiple events may be counted twice as the evaluation forms were anonymous.*

Overall, survey participants have a positive view of roundtables events. Most considered the events as excellent. Figure 4.4 presents the overall evaluation of the roundtable events. Positive comments about the roundtable events included "*very informative and interesting*" and "*qualified panel and very informed about the topic*". Recommendations to improve in future events included "*diversity in the panel*", "*have some dissenting views as part of the conversation*", and include materials (e.g., graphs, numbers) to support the oral discussion.

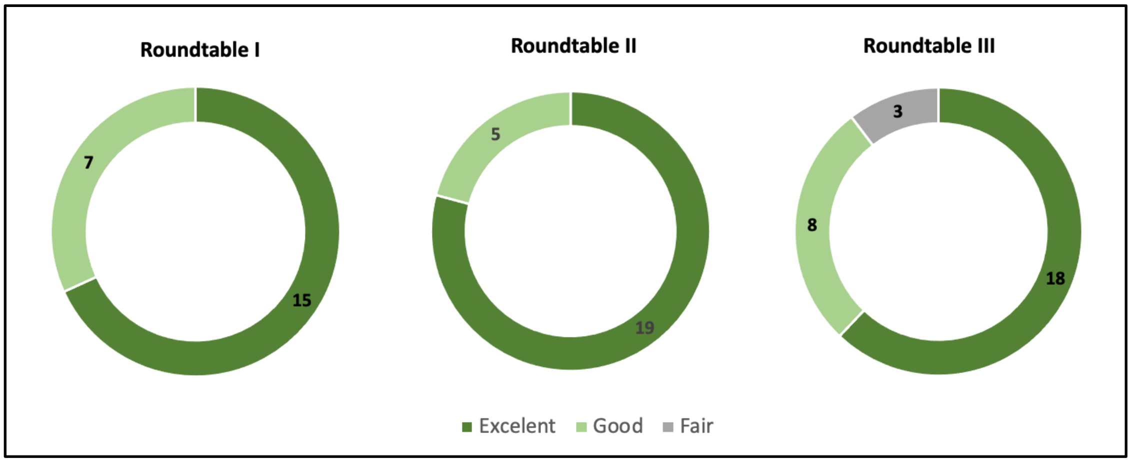

Figure 4.4 Survey Respondents' Overall Evaluation of Roundtable Events

4.2 TECHNICAL ADVISORY COMMITTEE MEETINGS

As part of the Minnesota Department of Transportation's Distance-Based User Fee (DBUF) Demonstration, the Humphrey School of Public Affairs provided logistical support[53] for the Technical Advisory Committee (TAC) meetings. There were thirteen TAC members that are affiliated to the Minnesota Department of Transportation (MnDOT), Minnesota Department of Revenue (DOR), Minnesota Department of Public Safety (DPS), Minnesota Management and Budget (MMB), Minnesota IT Services (MNIT), Association of Minnesota Counties (AMC), Metropolitan Council, City of Minneapolis, City of St. Paul, Transportation Alliance, Shared Mobility, Great Plains Institute, and the Center for Transportation Studies (CTS) at the University of Minnesota.

Researchers supported six meetings with TAC members. Attendees to these meetings included TAC members as well as core team members (MnDOT's staff, Humphrey School's researchers, and WSP's staff). Table 4.2 presents details regarding the dates of the TAC meetings, the number of organizations represented, and a summary of the topics discussed.

[53] This included the venue, notice, agendas, other handouts, minutes, and other relevant materials, as needed. These materials are available upon request, some are available at the demonstration's website.

Table 4.2 Summary of TAC meetings

TAC Meeting Date	Number of Organizations Represented	Topics Discussed
Jun 10, 2020	13 organizations	- Expectations from the TAC members - DBF background at the national level and in Minnesota (lessons learned) - DBF demonstration project design and update
Sep 3, 2020	11 organizations	- DBF demonstration and project updates - DBF demonstration scope - Overview of taxation principles - Discussion of policy considerations in developing a rate setting framework - Discussion of modal equity policy brief
Dec 9, 2020	10 organizations	- DBF demonstration and project updates - Review of November 23rd roundtable - Project website launch - Discussion of rate setting framework summary - Review of modal equity discussion and summary of modal equity TAC survey results - Discussion of social equity policy brief
Mar 2, 2021	12 organizations	- Overview of DBF discussions at the national level - Overview of DBFs at the state level and plan moving forward - Updates on C/AV Alliance - Review of social equity TAC survey results - Discussion of urban/rural equity and administrative costs policy briefs - DBF demonstration updates
Apr 23, 2021	9 organizations	- DBF demonstration and project updates - Discussion of focused project deliverables including mock audit, rate setting framework, and demonstration project report - Review of rural/urban and administrative costs TAC survey results - Discussion of privacy policy brief
Jun 22, 2021	7 organizations	- Recap of the DBF demonstration - Review of June 14th roundtable - Overview of DBF discussions at the national level - Summary of final demonstration report - Review of rate setting framework - Review of policy memos - Discussions of next steps

TAC members were asked to rank their familiarity with DBFs on a scale of 1 (very unfamiliar) to 4 (very familiar). Overall, TAC members were familiar with the concept of DBFs. Figure 4.5 presents their familiarity across the five meetings.[54]

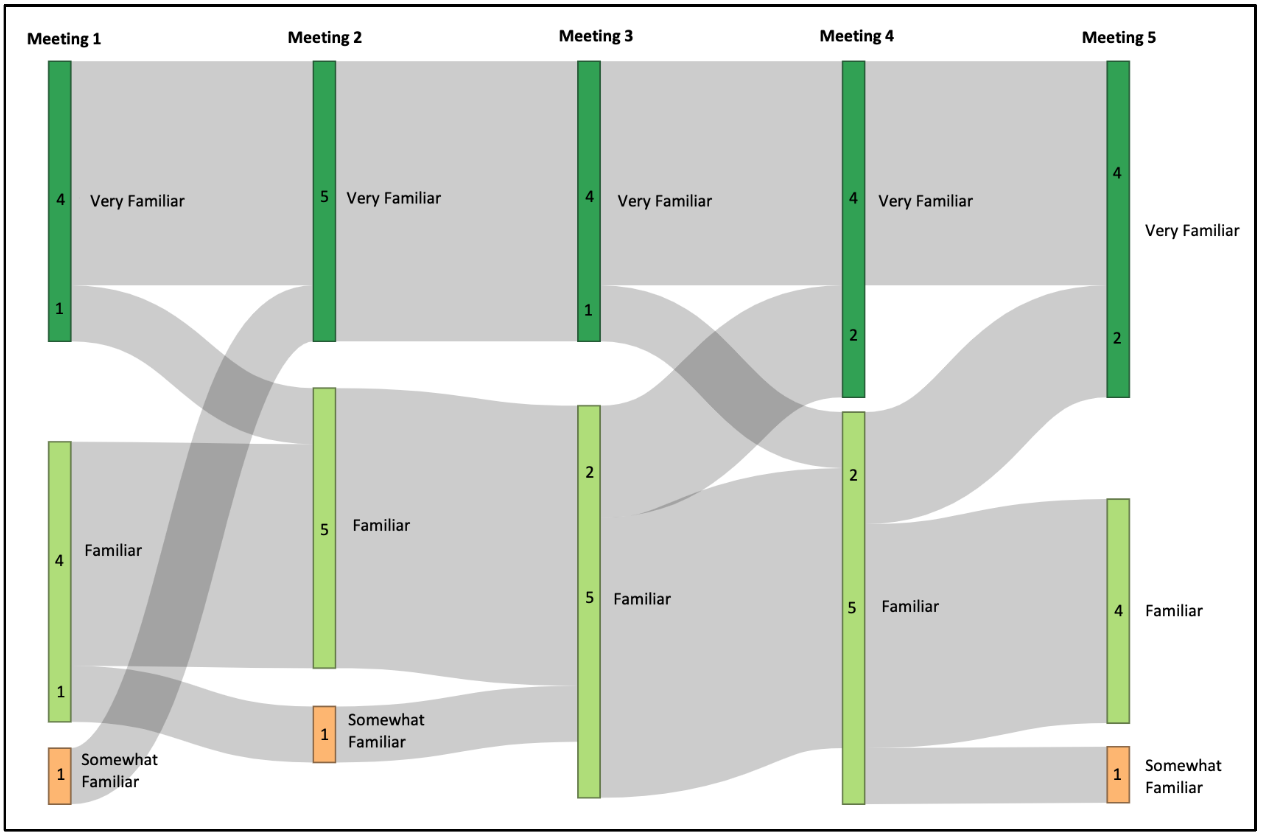

Figure 4.5 Familiarity of TAC members with DBFs
Note: *Numbers represent number of respondents with flows from left to right. Familiarity for TAC members that did not respond to one of the surveys was assumed to be the same familiarity they selected in the previous meeting. This does not apply to first time attendees or those that stop attending.*

4.3 COMMUNICATIONS PLAN

Early in the demonstration, the project team determined that the purpose of this unique, groundbreaking demonstration could be difficult to grasp, and different participants, stakeholders and observers may misinterpret the activities undertaken. Consequently, the team developed a communications plan to articulate the goals of Distance Based Fees generally, and the goals and

[54] Results from the last meeting were excluded from the graph as there was low attendance and low response rate.

purposes of the study, specifically. The team identified three key audiences for this effort: policymakers, national stakeholders, and customers of SM services. For each one, the team described the situation or context in which the communication would take place, the goal and key messages to be set forth, and subsequent "challenging questions" that might need to be addressed as follow ups. These plans are presented in Appendix A.

CHAPTER 5: EVALUATION OF THE DEMONSTRATION

Researchers at the Humphrey School of Public Affairs conducted an evaluation to assess the execution of the Minnesota DBF demonstration. The evaluation was performed based on four revenue-evaluation principles: Efficiency, equity, adequacy, and feasibility -which included both political and administrative feasibility. In this report feasibility is discussed first, as it was the focus of this demonstration.

The Minnesota DBF demonstration successfully showcased the potential to collect DBF from SM providers.

5.1 GOALS OF THIS EVALUATION

This evaluation assesses the execution of the Minnesota Distance-Based Fee demonstration on the basis of four revenue-evaluation principles: Feasibility -which included both political and administrative feasibility, efficiency, adequacy, and equity (Zhao J. Z., Guo, Coyle, & Munnich, 2015).

- Administrative feasibility: This criterion will assess the ease of administration of DBFs from shared mobility providers and state agencies. The ease of administration the costs of implementation, operation, enforcement, and compliance of a DBF system.
- Political feasibility: This criterion will assess the approval associated with the collection of distance-based fees, whether public concerns are addressed, and whether the DBF system ensures drivers' privacy and provides system security.
- Efficiency: This criterion will assess the extent to which DBFs may lead to more efficient use of resources, specifically looking into efficiency in operations, fee collection, and integration with other systems
- Equity: This criterion will assess equity from two perspectives: The benefit-received principle and the ability-to-pay principle. Since a DBF is intended as a user fee (payment for use of the transportation system), it is important to assess how closely it adheres to the benefits received principle. In addition, we will assess equity perceptions, social, modal, and geographical equity considerations of a DBF.
- Adequacy: This criterion will assess a DBF ability to raise adequate revenue to sufficiently fund the roadway system. The adequacy of a DBF is assessed through its ability to raise the same amount of revenue that is raised through the motor fuel tax and its potential to keep up with transportation costs.

Stakeholders involved in the Minnesota DBF Demonstration

- Minnesota Department of Transportation (MnDOT) - State agency leading the DBF demonstration project.
- WSP - Consulting firm leading the DBF demonstration project.
- Humphrey School of Public Affairs - Organization leading the research and evaluation efforts
- Minnesota Department of Revenue - State agency providing guidance in the collection, audit, and enforcement for the DBF demonstration.

- Shared Mobility (SM) providers - Private organizations providing trip and fuel data for the DBF demonstration. Providers of SM services include carsharing and ridesharing companies, and Transportation Network Companies (TNCs). To maintain the anonymity of the partners in this demonstration, we refer to them as ‘SM providers’.
- VSI - Data repository providers and connected and automated vehicle (C/AV) technology providers.
- TAC members - Individuals affiliated with 13 different organizations including the Minnesota Department of Transportation (MnDOT), Minnesota Department of Revenue (DOR), Minnesota Department of Public Safety (DPS), Minnesota Management and Budget (MMB), Minnesota IT Services (MNIT), Association of Minnesota Counties (AMC), Metropolitan Council, City of Minneapolis, City of St. Paul, Transportation Alliance, Shared Mobility, Great Plains Institute, and the Center for Transportation Studies (CTS) at the University of Minnesota. TAC members provide advice and guidance to the DBF project team on policy and technical issues, and to be an informed constituency in DBF discussions with the public and policymakers.

The Minnesota Distance-Based Fee demonstration received a grant from the Surface Transportation System Funding Alternatives (STSFA) Program to demonstrate user-based alternative revenue mechanisms that utilize a user fee structure to maintain the long-term solvency of the Highway Trust Fund. The following are the objectives of the program (FHWA, 2017):

- to test the design, acceptance, and implementation of two or more future user-based alternative mechanisms;
- to improve the functionality of the user-based alternative revenue mechanisms;
- to conduct outreach to increase public awareness regarding the need for alternative funding sources for surface transportation programs and to provide information on possible approaches;
- to provide recommendations regarding adoption and implementation of user-based alternative revenue mechanisms; and
- to minimize the administrative cost of any potential user-based alternative revenue mechanisms.

The goals and objectives of the Minnesota DBF demonstration are focused on developing and deploying a DBF system that will consider the future of personal travel and will create an efficient and affordable path toward broader deployment. The specific goals of the demonstration are:

- Fairness: Ensure all road users subject to a DBF pay a fair share for the use of the roads
- Public acceptance: If DBFs are viewed as a solution, more travelers will support it
- Privacy protection: Stringent security protocols must protect personal information
- Ease of payment and collection: Ideally, a system with low administration costs that uses existing technologies
- Transparency: Use and fee data readily accessible as needed
- Low evasion rates: Vehicle-embedded technology and encrypted transmission ensures low avoidance

- Scalability: DBFs are incrementally implemented as data collection technology becomes more widely available for vehicles

5.2 EVALUATION METHODOLOGY

To assess the execution of the Minnesota DBF demonstration on the basis of four revenue-evaluation principles, the evaluation team conducted a series of analyses against all of the data collected from each of the demonstration partners. These analyses conducted include quantitative and qualitative methods.

The information for this evaluation came from different demonstration partners and was captured throughout several instruments throughout the demonstration, including:

- Baseline and quarterly interviews with SM providers
- Baseline and quarterly interviews with VSI
- Baseline and after TAC meetings online surveys administered to TAC members
- Online surveys with participants of roundtables shared at the end of each event
- Baseline interview with DOR
- End-of-demonstration interview with WSP
- End-of-demonstration interview with MnDOT

In addition, the review of relevant documents complemented the information provided by demonstration partners. Documents reviewed include:

- Analytics from MnDOT DBF webpage
- The information systems management plan developed together by WSP and VSI (the data repository provider)
- WSP’s Mock Audit Final Report

Limitations

The Minnesota Distance-Based Fee Demonstration occurred during the COVID-19 pandemic. The pandemic affected the providers’ staff capacity and their regular internal activities, which affected the ability of some providers to participate in quarterly evaluation interviews. However, despite the challenges posed by the pandemic, shared mobility providers, the C/AV provider, and the data repository provider accomplished most of the demonstration activities during the twelve-month period. This was mostly attributed to the preparation work made ahead of the start of the demonstration.

5.3 EVALUATION FINDINGS

The evaluation was performed based on four revenue-evaluation principles: Efficiency, equity, adequacy, and feasibility -which included both political and administrative feasibility. In this report feasibility is discussed first, as it was the focus of this demonstration.

5.3.1 Feasibility

This evaluation criterion assesses the feasibility of a Distance-Based Fee system. The feasibility is assessed based on two criteria, administrative and political feasibility. *Administrative feasibility* assesses the costs associated with administering and collecting distance-based fees from the agencies' and providers' perspectives, while *political feasibility* assesses public approval associated with the collection of distance-based fees.

The administrative feasibility of DBFs is likely to improve over time. SM providers experienced high operating costs related to data-related activities at the beginning of the demonstration, however, the costs associated with data-related activities decreased as the processes were internalized, they built internal capacity, and were more familiar on how to meet the DBF requirements. Similarly, the C/AV provider spent the majority of their time preparing hardware and software in order to complete the tests successfully. Once all the parameters needed for the data collection are calibrated, the time spent on those activities is minimal. Lasty, the information systems management plan was successful in protecting data shared by SM providers throughout the demonstration. Overall, a limited number of demonstration team members had access to the data shared by SM providers and none of the research partners had access to SM customers' personally identifiable information (PII).

The administrative feasibility for state agencies depends on various factors. The DOR estimates that for a DBF system implemented at the SM provider level, the processes and costs of collection, enforcement, compliance, and audit would be somewhat similar to those of the current motor fuel tax system. However, these costs will largely depend on the scale of implementation and the pricing structure. Overall, it is hard to estimate the costs of administering a DBF system for a state agency with information for this demonstration as the DOR's involvement in administering the DBF was minimal and its participation focused on providing guidance.

The political feasibility of DBFs is likely to improve as details of the implementation are clearly laid out and the general public gets more familiar with them. According to SM providers, their acceptance of DBFs depends on the potential benefits their customers will receive if a DBF were to be implemented, the possibility that DBFs are levied only on SM providers and not on the general public, and the reaction of customers to potential changes in prices. Overall, the communication tools used in this demonstration (such as roundtable events and the DBF demonstration webpage) successfully communicated information and helped educate interested members of the public about DBFs. Although outreach activities for this demonstration focused mostly on policymakers, stakeholders, and members of the public interested in DBFs, this provided important information regarding concerns that the general public may have and suggestions to address them in the future. Further work will be needed in the future to identify and address concerns of the general public.

5.3.1.1 Administrative Feasibility - Ease of Administration for Shared Mobility Providers

Shared mobility providers experienced operating costs related to data-related activities, which included collecting, sanitizing, and reporting the number of miles driven and the fuel purchases made by their fleet on a monthly basis. These costs decreased over the demonstration. In addition, one of the providers experienced some initial costs related to updating their privacy policy to participate in the demonstration. Overall, SM providers did not incur capital costs due to this demonstration.

Prior to demonstration, the SM providers and WSP went through a pre-demonstration launch data collection testing in February. In addition, WSP conducted a proof of concept at the end of 2019 with one of the shared mobility providers. These activities allowed demonstration partners to understand what data could be reported, the detail of the report, as well as to standardize the data to be reported.

During the DBF demonstration, shared mobility providers performed demonstration activities in accordance with the following three phases:

- Phase 1, from April to July 2020 - Required SM providers to collect, sanitize, and report the number of miles driven and the fuel purchases made by their fleet on a monthly basis. The project team used the provided data to create revenue reports.
- Phase 2, from August to November 2020 - Required SM providers to generate a revenue report in addition to performing data-related activities. The revenue report was sent to the project team for validation.
- Phase 3, from December 2020 to March 2021 - Required providers to perform data related activities, create revenue reports, and send the report directly to the auditor.

Figure 5.1 presents the time spent per vehicle by SM provider to perform the demonstration activities. This includes time spent on data-related activities as well as time spent on explaining irregularities in the data to WSP. The time spent on these activities may vary based on the size of the organization, the fleet size, and the market penetration as measured by trip volume.

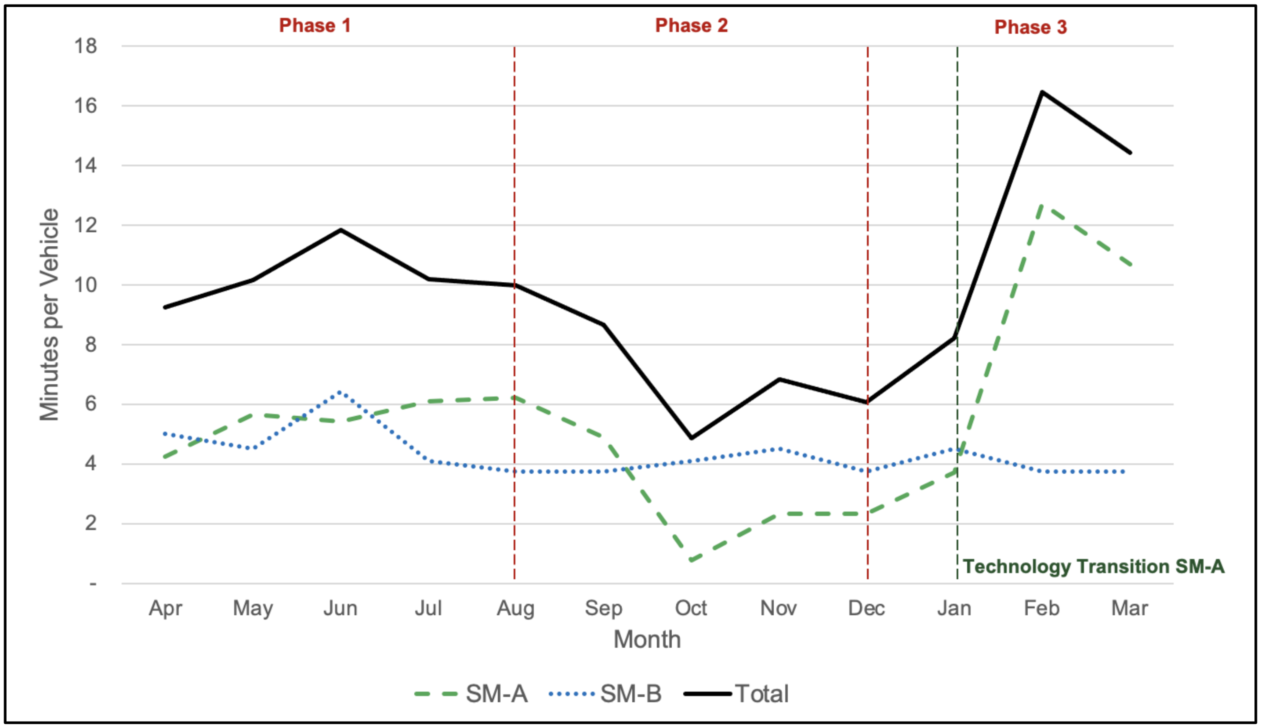

Figure 5.1 Time SM Providers Spent on Demonstration-Related Tasks

The time spent on data-related activities decreased as SM providers became more familiar with the information they were required to report. The inclusion of the creation of the revenue report (in Phase 2) increased the time spent per vehicle for SM-A but it was offset by a decrease in the time spent on collecting and sanitizing trip data. The increased time during Phase 3 was due to the adoption of a new technology system by SM-A. According to SM-A, ensuring any data errors were explainable to WSP was time consuming as it often required piecing together data points. However, as they learned more about the issues presented in the data, they were able to identify and address them before sharing the information with demonstration partners, which saved some time. According to SM-B, the time spent completing the data-related tasks for this demonstration remained consistent throughout the twelve months given that they spent time and resources prior to the start of the demonstration to customize their existing software and automate the process.

Overall, SM providers used their existing technology to participate in the demonstration and did not incur any additional capital costs due to demonstration-related activities (Appendix B details existing technology costs).

While SM providers collected information on mileage and fuel purchases from their fleet prior to this demonstration, they experienced several data collection challenges during this demonstration. Some of these challenges were anticipated by the SM providers, while others were not. Anticipated challenges included limiting data collection to specific vehicles in Minnesota and providing it at the frequency required for the demonstration. In addition, as part of the preparation for this demonstration, SM providers invested engineering resources in developing the tools or customizing their existing software to export and generate the mileage and fuel report for the demonstration. For one of the providers, this investment was significant and challenging due to their limited engineering resources.

On the other hand, the providers also experienced challenges that were not anticipated prior to the demonstration. While most of the challenges initially increased the time staff spent on data-related activities, over time the process became more efficient. Overall, there was a learning curve associated with these challenges.

- Addressing technology errors that interfered with mileage reporting - This increased the time staff spent on data-related activities as they had to investigate and follow up potential erroneous data points and ensure that any data errors were explainable. Some of the issues identified in the data related to technology errors include vehicles reporting zero miles while having some fuel purchases, and vehicles reporting extremely high miles for short-term reservations.
- Handling transactions out of the reporting system - There were cases when customers purchased fuel with their personal credit cards due to occasional issues with the fuel credit cards. Customers then submitted the receipt to the provider for reimbursement. These reimbursements were manually added to the fuel report.
- Fine-tuning export parameters - Although most of the software adjustments occurred prior to the demonstration, one SM provider had to readjust some of the export parameters to account for vehicle trips that started or ended outside the monthly report time frame. This resulted in additional staff time to manually retrieve mileage data and re-submit a new mileage report, in addition to the time spent to adjust the software.
- Formatting information to satisfy reporting requirements - One SM provider had to spend additional time to create the revenue report due to the vehicles not being listed in the provider's fuel card platform in the same format as required for the revenue report. This required the provider to edit the vehicle name in the fuel report manually.

SM providers also experienced some challenges due to internal changes in operations as a result of changing to a new fuel card vendor and transitioning to a new technology. Midway through the demonstration one of the providers changed its fuel card vendor, which resulted in the export tool no longer pulling fuel data from the correct fuel data source. The provider had to re-work the software solution they used to generate the reports. Similarly, the other SM provider transitioned to a new in-car and software technology system during the last quarter of the demonstration. The challenges the provider faced were related to (1) setting up all the exporting parameters to comply with the requirements previously identified for the demonstration; (2) verifying the exporting tool reported distance traveled in the correct units. The SM provider discovered trip data was reported in kilometers rather than in miles; (3) standardizing the languages between systems to integrate trip data with fuel data and make it comparable to previously reported datasets. During the technology transition, the SM provider relied on the software provider to customize and fix some billing problems with the new software system. This limited their ability to complete demonstration activities on time.

One SM provider collected real-time reservation location (or “trip-path”) data in addition to the regular demonstration activities. This data was only collected during the third quarter of the demonstration. This data provides a time-stamped geographic location of a vehicle every 60 seconds during a trip and makes it possible to string together a trip path allowing the providers to know when and where the car traveled. This trip-path data was downloaded, sanitized, and uploaded in the data repository, and was not used in the creation of the revenue report.

Compared to the data regularly used for the demonstration purposes, collecting trip-path data was more costly as it required an added technology feature and staff time. This was the first time the SM provider collected, sanitized, and exported this data, which doubled or tripled the time the provider spent on these activities. As the provider became more familiar with the data, the time spent on data-related activities decreased to slightly over 50 percent of the initial time spent on this data (from 165 minutes in October to 90 minutes in December). According to the provider, this cost could be reduced by asking the technology and software supplier to do the data export at no additional cost. In addition, enabling the option of collecting the trip-path data costs the SM provider $300 a month for the entire fleet. This cost was charged to the SM provider by their in-car technology and software provider.

The main challenge with the collection of the trip-path data was the size of it. Data exports were large and caused software crashes. The provider had to export the data in batches, sanitizing each batch and stitching them back together, which was time consuming. Dealing with this data created logistical challenges to the provider’s internal operations as it needed to balance time for the regular operations while trying to meet data requirements. It may be especially challenging to find this time if the organization has limited personnel.

One of the shared mobility providers incurred additional costs for updating its privacy policy in order to participate in the demonstration. The provider amended and reworked its privacy policy to add more robust sections and content related to the collection of customer information and vehicle use information, among others. The amended privacy policy allowed the SM provider to collect and share the necessary trip and vehicle level data with demonstration partners. The total cost of the privacy policy update included updating the terminology in the policy and setting up communications to share updates with customers. The cost of the lawyer was around $5,000, and SM provider staff spent one to two person-weeks of collective effort to adjust the privacy policy and communicate it to their customers.

5.3.1.2 Administrative Feasibility - Ease of Administration for C/AV Technology Provider

The connected and automated vehicle (C/AV) technology provider conducted two official tests[55] over the course of the demonstration: A state border crossing test and a high occupancy vehicle (HOV) lane test. Both tests were conducted with seat occupancy sensors.

Overall, the majority of the provider's time in relation to these tests was spent preparing hardware and software in order to complete the tests successfully. The programming included formatting the data to meet requirements established by the demonstration. On average, each test took 30 hours to program. Once a test was completed, the transmission of data from the vehicle to the data repository took approximately five minutes. For these tests, the C/AV technology provider verified and cleaned up the data on the vehicle itself without the need to download the data to an intermediary location.

The C/AV provider already possessed most of the equipment and software as part of its regular business operations. These include the connected and automated vehicle, vehicle software, wiring system, and various sensors. However, the C/AV provider incurred additional costs to acquire some capital assets to support the demonstration's tests (see Table 5.1).

Table 5.1 Additional Capital Costs for the C/AV Technology Provider

Equipment/Software	Cost
Seat sensors	$100 per sensor (acquired at no cost)
GPS unit with enough accuracy to determine lane location	$50,000 - $100,000 per unit (already possessed)
Arduino, cables, and connectors to set up the sensors	Less than $100 in total (acquired assets)

The C/AV provider experienced several challenges due to software issues when conducting the tests.

- Reporting data continuously - The provider experienced data reporting issues due to API calls that occasionally timed out due to limited internet connectivity during the state-border crossing test. In particular, the test trip was supposed to be recorded at 1-second intervals, but there are a few places where there are 2-second and 6-second interval gaps. At the end the providers had to redo the test due to the discrepancies.
- Discrepancies in fuel tank level data- While the provider did not remember filling the tank during one of the test trips, the fuel tank level data increased at one point. This was likely due to the

[55] The C/AV provider performed several tests but only two of these tests provided satisfactory data. Throughout the report we will refer to these as official tests.

fact that the test vehicle was a hybrid electric vehicle, and it is possible that the distance until the vehicle runs out of fuel increases as the hybrid battery regenerates.

- Capturing high precision lane location data - Due to inconsistent labeling schemes in the reference map, the provider experienced challenges in capturing high precision lane location data in the HOV lane detection tests. This challenge was not anticipated. They resolved this issue by locating a property that specifies the proper lanes and writing a code to develop a lane indexing system that enabled accurate lane detection. In addition, to determine accurate lane location, the provider required a high definition (HD) reference map and a high-end GPS to be accurate to less than a meter (or ideally into the centimeter range).
- Capturing seat occupancy - For the tests involving seat sensors, the provider noticed that installing the seat sensors under the seats resulted in the seat being reported as occupied due to the weight of the seats. They resolved this issue by installing the sensors above the seats and covering them with foam. According to the staff, sitting on these seats was slightly uncomfortable.
- Processing and transmitting data from seat sensors - For the tests involving seat sensors, the provider did not have a regular interface (such as a USB port) to the computer and had to develop an arduino code to process the seat sensor data and used cables to read and transmit the data to their computer to log with the rest of the data. The provider did not anticipate this as they had not worked with them before.

Overall, any data errors were treated as findings. Given that VSI trips were tests rather than actual trips, any errors identified in the data were treated as an opportunity to address them and rerun the tests.

5.3.1.3 Administrative Feasibility – Success of Data Protection

The data shared by SM providers was protected. A limited number of demonstration team members had access to the data repository and the data shared from SM providers[56] for research and audit purposes, as well as to support SM providers with the creation of the revenue report (in phase 1 and phase 2 of the demonstration). None of the research partners or government agencies had access to SM customers' personally identifiable information (PII) during the twelve-month demonstration. Additionally, SM providers did not have access to each other's data. The success of data protection measures in this demonstration could be attributed to two factors. First, the information systems management plan developed together by WSP and VSI (the data repository provider), and second, the SM providers' internal data protection practices.

First, WSP and VSI developed an information systems management plan for the data repository during the preparation stage of the demonstration. VSI built the data repository based on the established requirements and set up processes and procedures for managing security, privacy, confidentiality, and availability of the data managed by them. A summary of the plan is attached in Appendix C.

[56] Members of the demonstration team with access to the data signed a non-disclosure agreement.

Most of the costs associated with the data repository were to set the system up, while ongoing costs were generally low. For the initial set up, the provider spent 27.5 hours, which included building the website, setting up the server and server security, setting up automated backups of the data, creating the interface to upload and download data, and setting up the various types of user accounts. In addition, the provider spent about 5 to 10 minutes, on average every month, conducting regular repository activities including helping users regain access to their accounts and adding additional features. The only capital asset needed by the repository provider throughout the demonstration was the cloud service provider where the data and server were hosted. The monthly fee for this service was $10-$15.

VSI did not experience any challenges in managing the data repository throughout the demonstration except for addressing minor requests. These included handling mis-typed usernames or forgotten passwords and adding additional features to the repository and was easy to handle since there were a small number of account users using the repository. According to the provider, these challenges are typical of any kind of system with user accounts.

Second, SM providers had existing data sharing practices in place that contributed to data protection throughout the demonstration. Initially, they were slightly hesitant to share the data given the small number of SM providers participating in the demonstration. The providers were concerned that they were easily identifiable, which may have affected their customers as well as their businesses. Most of these concerns were discussed and addressed during the preparation stage, and both SM providers were comfortable sharing data with the demonstration partners and the purpose for which it was being shared. Overall, SM removed any PII from the data sets before sharing them with the demonstration partners. Only vehicle ID, miles driven per vehicle, and features from fuel purchases such as date, time, and place of the transaction were provided to the demonstration partners. In addition, it was agreed that the data SM providers shared with demonstration partners was to be purged from the repository no later than 90 calendar days following completion of the demonstration operations period, that was, June 30th, 2021. As of July 1st, 2021 the data repository was purged of the SM providers' data.

The SM providers had existing data sharing practices in place that allowed sharing data for research purposes with government agencies based on the research goals and objectives. The SM providers provide data to meet specific research goals rather than developing research goals based on the data they can theoretically collect. In particular, one of the providers spent many months prior to the demonstration discussing the objectives, goals, and hypothesis of this demonstration with MnDOT and determining what data they could provide to meet these goals as well as protect their members and business.

In addition, the provider spent eight months prior to the demonstration working with the research team to establish the data they felt comfortable releasing and the level to which that data needed to be aggregated. The research team initially requested more specific trip data such as trip origin and destination, geo-location data, and how mileage was split between trips. The provider did not collect this data and was concerned that collecting and sharing such specific information could potentially identify individuals if individual gas transactions end up in the wrong hands. After spending an extensive amount of time and several iterations ensuring the security of the information that was going to be shared, the provider was comfortable sharing the information with a government agency subject to the Minnesota Freedom of Information Act (FOIA). This process of ensuring data security was the largest burden the SM provider incurred in preparation to participate in the demonstration.

Similarly, prior to the demonstration, one of the SM providers was concerned about sharing their customer data with WSP. As a consulting firm, WSP is involved with many stakeholders and projects and the SM provider did not want it to hold on to its data for use in other projects. The SM provider was more confident with sharing the data with a government agency and therefore insisted on a contract in which MnDOT would own the data and that it would be used for the purposes of this demonstration exclusively.

In addition, while highly unlikely to happen, one of the SM providers had concerns about potential data breaches throughout the demonstration. One of these concerns was the potential for customer information being identified using a customer ID field in the data if someone could access their reservation system. According to the provider, generating a new unique customer ID that did not exist in their system could mitigate this risk, especially if randomized.[57] However, according to the provider, even with a novel unique customer ID, it would be easy to identify vehicles for someone with access to the mileage report and glean insights about individual users based on their vehicle usage patterns. In addition, the provider was concerned about the potential for increased risk of the unauthorized correlation of customers and vehicle usage with access to security camera footage.

These concerns further increased when trip-path data was collected. While this data allows a very thorough reporting and analysis of user activity and behavior, according to the provider, the more it is shared, the higher the risk of a data breach. While all PII was eliminated from the data shared with demonstration partners, the SM provider was concerned that, in a hypothetical situation, if someone had access to video showing a specific individual accessing a car, they could tie this information to the trip-path data and learn individual location and time.

5.3.1.4 Administrative Feasibility – Ease of Administration for State Agencies

Overall, it is hard to estimate the costs of administering a DBF system for state agencies with the information from this demonstration. The DOR’s involvement in administering the DBF in this demonstration was minimal and did not incur any administrative costs due to its participation. According to the DOR, the costs of collection, enforcement, compliance, and audit of a DBF system will depend on the scale of implementation as well as the pricing structure. If implemented at the SM

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[57] Although generating a novel unique ID mitigates privacy concerns, as a password with the right administrative privileges needs to be used to access private data, there is a risk of data breach associated with it. For instance, someone using the unique ID in the back end of the provider's administrative software could link it to a customer and have access to their personal information such as their driver’s license.

provider level, the processes and costs would be somewhat similar to those of the current motor fuel tax system.

For the purposes of the DBF demonstration, it was assumed that the DOR would be in charge of the collection, enforcement and compliance, and auditing taxpayers, similar to the current motor fuel tax system. For this demonstration, the DOR provided guidance for the creation of the revenue report template, set standards to complete the reports, and provided guidance for the execution of mock audits, while WSP worked with SM providers and the C/AV provider to establish data requirements, ensure data accuracy, and to ensure smooth administration. The DOR did not incur any administrative costs due to its participation in this demonstration as its involvement in administering the DBF was minimal. Therefore, it is hard to compare DOR's anticipated administrative costs and those incurred during the demonstration.

The costs of administering a DBF system would depend on several factors and it is difficult to estimate them with the current information. According to the DOR, collection, enforcement, compliance, and auditing processes and costs of a DBF system will largely depend on the scale of the implementation and thus the number of DBF-payers in the system. Other factors that could be considered in a pricing scheme, such as time of day or lane used, would likely make all these processes more complicated and increase their costs. If the DBF is implemented at the SM provider level similar to the demonstration, the Department anticipates the processes and costs to be somewhat similar to those of the current motor fuel tax system.

According to the DOR, the startup costs of collecting the DBF would depend on the kind of data that would be required to be collected. These costs are likely to be significant, but may be the same regardless of the number of taxpayers. Initial startup costs would include capital costs associated with building the necessary functionality into the DOR's accounting system (Gentax). On the other hand, the Department expects the ongoing costs to depend on the scale of implementation. Implementation at the SM provider level would be less costly than at the individual level as the Department expects the need to hire more personnel and the respective equipment. The DOR believes under a DBF program at the SM provider level, no additional staff will be required.[58]

The DOR believes that the process and costs of enforcement, compliance, and audit would be similar under a DBF system at the SM provider level due to a smaller number of taxpayers. For instance, the DOR estimates the audit process for a DBF system at SM provider level will take relatively less time compared to the current motor fuel tax audit. The Department estimates that performing a 24-month audit would take approximately half the amount of time it takes to perform the current fuel tax audit.[59] However, it would largely depend on the size of the fleet, the organization of the company's records,

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[58] Currently, there are eight staff assigned to motor fuel tax related activities such as collection, compliance, enforcement, and audit.

[59] The Department estimates that an audit under the current motor fuel tax typically is conducted in 80 hours or less.

and the availability of the necessary audit information. In addition, the Department feels if on-board telematics present SM vehicles are deemed reliable, it could remove the need for in-person verification during the audit. On the other hand, if on-site DOR presence is deemed necessary during the audit process, the protocol could be to verify odometers of a random subset of vehicles.

In late January/early February, WSP conducted a mock audit following the guidelines of the DOR. To make the audit more robust, the staff conducting the audit ('the auditor') was not involved in the other tasks of the project.[60] For the mock audit, WSP analyzed and reconciled the monthly revenue reports and the backup raw datasets, both submitted by each SM provider, to determine whether the miles driven, fuel purchased, and calculated DBF revenues and fuel tax credits were correctly captured, calculated, and reported. To address any anomaly found, the auditor was planning to contact the SM provider. However, SM providers were not contacted, given that the staff involved during the process had enough information to explain any anomalies found by the auditor.

Table 5.2 presents the monthly datasets considered in the mock audits.[61]

Table 5.2 Monthly Datasets Considered During the Mock Audit

	Phase 1				Phase 2				Phase 3			
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Audited month	X	X	X					X				

The auditor spent around 40 to 50 hours to complete the audit. This time included understanding the guidelines; collecting, compiling, and analyzing datasets containing fuel and miles driven; identifying gaps; and documenting the findings. The auditor spent more time auditing the first months of data given that they were the initial months and required more time to get familiar with the datasets.

During the mock audit, the auditor identified the following issues:

- Missing data - During the cross-checks there were vehicles with significantly lower MPG than others, vehicles reporting zero miles driven, vehicles with no fuel purchased recorded, mismatches between fuel transactions and the corresponding trip data reservation date/times. These would affect fee calculations and fuel credits in a DBF system.

[60] During Phase 1 of the demonstration, SM providers submitted miles driven and fuel data, while WSP's staff involved in the project created the revenue report. During Phase 2, SM providers submitted miles driven and fuel data and created the revenue report with support from WSP's staff involved in the project.
[61] In addition, the auditor randomly selected unique vehicle IDs to cross-validate the overall robustness of the other monthly revenue reports.

- Identifying fuel purchases only made in the state of Minnesota - Out-of-state fuel purchase transactions appeared in the raw data sets, but were not considered in the revenue report as fuel credits are based on fuel purchases made in the state of Minnesota.
- Timing discrepancy between fuel reimbursements and the submission of monthly revenue reports - Currently, given the business model, it is not a priority for SM providers to include fuel purchases made by customers in their systems in a timely manner. This may affect the assessment of fuel credits.
- Inconsistent data sources - At the beginning of the demonstration, a SM provider and WSP clarified the difference between 'reservation miles' and 'trip miles'[62] and agreed on using 'reservations miles' to generate revenue reports as it reflected the most accurate mileage. However, in one of the audited months 'trip miles' were reported. Inconsistent data sources may affect the mileage reported and thus, the calculations of a fee in a DBF system.

SM providers anticipated receiving requests for the audit process during the third phase of the demonstration, but in the end, they were not directly involved in the mock audit.[63] During the last phase, SM providers created the reports by themselves and anticipated being contacted for irregularities found during the audit process. However, during the last phase, there were no data validations given that the mock audit was performed in late January/early February using data from previous months. The SM provider that transitioned to a new technology expected to explain several anomalies and to receive a 'mock fine' for the late submission of the revenue report and the errors in it. For instance, under the motor fuel tax system, the late payment fee is one percent per day for up to ten days. In a future DBF program, these late fees can become substantial and may result in an incentive to pay on time.

5.3.1.5 Political Feasibility – Acceptance from Shared Mobility Providers

Several factors affect the acceptance of DBFs from SM providers. According to one of the SM providers, some factors that positively affect their acceptance are related to the potential benefits their customers will receive if a DBF were to be implemented in the future. For instance, the provider anticipates that revenue that would otherwise go uncaptured from EVs would be captured under a DBF, which will result in better infrastructure. In addition, the provider expects to implement a robust reporting system (partially as a result of this demonstration), which may result in customers benefiting from better pricing, more logical service areas, and efficient distribution and rebalancing of their fleet. Lastly, if DBF

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[62] 'Reservation miles' represent the total miles driven during the duration of reservation, while 'trip miles' are the total miles driven in a trip, that is, every time the user swipes in and out. At the end, the sum of multiple 'trip miles' for a particular reservation should equal the 'reservation miles'. Ideally, all users would only swipe in and out once, at the start and end of a reservation, respectively, then the reservation and trip would be the same. However, some users swiping out each time they stop the vehicle, which generates multiple trips under a single reservation.
[63] According to the auditor, involving SM providers was not necessary as WSP had sufficient information due to their involvement in the demonstration process.

is implemented in such a way that the provider will pay less than they currently do under the MFT, their customers would benefit from a reduction in the pricing of the service.

Similarly, there are other factors that may negatively affect SM providers' acceptance of DBFs. These include the possibility that DBFs are levied only on SM providers (and not on the general public) and the reaction of customers to potential changes in prices.

First, SM providers expressed concerns about a scenario where DBFs are levied only on shared mobility providers and not on the general public. In this scenario, the state would be shifting the burden of fee collection from fuel providers to SM providers. One SM provider believes this would be the worst-case scenario, while the other feels this increased burden is unfair unless there is compensation. While the provider has gained more robust data from this demonstration due to the reports they were not previously generating, they do not feel this is a fair compensation for bearing the burden of collecting the fee. According to them, some compensation possibilities to account for that additional burden include the exemption from the fuel tax and tax breaks from other taxes these organizations are subject to. The providers also believe that in addition to the extra burden of data-related activities, a DBF that only applies to them would impact their ability to remain competitive in the transportation market due to increased costs for their customers. According to the providers, this would be seen as purposely taxing people who make a responsible decision of not owning a car. Overall, SM providers feel that their customers should be rewarded for their participation in a sustainable transportation choice and not penalized.

Second, one of the largest potential impacts of a DBF for the SM providers is how to present the charge to their customers, and ultimately their reaction. That is, whether they treat the charge like the motor fuel tax, which is built into their rates and not visible to customers, or they make it more visible and transparent to their customers so that they are aware of paying a per-mile fee. For example, a DBF could be an additional line item on trip invoices. Overall, it is hard to predict how people will react, but according to one of the providers, some users will feel punished, others will support it, and the majority will be confused. Some opportunities they identified are (i) clarifying DBFs as a replacement for the motor fuel tax, and (ii) communicating DBFs to customers as their contribution to the common good to build and maintain the transportation infrastructure. Additional opportunities can be created, for instance, by providing a tangible reward or incentive that is linked to their participation in DBFs.[64] Otherwise, the cost increase may make them upset.

Another factor that will contribute to their acceptance toward DBFs is the actual amount they have to pay under the DBF system. For the purposes of this demonstration, SM providers were shown a

[64] For instance, MnPASS or passes for state parks. In addition, in a future iteration of DBF in the context of congestion pricing, there could be some reward for good behavior. For instance, it could be a lower charge if the customer is reverse commuting.

simulated DBF charge based on their total VMT reported and a DBF rate of 2.7 cents per mile.[65] Overall, SM providers did not have strong reactions to a simulated DBF charge, however, they were more supportive of paying a lower amount under a DBF than the amount they currently pay under the MFT.

One of the SM providers was not sure how to compare the simulated charge to the amount of motor fuel tax they paid during the same time period. The provider raised concerns about paying the same amount under a DBF system arguing that a DBF system would represent a significant increase in cost due to operational and capital costs associated with maintaining the required records. Thus, the provider believes paying a lower amount under a DBF system than the amount they currently pay under the motor fuel tax system would be beneficial to them, but it would depend on how much less they would be paying. According to the SM provider, the amortized costs of in-car technology and record-keeping are likely more than the amount they would be saving in DBF as the technology they use for their operations is more expensive than what would be required to only track miles. Similarly, the provider was unsure about the amount of a DBF they would be charged in case of transitioning to a different service, such as from a two-way to a one-way service, or changing their internal combustion engine fleet to all-electric.[66]

The other provider did not comment on the simulated charges, but noted that it would not be a problem for them to pay the same amount under a DBF to the amount they currently pay in motor fuel taxes, but would prefer paying a lower amount.

5.3.1.6 Political Feasibility – Addressing Public Concerns

The roundtable events and the DBF demonstration webpage successfully communicated information and helped educate interested members of the public about DBFs. Although outreach was mostly focused on policymakers, stakeholders, and members of the public interested in DBFs, this provided important information regarding concerns that the general public may have and suggestions to address them in the future. Throughout this demonstration, SM providers did not have any interactions with their customers related to DBFs or this demonstration and, as a result, no concerns from SM users were identified or addressed. More work will be needed in the future to identify and address concerns of SM users and the general public.

As part of the Minnesota's DBF demonstration, the Humphrey School developed three roundtable series to "help educate policymakers, stakeholders, interested members of the public, and others that will need to understand the context and importance of this demonstration". The first event was in-person at the facilities of the Humphrey School, while the two other events were hosted online through zoom due

[65] The simulated DBF rate of 2.7 cent per mile is composed of a federal rate of 1.1 cents per mile and a state rate of 1.6 cents per mile.
[66] Two-way (round-trip) carsharing service is typically used for longer trips such as camping or brief out-of-state trips, whereas a one-way service typically serves more local trips and are shorter.

to pandemic-related restrictions. At the end of these events, an evaluation form was shared with attendees to capture their perceptions on DBFs and the overall event.

Table 5.3 presents attendance and evaluation response rates for all events. The roundtable survey participants were public employees (36%), private employees (25.3%), academics (16%), and elected officials and interested citizens (both with 9.3% participation). In addition, most survey participants were in Minnesota, particularly from the Twin Cities Seven County Metro Area. However, the last event brought interested people from other U.S. municipalities (accounting for 30% of all survey participants in the third event).

Table 5.3 Attendance to Roundtable Events

	Event 1	Event 2	Event 3	All Events
Registered	53	120	154	327
Attendees	41	104	96	241
Attendance rate	77.4%	86.7%	62.3%	73.7%
Evaluation participants	22	25	30	77
Evaluation response rate	53.7%	24.0%	31.3%	32.0%

Notes: *Participants may also include members of the DBF core team.*

Overall, these events were successful in communicating information about DBFs. Although there was a variation in the respondents' level of familiarity with DBFs, most of them experienced an increased level of familiarity after these events. On average, 30 percent of participants in each event were unfamiliar with DBFs before the event, but around 90 percent of these cases reported an increased level after the event. In addition, around 90 percent of the evaluation participants expressed their support to further explore DBFs as a possible funding source for the transportation system.

Similarly, as part of the communication strategy, MnDOT built a website for the DBF demonstration. The website received visits from 186 users with 1,237 pageviews from October 15, 2020 to April 19, 2021. While a third of the website users were located in Minnesota, the website received visits from users located in other states including Colorado (17%), Washington (11.9%), Wyoming (6.8%) and California (5.7%). In addition, most of the users were new visitors (76.2%) compared to returning visitors (23.8%).

During the demonstration period, the MnDOT team received requests from state agencies, transportation organizations, and interested citizens to share information regarding DBFs. Several of these communications requested sharing the Minnesota experience with DBFs in general as well as with the demonstration. In addition, the team received questions regarding the transition from the shared mobility model to privately-owned vehicles, the use of DBF data to analyze backups and congestion problems in work areas, and user perceptions throughout the demonstration. The MnDOT team also had the opportunity to explain the reasons behind the consideration for adopting a VMT tax to a concerned constituent that opposed the proposed VMT tax.

Throughout the demonstration, SM providers did not have any interactions with their customers related to DBFs or this demonstration. During the planning stages of the demonstration, it was agreed that SM providers would not have any interactions with their customers regarding this DBF demonstration as a way to respect the business of SM providers and avoid potential misunderstandings with a demonstration project. Therefore, no public concerns from SM users were identified or addressed in this demonstration.

Questions from TAC members and participants of roundtable events were answered by MnDOT. These are presented in Appendix D.

5.3.2 Efficiency

This evaluation criterion assesses the extent to which DBFs may lead to more efficient use of resources. Given that the current demonstration utilized hypothetical charges and there were no money transactions, the efficiency of DBFs is assessed through hypothetical situations. This evaluation assessed efficiency in operations, efficiency in fee collection, integration with other charges, and efficiency in fee auditability. Overall, in terms of operations, this demonstration improved some of the SM providers' internal processes but did not affect C/AV operations, or operations in the organizations TAC members represent. In addition, demonstration partners discussed the potential impacts on their operations, users' driving patterns, and cities' goals if a DBF system is implemented in the future. In terms of efficiency in fee collection, demonstration partners identified various factors that may improve fee collection including the use of in-vehicle telematics, the use of incentives, and the use of existing taxpayer information. Other factors that may limit fee collection include technology changes and third-party dependency. In terms of integration with other charges, demonstration partners believe DBF charges could be integrated with the payment of other taxes, fees, or payments users are subject to. Lastly, this demonstration presented an approach to implement DBFs with a small number of DBF-payers that benefits efficiency in fee auditability. However, from DOR's perspective, the enforcement, compliance, and audit processes of a DBF system are expected to increase as the number of DBF-payers increases.

5.3.2.1 Efficiency in Operations

This demonstration improved some of the SM providers' internal processes but did not affect the services SM providers offered to their customers, C/AV operations, or operations in the organizations TAC members represent. In addition, demonstration partners discussed some of the potential impacts on their organizational operations if a DBF system is implemented in the future. Overall, the SM providers anticipate several changes that may contribute to the efficiency of the SM providers' operations that would likely impact SM users' driving patterns. Similarly, the TAC members discussed the potential impacts of a DBF system on organization costs as well as on cities' goals.

The demonstration did not affect the services SM providers offered to their customers, but they experienced improvements in some of their internal processes. For instance, one of the SM providers saw an improvement in the quality of data used for their own operations as a result of this demonstration. Addressing some of the atypical circumstances that led to data errors in the monthly reports helped the provider refine their monthly automated reporting process. This may have helped the SM provider capture more mileage revenue. In addition, they started to analyze other aspects of the monthly export that potentially affect their operations. These include reservations that are made and go unused and user behaviors that might flag problematic user activities such as length of reservation.

SM providers anticipate several changes in their internal operations if a DBF system is implemented in the future. These include, for instance, changes in the structure of the rate plans to include mileage, type of vehicles offered (internal-combustion engine vehicles and electric vehicles), and changes in the plans offered (one-way-trips and round-trips). For example, shorter and more frequent trips could be better served by one-way all-electric vehicle service, while longer and less frequent trips could be better served by round-trip ICE vehicle service. Similarly, they anticipate increasing the priority to solve mileage reporting errors to accurately collect mileage data, and upgrading their technology systems if their existing technology does not meet state-mandated requirements. These changes could also contribute to the efficiency of the SM providers' operations as well as impact billing structure, for example charging per minute of use rather than per hour.

All these changes in SM providers' internal operations are likely to impact SM users' driving patterns. A SM provider notes that the transition to a user fee system could generate an opportunity to change the way people think about the miles they drive. For instance, people could become more aware of the impact of driving and be willing to take on the cost of a DBF. This, in turn, may benefit SM providers as using shared mobility services may become more appealing given that providers take care of the administrative hassle of gas, insurance, and the DBF.

VSI, the C/AV provider, did not experience any changes in their operations. However, if DBFs are levied on C/AVs in the future, it may lead to more efficient use of resources. For instance, automated processes could be incorporated into C/AVs so that they are capable of collecting and transferring adequate data to support DBF systems. In addition, more sophisticated technology gadgets could be the standard in these vehicles, such as seat sensors and more precise navigation systems. It could also improve internet access by increasing the demand for reliable and stable connections.

TAC members often brought up the potential impacts of a DBF system on their respective organizations' current operations. For instance, if a DBF system is implemented and the Department of Public Safety is in charge of the fee collection, vehicle registration operations may take slightly longer than it currently does if more vehicle information would need to be collected at registration. This increased registration transaction time could be especially notable under a DBF system that applies to individual vehicles, rather than to fleets. Similarly, it was noted that there is a potential for increased operating costs for metropolitan planning organizations (MPOs). If additional revenue is not provided to cover increased costs, the organization might need to cut the services they offer.

TAC members also mentioned potential impacts of a DBF system on cities' goals. In terms of benefits, cities, for instance, could improve mobility options and improve the attainments of climate goals. In addition, depending on the allocation of DBF revenues, cities could experience a potential increase in funding for capital projects and reduce the burden on local property taxes for transportation infrastructure. Some TAC members also suggested that DBF impacts on VMT and revenue change can cause a shift in transportation investment priorities - for instance, there could be more funding for improved transit, carshare, bike and pedestrian mobility. Similarly, some challenges are also anticipated with the implementation of a DBF system. According to TAC members, a DBF system is a revenue structure that relies on people driving more miles, which is in opposition to the climate change mitigation strategy of VMT reduction.

Overall, there are still some questions regarding the extent to which DBFs may lead to more efficient use of resources. These include the impact of DBFs on travel choices and on the wide adoption of electric vehicles. Half of the TAC members believe the adoption of DBFs could reduce the number of miles driven, and the number of vehicles owned and operated. A large number of TAC members also believe that DBFs will not impact the use of other transportation modes including carpooling, car-sharing, ridesourcing, and using transit services. Some TAC members also believe that the use of bikes may increase slightly due to the fact that DBFs could be only levied on miles traveled by vehicles. Other impacts DBFs may have include affecting people's choices on where to live as they may lead people to live closer to where they work, shop, and socialize. However, future research would be needed to determine the actual impact of DBFs in these areas.

5.3.2.2 Efficiency in Fee Collection

Some factors that may improve and limit the efficiency in fee collection were identified by various demonstration partners throughout the demonstration. According to the SM providers, the use of in-vehicle telematics and mileage tracking may make fee collection efficient while technology changes and third-party dependency may limit their ability to comply with DBF requirements. Similarly, the DOR believes there are several factors such as the use of incentives, online filing, adjusting fee collection schedule based on level of implementation, and the use of existing taxpayer information may contribute to a more efficient fee collection. TAC members also suggested ways to improve efficiency in DBF collection including self-reporting and leveraging the existing technologies among others.

From the SM providers' perspective, there are two factors in their business that may contribute to the efficiency in fee collection. First, is the use of in-vehicle telematics. According to one of the SM providers, leveraging in-vehicle telematics rather than after-market technologies makes the data collection process seamless and keeps the administrative and overhead costs low. Second, is the disclosure of total VMT in trip invoices. One SM provider believes that their current practice of disclosing this information in the customers' trip invoice could ease the communications with customers regarding the collection of a fee for the miles driven.

SM providers also highlighted changes in technology and software and third-party dependency as factors that may limit their ability to comply with a DBF system, especially initially. SM providers are likely to experience technology transitions often as the technology adapts and changes. These changes may affect the existing processes and increase personnel time required to comply with DBFs. Similarly, third party dependency may limit SM providers' ability to comply with DBF requirements. For instance, if a technology transition results in a need for adjustments (such as in the billing system), the SM provider may depend on the software provider to make the necessary adjustments.

Other factors that may improve the efficiency in fee collection are identified from conversations with the DOR. These include having a licensing process with an incentive, having legislation requiring online filling, adjusting the fee collection schedule according to the scale of implementation, and using the existing taxpayer information.

First, having a licensing process with an incentive to any intermediary collecting organizations to enroll in the DBF system and contribute to the enforcement of the system. Under the motor fuel tax system, if a fuel distributor wants to purchase fuel tax-free in the state of Minnesota, it has to go through a licensing process.[67] This license allows the distributor to self-report the tax. If a distributor does not have a license, its supplier is required to charge the distributor tax up-front on the load, and the supplier pays the tax to the State. One of the benefits of having a fuel license for the fuel distributor is that the license gives cash-flow to the distributor,[68] which allows them to acquire the fuel, sell the fuel, get paid for the fuel, all before the distributor has to pay the fuel tax.[69] Currently, SM providers are subject to a license to operate within certain areas. Such a license could also be used as a collector's license and be linked to an incentive for SM providers to enroll in a DBF system. Otherwise, it would be better for them to continue paying the fuel tax at the pump.

Second, having legislation requiring online filing to fulfill state filing requirements may improve the efficiency of fee collection. Under a DBF system at the SM provider level, the DOR anticipates the fee collection schedule to be similar to the current fuel tax collection system, filed electronically on a monthly basis to fulfill federal filing requirements as well as a state law.[70] Therefore, a similar legislation requiring online filing would be needed in a future DBF program. The Department believes any refunds owed by the state to DBF-payer would be electronically deposited in the taxpayer's account in approximately 10 days after the tax return is processed. However, if the DBF charged for the miles driven exceeds the paid fuel tax, the difference would be due by DBF-payer on the same day the report is due.

Third, adjusting the fee collection schedule according to the scale of implementation may lead to a more efficient fee collection process. Under a DBF system at the SM provider level, the DOR anticipates a fee collection made on a monthly basis, similar to the current motor fuel tax system. However, under a DBF system at the individual level, according to the DOR, a less frequent schedule such as a quarterly or annual tax collection would be more feasible and less costly due to the large number of DBF-payers in the system.

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[67] The distributor should complete and submit a license application and pay a $25 application fee. Licenses must be renewed annually. Potential distributors must meet all requirements for a license in M.S.296A.03.
[68] A second benefit is that the distributor receives an allowance for evaporation. This is a deduction of 2.5 percent of the quantity of gasoline on which tax is due (Minn. Stat. § 296A.15, Subd.1 [c]) and a deduction of one percent of the quantity of special fuel on which tax is due (Minn. Stat. § 296A.15, Subd.3 [f]).
[69] For example, if the distributor purchases 10,000 gallons on the first of June, the tax is due on July 23.
[70] The state law requires taxpayers to file and pay fuel tax returns electronically.

Fourth, using the existing taxpayer information across different state agencies may simplify the fee collection process in a DBF system. If implemented at the SM provider level, the collecting agency would require information from another state agency regarding the vehicles that compose the SM provider's fleet to ensure all vehicles are accounted for in the revenue report. If implemented at the individual level, most DBF-payers likely already exist in the State's tax system if they pay individual income tax.

Similarly, SM providers and TAC members believe efficiency in fee collection to be improved with the approaches used to capture DBF information. These approaches include using a self-reporting approach through a smartphone application or an odometer reading; using a prepaid system approach; and leveraging existing technologies such as in-vehicle telematics and the toll technology. The DOR also believes that a DBF system at the individual level can be simplified by leveraging a self-reporting approach such as the use of a smartphone application.

5.3.2.3 Integration with other Charges

DBF charges could be integrated with the payment of other taxes, fees, or payments, users are subject to in order to increase efficiency in fee collection and reduce the costs of administering a DBF system. SM providers and TAC members brought up several considerations for integrating DBF with other charges.

SM providers believe they could incorporate the payment of a DBF into other tax payments. According to one of the providers, making the payment would not be difficult, but calculating it would require more rigorous standards of accounting. Although the provider did not elaborate on this, it is important to consider in a future DBF program as it may increase costs due to the need for more advanced software or hiring additional staff to manage such payments. According to the provider, they would be able to do this once they have the proper tools in place to easily access and export the data in their software system. Depending on the fleet ownership model, such integration with other tax payments may require coordination with parent companies.

TAC members also suggested other possibilities of integrating a DBF with other taxes as well as allowing payment plans. First, including a self-reporting method integrated with the license renewal that could be verified regularly (annually or once every three or five years) to minimize fraud. Second, having an annual DBF payment at the time of vehicle registration or allowing payment plans. Third, integrating DBF payments with vehicle insurance payments every six months. Fourth, verification of total miles traveled at the time of vehicle purchase/sale.

5.3.2.4 Efficiency in Fee Auditability

[This demonstration presented an approach to implement DBFs that benefits efficiency in fee auditability. Overall, the 'mock' audit conducted in this demonstration benefited from the small number of DBF-payers as the auditor audited two SM providers rather than more than 3,000 individual users of these SM services. From DOR's perspective, the enforcement, compliance, and audit processes of a DBF system at the SM provider level would be similar to those of the current motor fuel tax due to a smaller number of taxpayers. However, the complexity of the processes is expected to increase as the number of DBF-payers increases. From the SM providers' perspective, the audit requirements of a DBF system at the SM provider level may pose some challenges to the providers' operation

According to the DOR, auditing motor fuel taxpayers is important for two reasons. First, the fee can add up to a substantial amount of revenue. The Department is concerned that if a taxpayer files bankruptcy, the state may not be able to collect the fee. Second, the Department has a reporting cutoff and therefore, wants to report the most accurate information to MnDOT, so that it can report to the Federal Highway Administration in a timely manner. Currently, the DOR audits all of its motor fuel taxpayers, but cannot anticipate what percentage of taxpayers would be audited under a DBF system.

The DOR believes that administrative and civil penalties may contribute to improving compliance and enforcement under a DBF system. Currently, non-compliance under the motor fuel tax involves administrative and civil penalties. Taxpayers with balance on their account within a certain number of days past the due date can be referred to the collections department's license clearing program, which can ultimately result in revocation of any state licenses.[71] According to the DOR, under a DBF system at the SM provider level, this mechanism would provide a greater incentive for compliance as certain SM providers are required to have a motor vehicle dealer's license in the state of Minnesota to engage in the short-term rental of vehicles. If a SM provider was late on their DBF payment and ended up in license clearance, their ability to operate would be compromised if their dealer's license was revoked.

Similarly, substantial late payment penalties can improve compliance and enforcement of a DBF system. As with the current motor fuel tax, late payment in a DBF system could be subject to financial penalties to ensure compliance and enforcement. While late payment fee under the current fuel tax system is one percent, this amount could be higher under a DBF system. This is particularly important if a DBF is built to be revenue neutral as the difference between what is paid in fuel tax and amount owed in DBF will likely be small and would make a small penalty inconsequential. According to the DOR, substantial late payment penalties would be especially important if a DBF is implemented at an individual level to ensure compliance.

From the SM providers' perspective, under a DBF system at the SM provider level, the audit requirements may pose some challenges to SM providers' operations. According to one of the SM providers, audit requirements could affect their ability to balance fulfilling those requirements with other high priority operational activities. The SM provider believes that during the demonstration, one of the biggest challenges for them was to ensure data anomalies were explainable to WSP. According to the provider, if a provider tracks mileage of company vehicles to prevent employee fraud or abuse, it may not take mileage collection very seriously if employees are trusted. On the other hand, under a DBF system it would need to address mileage reporting issues more urgently for audit purposes.

[71] Another new state statute also enables suspension and ultimately revoking of fuel license for a taxpayer that is late in remittance of fuel tax.

5.3.3 Equity

This criterion will assess equity from two perspectives: The benefit-received principle and the ability-to-pay principle. The benefit-received principle posits that only individuals who receive benefits from a public service pay for it and the payment should equal to the benefit share. The ability-to-pay principle assesses whether the fee burden is fairly distributed across people with different abilities with pay (Zhao J. Z., Guo, Coyle, & Munnich, 2015). Since a DBF is a payment for the use of the transportation system (a user fee), it is important to assess how closely it adheres to the benefits received principle. While this criterion is difficult to assess based on the current demonstration, the equity implications of DBFs should be considered for its future implementation.

Overall, demonstration partners believe that a DBF system adheres to the benefit-received principle since a system based on miles traveled would more accurately reflect the use of the roadway infrastructure. However, there are some concerns regarding the ability-to-pay principle. Various equity considerations including equity perceptions, social, modal, and geographical equity considerations were brought by different demonstration partners and attendees of roundtable events throughout the demonstration.

5.3.3.1 Equity Perceptions

SM providers shared their perceptions about equity implications of a DBF program implemented at the SM provider level. The SM providers believe if a DBF is implemented at the SM provider level, it would be inequitable to them due to increased costs and the fact that their services have societal benefits. They also brought up the potential for increased inequity if a DBF is implemented on fleet owners only.

Overall, SM providers believe a DBF system would be fair if implemented to all drivers. According to the SM providers, if a DBF is implemented at the SM provider level only, it would be inequitable to them due to increased costs. One SM provider, in particular, believes shifting the burden of collecting the fee to them would increase their operating costs and affect their ability to remain competitive in the transportation market. Similarly, the other provider believes a DBF would be fair if they are given the opportunity to build the fee into their business models. The provider is concerned if there is legislation in the future that prohibits passing the fee to their customers. According to them, this would be unfair to them as it would affect their business sustainability.

Similarly, the SM providers believe if a DBF is implemented on fleet owners it would be inequitable to SM providers that own their vehicles. According to the providers, under such an approach, SM providers who do not own their fleet will not be subject to paying the DBF. Such an implementation would dramatically tip the scales in favor of personal vehicle ownership affecting the overall business model of SM providers that own their fleet and their ability to operate. Considering Transportation Network Companies (TNCs) as an example,[72] the providers believe arguments can be made in favor or against

[72] TNCs vehicles are personally owned vehicles and are not required to be registered as SM vehicles.

implementing a fee on them. For instance, one can make the argument that it is unfair to pass a DBF on to a TNC driver, as the driver is facilitating the trip on behalf of the TNC. Conversely, one can also rationalize that the TNC driver is choosing to be in the system and therefore, should be responsible for the DBF.

Similarly, the SM providers believe implementing a DBF only on SM providers would be unfair as their trips provide benefits to the community and are more environmentally friendly. First, shared mobility trips are often purpose-driven trips as their customers use their services for very necessary trips and engage in trip-chaining activities rather than making many single-purpose trips. According to the SM providers, their customers drive fewer miles when they use SM services compared to before using them. Second, SM trips can help reduce congestion due to their higher average vehicle occupancy. Third, SM services allow people to make sustainable transportation choices such as walking, biking, or using transit services. According to them, a high percentage of their customers use transit regularly.

5.3.3.2 Social Equity

SM providers and TAC members expressed concerns about the potential impacts of DBFs on low-income people, those who drive for a living, those with disabilities, those with no access to alternatives to driving, and unbanked people. To address these concerns, TAC members suggested variable rates based on various socioeconomic factors as well as trip characteristics. In addition, TAC members believe better alternatives to driving should be improved and transportation revenues should be allocated differently under a DBF system to address potential social inequities of a DBF.

SM providers and TAC members believe low-income users would be disproportionately impacted by a DBF. According to them, given the spatial mismatch between low-wage jobs and affordable housing and services, low-income people usually have to drive more and farther to get to work and essential services such as groceries and doctor appointments and thus would be more affected by a DBF system. In addition, TAC members noted that it would be easier for higher-income individuals to adapt to a new fee system as they are better resourced to adapt to change.

TAC members also mentioned other groups that will likely be disproportionately impacted by the implementation of a DBF system. This includes those with disabilities; those who drive for a living -like TNC drivers-, and who are more likely to be low-income; and those who do not have alternatives to driving, such as access to public transit. Lastly, TAC members also noted that a DBF system that requires the user to have a bank account will be inequitable for unbanked people.

TAC members believe a variable rate structure could potentially address social equity concerns associated with DBFs. Fees could be adjusted based on income, type of vehicle, commercial use, trip purpose, time of day, and trip length as well as based on a combination of income level and commute distance in order to address the spatial mismatch between low-wage jobs and affordable housing and services. Additionally, policies outside of the rate structure could address social equity concerns. These include subsidies for low-income individuals to help them better adapt to a DBF (for instance, funds to purchase an EV), rebates, tax credits, and tax changes. TAC members suggest these subsidies could be funded through a surcharge on a DBF, a surcharge on vehicle registration, or from DBF revenues. Similarly, shared mobility providers think they could reduce some of the social inequities of a flat-rate DBF by charging less per mile for qualified low-income customers and by passing those costs along to those with more ability to pay.

TAC members also suggested providing better alternatives to driving as a way to address potential inequities of a DBF. These include improving public transit, active transportation (walking and bicycling), and access to ride-sharing and car-sharing for both the general public and certain populations (e.g. low-income people and people with disabilities). Additionally, they suggested allocating transportation revenues differently under a DBF system such as to public transit and active transportation modes in order to improve transportation access for low-income people and those with disabilities.

5.3.3.3 Modal Equity

Demonstration partners believe that a system based on miles traveled would more accurately reflect the use of the roadway infrastructure, however, there are some concerns regarding the modal equity impacts of DBFs. The SM providers and TAC members expressed concerns about the potential negative impacts of a DBF on the adoption of electric and more fuel-efficient vehicles and suggested variable rates based on vehicle contribution to pollution, weight, noise level and safety, innovation, and evidence of damage caused to the road to address these concerns. In addition, TAC members and participants of the roundtable events commented on the non-inclusion of commercial vehicles and heavy trucks in this demonstration and expressed interest in seeing DBFs applied to these vehicles.

Although SM providers and TAC members believe that a system based on miles traveled would more accurately reflect the use of the roadway infrastructure, they expressed some concerns about DBFs discouraging the adoption of electric and more fuel-efficient vehicles. While EVs do have societal benefits in terms of reduced emissions, they are still a car on the road contributing to road damage and congestion. However, under a DBF system, hybrid and electric vehicles will pay more than they currently do under the motor fuel tax system, which could discourage their adoption. Furthermore, DBFs could be particularly discouraging for providers and individuals who are consciously moving away from fossil fuels to electric vehicles powered through renewable sources.

Providers and TAC members believe this concern could be addressed through the DBF rate. According to TAC members, this could potentially be avoided if vehicles that pollute less pay lower fees, or if ICE vehicles contribute more in DBFs than EVs to account for environmental costs. Similarly, a SM provider noted that packaging a DBF with a broad-scale EV adoption program might be appealing to people. For example, an EV purchase assistance program combined with the benefit of lower DBF rates for EVs (compared to ICE vehicles) might be better received by the public.

TAC members and participants of the roundtable events commented on the exclusion of commercial vehicles and heavy trucks in this demonstration. Prior to launching the demonstration, TAC members noted that the model used in the demonstration seems to favor heavy vehicles and less fuel-efficient vehicles, which cause a higher road damage than a compact car (typically used by SM providers).

Similarly, some participants of the roundtable events expressed interest in seeing DBFs applied to commercial vehicles and heavy trucks. According to one of them, these vehicles disproportionately affect roads, in particular rural roads and municipal streets, and suggested a sliding scale for DBFs over these routes.

In addition, TAC members believe that vehicle weight should be considered in the design of a DBF rate to account for their contribution to road damage. Several categorizations could be used to account for vehicle weight,[73] including distribution of weight across axles. According to TAC members, this could be the most fair and useful approach to categorize vehicles in the design of a DBF rate. Similarly, some TAC members suggested exemption of public transit from a DBF to keep costs lower for under-resourced riders in addition to tailored rates based on vehicle weight distributed across axles.

TAC members also suggested other methods and categories for consideration in a DBF rate design. These include vehicle capacity to operate safely and peacefully in a neighborhood, innovation, and evidence of damage caused to the road. According to them, categorization based on safety and noise level would account for the impact of light duty vehicles and minimize operation of vehicles that generate noise and interfere with pedestrian activities in neighborhoods. They also believe the commercial sector should not be overtaxed if they are transitioning to driverless or more fuel-efficient vehicles and categories should be based on evidence of the damage caused to roads by different types of vehicles.

Overall, TAC members generally think road damage is the main cost to be considered in the design of a DBF, followed by environmental costs. One TAC member highlighted that wear and tear on the roads and environmental impacts of driving are the characteristics most easily understood by the public and would be most effective in guiding driving behavior and travel choice.

5.3.3.4 Geographical Equity

Regarding geographical equity, TAC members were divided between those who believe DBFs have the potential to become equitable and those who believe a DBF system would generate rural/urban inequities. To address rural/urban inequities, TAC members suggested including adjustments such as congestion pricing to the DBF rate structure and charging a fee based on vehicle type.

Half of the TAC members felt that DBFs have the potential to become equitable. While people in rural areas drive longer to get to their destinations, a gallon of gas gets farther in rural areas than in urban areas. In addition, rural drivers currently purchase more fuel and pay more fuel tax due to their long travel distances and the use of more fuel-inefficient vehicles, but in a DBF system that difference should even out. One of the TAC members felt that the focus should be on whether there are inequities in the

[73] Vehicle weight can be categorized in several ways included, but not limited to: (i) Two categories such as light- and heavy-duty vehicles. (ii) Several categories according to vehicle type such as sedans, SUVs, pickups, vans, light-duty trucks, buses, single units, axle semis, and twin trailer semi (as included in the MnDOT Vehicle Classification Scheme). (iii) Lastly, as the distribution of weight across axles.

current system that can be ameliorated through a DBF system as well as ways to recover costs of the system by users.[74]

On the other hand, half of the TAC members felt there will be rural/urban inequities in a DBF due to greater travel distance in rural areas, regional income disparities, and fewer travel mode choices in rural areas. People in these areas travel longer distances to access basic needs such as medical, food, and other basic human services and therefore would be more affected by a DBF system. In addition, it was noted that there may be inequities based on regional income disparities. In particular, if in the future there will be significant variations in vehicle fuel efficiency based on vehicle cost, where more expensive vehicles are more efficient, then regional income variability could become an equity issue with regards to a DBF. If regional incomes vary significantly across the state, lower-income individuals are likely limited in their purchasing power, which may result in purchasing less efficient vehicles that cost more to operate.

TAC members suggested adjusting the DBF rate structure to account for rural/urban equity concerns. Suggested adjustments to the rate structure include incorporating congestion pricing and charging a fee based on vehicle type. According to a TAC member, incorporating time of day and location into the rate would increase the tax equity for road payment as users would pay a rate closely tied to the public cost of the service they are using. Another TAC member believes that if the status quo is retained, rural drivers will continue paying more because they drive more. However, if a DBF incorporates congestion pricing, urban drivers will pay more.

5.3.4 Adequacy

This evaluation criterion assesses whether DBFs can raise adequate funding for the transportation system. The adequacy of a DBF is assessed through its ability of DBFs to raise the same amount of revenue that is raised through the motor fuel tax and its potential to keep up with transportation costs. Overall, demonstration partners believe DBF revenue neutrality depends on the pricing structure and the ability of DBF revenues to cover roadway expenditures, while the potential to keep up with transportation costs depends on whether the DBF rate is increased regularly, either through periodic rate adjustments or indexing.

5.3.4.1 DBF Revenue Neutrality

Based on comments from TAC members, the ability of DBFs to raise the same amount of revenue that is raised through the motor fuel tax depends on the pricing structure and the ability of DBF revenues to cover roadway expenditures.

[74] We interpret this as costs imposed by users on the roadway system.

First, DBF revenue adequacy depends on the price users and drivers pay for the miles they travel. According to some TAC members, it is crucial to evaluate the impact of prices on transportation behavior as high rates might incentivize people to decrease their vehicle travel.

Second, DBF revenue adequacy depends on the ability of DBF revenues to cover roadway expenditures. Some argue that if the revenue from a DBF is not constitutionally dedicated to the Highway Users Tax Distribution (HUTD) fund, the overall amount of money spent on the roadway system could decline. Others argue that DBF revenues might be more adequate if spending was not focused on the continual expansion of the highway system, but rather on investments in transit, multimodal transportation, and other alternative transportation modes.

5.3.4.2 Potential of DBFs to Keep up with Transportation Costs

Common reasons cited for the low revenue adequacy of the motor fuel tax may also apply to DBFs, particularly the loss of purchasing power due to inflation and the fact that the motor fuel tax has remained constant for the last decade. DBFs have the potential to keep up with transportation costs if the DBF rate is increased regularly, either through periodic rate adjustments or indexing. If DBF rates are set without an adjustment factor, transportation agencies will ultimately run into the same issue they are currently experiencing with the motor fuel tax. Another limitation of the potential of DBFs to keep up with transportation costs is its reliance on people driving more miles, which opposes the climate change mitigation strategy of VMT reduction.

5.3.5 Future Considerations

Data collected from demonstration partners during the twelve-month period provided important considerations for future implementation of a Distance-Based Fee system or additional demonstrations or pilot programs in Minnesota. Several demonstration partners and stakeholders brought up administrative considerations, public outreach and communication strategies, privacy and data management considerations, and scalability and transferability of DBFs to be taken into account in a future DBF program or pilot. In addition, they provided several suggestions that could help to address such concerns. Lastly, they suggested several scenarios for future DBF demonstrations or pilot programs.

5.3.5.1 Administrative Considerations

Demonstration partners brought up several administrative considerations that need to be taken into account in a future DBF program. These include reducing administrative costs, handling out-of-state miles, handling out-of-state fuel purchases, and addressing additional burden for DBF intermediary collecting organizations. To address these concerns, they provided several suggestions.

Reducing Administrative Costs

Several demonstration partners were concerned about high DBF administrative costs and considered addressing this crucial for an implementation of a DBF system. Considering the experiences of other states with regards to high DBF administrative costs, TAC members provided several suggestions about ways to reduce administrative costs. Some suggestions are related to mileage reporting methods, including using a self-reporting system, using a prepaid system, and using existing technology (such as toll technology). Other suggestions include implementing a simple DBF system that uses a less complicated fee stratification and integrating DBFs with other systems such as vehicle registration or vehicle insurance payments. In addition, most TAC members believe administrative costs should be considered within the DBF rate to ensure system maintenance and efficiency.

Handling Out-of-State Miles

Several demonstration partners were concerned about how out-of-state miles would be handled in a future DBF implementation. For instance, the DOR raised two issues regarding out-of-state driving. First, whether and how to track out-of-state drivers driving on Minnesota's roads. Second, what to do with respect to drivers who purchase fuel in the state of Minnesota and then drive out-of-state. TAC members also had suggestions on this issue. TAC suggestions on handling out-of-state miles varied from not levying a fee on them to charging a fee in the state where the driving occurs or where the vehicle is registered. Overall, TAC respondents acknowledged the difficulty of handling out-of-state miles in the absence of a national system.

Handling Out-of-State Fuel Purchases

During the demonstration, out-of-state fuel purchase transactions were not considered in the revenue report as recommended by the DOR. The DOR could credit fuel tax only on fuel purchases made in the state of Minnesota with a receipt that supports the transaction.

WSP recommended various ways to handle out-of-state fuel purchases in a future DBF system. First, the agency in charge of crediting the fuel tax could assume or estimate fuels traveled for any missing fuel purchases based on the miles that were traveled. Second, the agency in charge of crediting the fuel tax could assume fuel purchase based on average fuel purchase from that vehicle. Third, the agency in charge of crediting the fuel tax could simply omit out-of-state fuel purchases, as it is on the company to go after that credit.

Addressing Additional Burden for DBF Intermediary Collecting Organizations

During the demonstrations, several partners expressed concerns about the additional burden borne by DBF intermediary collecting organizations. DBF intermediary collecting organizations are those organizations that collect the DBF charge from their customers or users and report to the state agency. In this demonstration, SM providers acted as such organizations and brought up three factors that need to be clarified before implementing a DBF system, especially if it is implemented at the SM provider.

First, clarity about the level of detail in the data required for a DBF system. According to the providers, the responsibility for protecting personal data becomes greater if more detailed data -such as trip destination or route, vehicle occupancy, or lane location- is collected for a variable DBF rate. While detailed data would allow thorough and detailed reporting and analysis of user activity and behavior and may allow a more precise DBF rate, the more it is shared, the higher the risk of a data breach.

Second, clarity about whether intermediary organizations will be allowed to pass on DBF costs to customers. Costs to pass to customers include the DBF charge itself as well as a fee for administering a DBF on behalf of the customer. According to one SM provider, the State of New York, for instance, has a very restrictive philosophy on what fees must be paid by the fleet owner and what can be passed on to customers.

Lastly, they questioned the fairness of shifting the burden of revenue collection from fuel providers to intermediary organizations without compensation. SM providers highlight the creation of opportunities and incentives for early adopters of DBFs and suggest compensation strategies such as the exemption from the fuel tax, or tax breaks on other taxes these organizations are subject to.

5.3.5.2 Public Outreach and Communications Strategies for DBFs

Throughout the demonstration, several demonstration partners and participants of roundtable events discussed the importance of public outreach and communications.

First, to continue with the engagement of key stakeholders to ensure their voices are represented on the table and to understand their concerns. Engaging key stakeholders would likely contribute to getting them comfortable with the purposes of a DBF system, identifying concerns that have not been identified before, and informing solutions to address their concerns. Key stakeholders include state agencies in charge of the administration of DBFs, intermediary organizations, and the general public.

Second, to develop communication tools accessible to the general public. According to demonstration partners and participants of roundtable events, these communications tools would be important to explain the individual and public benefits of collecting a DBF to the general public, explain to DBF-payers the types and the purposes of the data that will be collected under the DBF system, and educate DBF-payers and ensure their compliance with the DBF system.

Third, to include general provisions in any new legislation and complement it with specific rules and regulations. Legislations are hard to change, while rules and regulations allow the administering agency to make updates as necessary. This regulatory arrangement may allow the creation of an engagement and feedback loop, while taking public opinion into account and allowing the DBF system to evolve.

5.3.5.3 Privacy Considerations

Public privacy concerns were brought up by different demonstration partners. Issues related to public acceptance of personal data being shared with the government, compliance with privacy laws as well as tax laws, the additional privacy burden placed on collecting organizations, and public acceptance and trust are issues to be addressed in a future DBF implementation.

TAC members and SM providers brought up concerns related to the sharing of personal data with the government for DBF purposes. From the SM provider's perspective, shared mobility customers feel more negatively about sharing their data with the government, rather than with the private sector. Similarly, TAC members noted that individuals will be concerned about the collection of their personal information as well as the government potentially tracking that data. TAC members suggested using a third party to collect data, limiting the type of data collected, and having public outreach and communications as ways to address privacy concerns in the implementation of a DBF system.

First, bringing a third party to collect data may address some privacy concerns. These concerns may not be entirely addressed as there is some risk for the data to be leaked or attacked by other parties. Overall, private companies are already tracking some data and have practices in place to protect it. SM providers, for instance, generally have details regarding how and when customer data is used in their privacy policies and are subject to laws and regulations regarding the maintenance of that data.[75] Generally, there is a balance to be struck between data maintenance requirements for tax purposes and customer's needs for security and privacy. For example, if there is a tax record associated with SM customer data, such as under a DBF, it is unclear how a scenario where regulation requires data purging upon customer request, would be handled. The TAC suggested limiting data collection for tax collection purposes only, as well as separating personal and financial information from trip data before forwarding it to the tax collecting authority and deleting the original data immediately after the mileage fee is determined as methods for protecting personal privacy. In addition, governments could also set standards or laws for data generation and reporting as well as audit third parties for compliance.

Second, limiting the type of data collected could address some of the privacy concerns in a DBF system. This includes collecting only mileage data or odometer readings rather than trip location or occupancy data, limiting data collection to general geographic areas (metro, non-metro, and out-of-state), de-personalizing and aggregating collected data rather than individual data, and using an intermediary system such as a second system in the vehicle or a cell phone application to capture and transmit DBF data to the government. However, it is worth noting that limiting data collection to only mileage or odometer readings in an effort to protect privacy constrains the ability to implement a variable DBF rate.

Third, public outreach and communications to address public concern and distrust of a DBF system. It is important to communicate the types and purposes of the data being collected as well as the individual and public benefits of a DBF system. In addition, publicly communicated standards for data security can also help build public trust.

[75] For instance, providers in California are subject to the California Consumer Protection Act (CCPA) that requires companies to purge customer's personal data if the customer requests.

5.3.5.4 Scalability and Transferability

Several demonstration partners brought up factors related to the scalability and transferability of a DBF system that could be considered in a future implementation. These include the ease of implementing a DBF on C/AVs, collecting detailed trip data for variable DBF rates, costs of developing a data systems management plan, and the design of a DBF rate to address equity concerns.

Using C/AVs to Administer a DBF system

Connected and automated vehicles are likely one of the easier vehicle types on which a DBF can be implemented. These vehicles already contain many of the necessary components to collect and report mileage and other data needed for a DBF such as GPS, inertia sensors, modems, and connections to vehicle sensors. Due to this pre-existing equipment, the capital cost of implementing a DBF with these vehicles would likely be very low. However, there would be a logistical burden to collect, record, manage, and upload data, which is likely to decrease over time as the processes are automated.

The C/AV provider anticipates the need for certain kinds of agency requirements to certify and validate technologies if a DBF system is implemented through C/AVs. According to the provider, each vehicle and the software system used to record trips will need to contain checks to ensure every component is working correctly throughout the vehicle's operation. The C/AV provider or a similar company can provide expertise for independent validation or certification for this.

The type of data generated by the C/AV provider for this DBF demonstration could be used for several purposes if a DBF system is implemented in the future. In addition to the DBF purposes, private parties and government agencies, for instance, could use aggregated data from many different C/AVs to improve the transportation system such as by managing traffic flow, verifying carpooling, and optimizing transit or ride-sourcing services.

Data Management

There are several elements and additional costs to take into consideration when developing the requirements for a Data Systems Management plan in a future DBF system. According to the Data Repository Provider, the management of the data repository under a future DBF system would have to be scalable because there may be thousands of users. However, they believe that the process could become more automated in the future, with vehicles automatically uploading data to the repository and without the need for users to have their own accounts.

Additionally, the Data Repository Provider believes additional staff will be needed under a C/AV fleet-based deployment of a DBF. According to them, there would have to be some staff in charge of ensuring data logging is happening correctly that is managing the data plans and internet connectivity for all vehicles in the fleet, monitoring for internet outages that could cause data loss, and ensuring the functionality of in-vehicle technology. In addition, the provider anticipates the need for a security engineer who ensures adherence to safe data practices and monitors for vulnerabilities in the physical or digital processes. Similarly, data will need to be uploaded and deleted fast enough to avoid data storage from filling up. This is regardless of whether the data is stored locally at the vehicle or in the cloud. Overall, there would be personnel costs related to these activities as well as a cost associated with the data plan required for vehicles to connect to the internet and for the server space to store data.

DBF Rate Design

The design of the DBF rate could help address several equity concerns brought up by demonstration partners. Overall, while there are many potential approaches to design the DBF system, demonstration partners believe it might be better to start with a simple rate structure and add complexity later to address goals other than revenue generation (e.g., modal, social, and rural/urban equity adjustments). According to them a simple rate is clearer and easier for the public to understand and would contribute to the political and administrative feasibility of a DBF system.

Although there is no clear consensus on whether DBF rates should be flat or variable (or precise), more TAC members were leaning toward variable rates. Some TAC members think a flat rate would be regressive and would exacerbate existing inequities. Others believe variable rates will encourage the efficient use of the roadway system, will encourage development focused on mass transit, and will provide the DBF system with the capability to make adjustments. In particular, equity adjustments for low-income users in urban and rural areas, users with disabilities, and transportation disadvantaged groups.

Some TAC members and roundtable participants advocated for a variable pricing structure based on various factors. They suggested variable rates based on vehicle weight, damage to roads, pollution generated, and congestion pricing. While some roundtable participants advocated for a DBF charge as the society transitions from ICE vehicles to EVs, one participant warned against a fee structure that may penalize EVs.

Finally, TAC members believe implementing future DBF pilots with different pricing could serve as an opportunity to understand the “different levers” that impact people’s transportation choices and advance understanding of how a DBF system with variable rates could impact other transportation policy goals.

Collecting Additional Data for a Variable-Rate DBF

Implementing a variable-rate DBF structure could address issues of modal, social, and rural/urban equity, in addition to pricing transportation in a way that influences travel behavior to achieve policy goals. This project demonstrated the collection of vehicle occupancy, lane location, and trip destination and route as potential variables on which to base a DBF rate in the future.

Vehicle occupancy during a given trip could be used to determine a DBF rate. However, accurately collecting occupancy information is an anticipated challenge of this approach. During the demonstration, the C/AV provider conducted test trips with seat occupancy sensors installed in the vehicle, which were able to accurately capture occupancy information. However, more advances in seat sensor technology are required in order to accurately collect occupancy information under all circumstances. For example, a small child may not be detected by the sensor or a heavy bag could trigger the sensor. In-vehicle cameras could be an alternative potential solution for collecting occupancy data. However, future research will be needed to assess and address potential privacy concerns that may arise.

Lane location is another variable that could be used to determine the DBF rate. According to the C/AV provider, who conducted the HOV lane tests during the demonstration, the experiment could be transferable to other special use lanes such as dedicated EV lanes or C/AV lanes. Accurately matching GPS trip data up with these special-use lanes could be challenging if the GPS is not accurate enough. Additionally, out-of-date reference maps used to indicate vehicle lane location could pose a challenge and will need to be kept up-to-date as roads can change over time due to construction.

Trip destination and route could also be used to determine DBF rates. Destination and route data could be used to facilitate congestion pricing, cordon pricing, variable rates based on road type, and to identify out-of-state miles. While trip destination and route data are potentially very helpful in pricing travel, collecting them would create an additional burden for the intermediary/collecting organization in terms of operational costs as well as in the protection of PII.

Suggestions for Future Demonstrations or Pilot Projects

Several TAC members, shared mobility providers, and participants of roundtable events suggested several approaches for future demonstrations.

- *Consider other partners to act as the intermediary collector* - This may include original equipment manufacturers (OEMs) and car rental companies. According to the C/AV provider, any vehicles today, even non-automated ones, already come from the OEM with technology devices[76] required for a DBF system. However, there would be some work required to add the extra software process to collect and share data. Overall, the provider feels that once those systems are created it is very feasible to manage a DBF fleet or for consumer vehicles to be able to participate in a DBF system.
- *Consider other partners for a DBF pilot to levy DBF charges on other vehic*le *types* - This includes heavy vehicles and EV owners willing to swap out the standing EV fee for a DBF.
- *Consider engaging in a national or Midwest pilot* - A DBF system that can be used by all states may potentially create economies of scale including standards for in-vehicle technology installed and for transmitting data to revenue collecting agencies.

[76] This includes cameras and LTE modems (that utilize cellular data to connect to the internet).

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APPENDIX A: COMMUNICATIONS PLAN

Communications Plan for Policymakers

Situation. What is the environment in which the communications will take place?	Minnesota relies heavily on the gasoline excise tax to fund roads and bridges. Increasingly, vehicles are using less gasoline, because they use other energy sources and/or are more fuel-efficient. Therefore, many research projects around the nation, with the support of the federal government, are exploring the feasibility of charging based on the distance, or miles, traveled, rather than gasoline use. These Distance Based Fee (DBF) projects have predominantly been exploring application of DBFs to all types of vehicles. That model is showing promise, but it does face challenges related to public acceptance and administrative cost issues. Those challenges are making some policymakers reluctant to broadly implement such systems. With that backdrop, we also realize that vehicles are changing rapidly and how we use them. We are also becoming less reliant on gas to power our vehicles. Cars today are already coming factory equipped to securely communicate with the "cloud." That capacity allows us to think differently about how fees are collected, how administrative costs can be reduced, and how individual privacy can be protected. We believe the technology of tomorrow and the associated capacity to process electronic data is already embedded in car-share vehicles today. A DBF applied to car-share fleets, and in automated vehicles could mitigate some of those concerns. For instance, compared to using DBF with all vehicles, with this approach: 1) there are fewer payers, which limits tax collection costs; 2) there should be fewer technological installation and management challenges; and 3) the experience for fleet s may be mostly unchanged. Increasingly, newer vehicles will have built-in technology that can log distances. Therefore, those vehicles won't

	require major retrofitting or new equipment, as has been necessary with older vehicles. Vehicle market analysts say that large numbers of Americans may one day be taking advantage of car-share and automated vehicle options because of the reduced personal costs and added safety benefits. They expect that what is currently a relatively small share of the vehicle pool will be growing very significantly. Applying DBFs to car share fleets and automated vehicles has not been tested yet. There is much to learn about technological, policy, and public acceptance issues. That learning and the application of the technology and processes developed will be transferable to larger and larger sectors of transportation in the future. With funding from the federal government, a team led by the Minnesota Department of Transportation (MnDOT) will be operating a DBF demonstration project involving car share fleets and automated vehicles. The purpose of that demonstration will be to show how the car-share platform can be used as a model for future distance-based fee collections. Two car-share companies and an automated vehicle developer are cooperating with MnDOT on the project. This demonstration is focused on the vehicle fleet rather than customers/drivers/accounts. The demonstration project will be simulating revenue collection. As part of this demonstration, no money will be changing hands. The research will focus primarily on technical issues associated with DBF collection. The experience and public acceptance are also important considerations. If misunderstandings about the DBF demonstration project were to grow widespread, they could make it difficult for the demonstration project to be started and/or completed,

	which would limit important learning about this alternative transportation financing option. If misunderstandings about the project grow widespread, they could cause policymakers to not give fair consideration to the findings of the demonstration project. It is important for the public and decision-makers to know that the vision is not transformational, but rather it is a measured and incremental migration away from the current model of reliance on the motor fuel tax. In the mean-time, the motor fuel tax will likely remain in place.
Goal: What do we want to happen as a result of the delivery of these messages?	Ensure the new DBF demonstration project is clearly and accurately understood by key audiences so that: 1) the project can be completed efficiently; 2) misunderstandings can be minimized, and 3) the learning process about the potential for future use of DBFs progresses.
Target Audience. Who do we most need to persuade in order to achieve our goal?	**Primary Audience**. Minnesota state and local policymakers, particularly those in an institutional position to shape transportation policies. • Rationale: These are the people who will ultimately decide whether this approach should be further explored or implemented. The demonstration project findings will inform their decision, so they need accurate and complete information. **Secondary Audience**. Those policymakers' key influencers, such as other policymakers, reporters, activist citizens, and lobbyists. • Rationale: In a democracy, policymakers have to pay attention to what others think. These are some of representatives tend to listen to the most. *Note: Separate communications plans will be developed that are aimed two other target audiences: 1) Car-share fleet customers/users and 2) National stakeholders and observers.

Key Messengers. Who does the target audience find most credible for delivering our key messages?	In no particular order: • MnDOT spokespeople (for media relations): Jeanne Aamodt or designee. • MnDOT DBF expert: Ken Buckeye or designee. • MnDOT government relations staff: Erik Rudeen or Serge Phillips. • University of Minnesota Humphrey School experts: Frank Douma, Lee Munnich and Zhirong Zhao. • (When/if available) State Legislature legislative champion(s) from each party.
Key Messages. What will we repeat and stress in all our communications to achieve our goal. (Note that these are general ideas that will be phrased differently by various messengers, and are not intended to be used as verbatim scripts.)	**WE HAVE A PROBLEM TO FIX**. We are reliant on gasoline tax revenues to maintain roads and bridges. Because vehicles are increasingly use less or no gas, a gas tax alternative will be needed in the future so our roads and bridges don't become underfunded, inadequate, and unsafe. • Motor vehicles today get two or three times the gas mileage of those in the 1970s. • The public is driving more but paying less for gasoline • We are seeing gas tax revenue flattening already, and that problem will become more acute in the future. • Increasingly, electric and other alternative fueled vehicles will become a more significant part of the fleet. **DISTANCE-BASED FEES COULD BE THE FIX**. As newer vehicles use significantly less gasoline or no gasoline, a distance-based fee is one potential way to ensure everyone is paying their fair share for the cost of roads and bridges. Therefore, we need to learn more about the feasibility of this approach. **CAR-SHARING COMPANIES AND AUTOMATED VEHICLES PRESENT A UNIQUE OPPORTUNITY**. Car-sharing and automated vehicles and fleets present a unique opportunity for using distance-based fees. First, more Americans will be using these options in the future. Second, compared to a system focused on all vehicles, distance-based fees focused on car share fleets have the

<table>
<tr><td></td><td>potential to be easier to collect and manage when charged via the car-sharing companies.

• On-board and embedded technology will help to ensure user privacy and data security.
• Evasion can be reduced or eliminated.
• Reconciliation of fees will be managed to ensure that users are not double charged for use of the road.

PROJECT WILL HELP US LEARN WHAT DOES AND DOESN'T WORK. This demonstration project will help us learn the extent to which the DBF approach applied to car-sharing fleets and automated vehicles is practical and feasible, and how best to structure it if it were used in the future.

SIMULATION ONLY — NO MONEY CHANGING HANDS. During this demonstration project, fleet users likely will notice little to no difference in their experience. No money will change hands. No additional actions by users will be required. This is a limited simulation that is using electronic “play money" for learning purposes only.

WE'LL BE TRANSPARENT. We're committed to being transparent about this pilot project and our findings. We'll be doing regular public updating events during the project. Among other things, we expect to learn about technical issues for both the government and companies. We'll have a final report available to anyone who is interested, and will be sharing those learnings with interested parties nationally and locally.</td></tr>
<tr><td>Challenging Questions. What are some of the primary challenging questions we should expect?

(Unlike key messages, these aren't issues we will repeat and</td><td>• How will privacy be protected?
• Is this a new tax added on to the gas tax?
• Is this a backdoor way to raise taxes? Will you guarantee it won't raise taxes?
• Shouldn't this raise more than the gas tax, since studies show we have huge unmet needs with the current gas tax rate?
• Why not raise the gas tax instead of this?
• Why not let other states take the lead?
• Why focus on such a small niche market?</td></tr>
</table>

stress in our communications. But we should be prepared to be responsive to them.)	• How can you assure the technology will work? After all the state didn't do too well with MNLARS? • Will this cost more to administer than the gas tax? How much more? • Will this be punitive for rural drivers, whose circumstances force them to drive more miles than urban drivers? • Will this be fair for low-income people? • What is this project costing taxpayers? • Doesn't a demonstration project just start a slippery slope that inevitably leads implementation? • Shouldn't there be a variable rate to incent clean fuels, manage rush hour traffic, and/or incent carpooling? • Shouldn't the rate be based on income, or ability to pay? • Should there be a variable rate for larger vehicles that take a larger toll on roads and bridges?
Tone. What should the audiences *sense about us* whey they hear us deliver the key messages?	The target audience will sense that we are: • Fact-based, not speculative. • Responsible, sensible planning for the next generation • Focused on rules for fleet operators, not individuals • Respectful, not disrespectful. • Explaining the approach, not cheerleading for it. • Exploring an alternative, not pushing anyone to do anything. • Learning, not just knowing. • Listening, not just telling. • Transparent, not secretive.
Strategies. What communications approaches do we need to use achieve the goal?	All documents and major decisions will be approved by MnDOT communications professionals. We will avoid the temptation to overload this plan. We will keep the list of tactics relatively short and doable, since we don't have resources to implement extensive communications, and we won't have a lot to say until findings are available.

	We will have basic information about project rationale and scope publicly available at the outset, but won't communicate more proactively until there are findings. If inquiries are made before the end of the project, we will answer as best we can and note that we will provide more information once the findings are available. Leave no question unanswered. We won't allow misinformation or misunderstandings to spread. We will strive to involve messengers from both major political parties, so the idea doesn't develop a one-sided partisan identity. We will use this plan as a guide, but won't be a slave to it. We will continually reassess the environment and add or remove tactics as needed.
Tactics. What specific actions will we take to most systematically deliver our key messages? (These can be viewed as a menu of options from which to choose. They should not be viewed as an all-or-nothing proposition.)	**<u>Phase I: Pre-launch (Now until April)</u>** **Communications Plan**. Finalize this communications plan so we are clear about which key messages to stress and how to stress them. Lead: Joe Loveland **Users Notified**. Car-share customers are advised about the project, if desired (their respective decision). Lead: Car-share companies **Website**. Establish a basic website that includes basic information about the project rationale and scope. Lead: Chris Berrens and webmaster **Challenging Question Document**. Using the Humphrey School's Issue Briefs, develop a "challenging questions and answers" internal briefing document to reach a project team consensus on some of the toughest questions we face. If public, policymaker or news media inquiries are fielded, this document will guide and inform the spokesperson's answers. Lead: Humphrey School team **First Round Table Event**. Hold a Round Table event for transportation finance stakeholders, partially focused on

	national DBF projects, but also giving an overview of the MN project. Lead: Humphrey School team **One-Pager**. Develop a simple one-pager for briefings in phase II. Lead: WSP/ MnDOT with the Humphrey School **Respond Only**. Don't seek interviews during this phase of the project. Only do interviews with leaders, the public or news reporters if they request them. Point to the website and Round Table Discussion to show that the project is public and no secretive. Provide the project one-pager. Lead: WSP/ MnDOT with the Humphrey School **<u>Phase II: Project Being Implemented</u>** **Legislative Briefings**. One-on-one or small group briefings of key legislators about the scope of the project. Promise to share results with the legislators when available. Lead: Frank Douma, Lee Munnich and MnDOT government relations lead. **Update Website**. Update website with project specifics as they develop. Lead: Chris Berrens with the webmaster **Respond Only**. Don't initiate publicity. Only do interviews with leaders, the public or news reporters if they request them. Point to the website and Round Table Discussion to show that the project is public and not secretive. Lead: MnDOT with HHH **<u>Phase III: Project Results Available</u>** **Draft and Distribute Report**. Draft a report that summarizes the results, with a succinct executive summary. Lead: WSP with HHH **Update Website**. Update website with the report and findings summary. Lead: Chris Berrens with webmaster **Second Round Table**. Do a second Round Table discussion after demonstration project results available, and when representatives have more time and attention after the elections. Lead: Humphrey School team

	Legislative Briefings. For key legislators and staffers who don't make it to the Round Table, conduct one-on-one or small group briefings of key legislators about the results. Lead: Frank Douma, Lee Munnich and MnDOT government relations lead. **Commentary**. Option: Ask one of our key messengers to submit an easily understandable commentary to a policymaker-type publication, such as the Star Tribune and/or MinnPost, stressing our key messages, demonstration project findings, and areas of future learning needed. Distribute the commentary to key stakeholders. Lead: Joe Loveland

Communications Plan for National Stakeholders

Situation. What is the environment in which the communications will take place?	Minnesota relies heavily on the gasoline excise tax to fund roads and bridges. Increasingly, vehicles are using less gasoline, because they use other energy sources and/or are more fuel-efficient. Therefore, many research projects around the nation, with the support of the federal government, are exploring the feasibility of charging based on the distance, or miles, traveled, rather than gasoline use. These DBF, or mileage-based fee, projects have predominantly been exploring application of DBFs to all types of vehicles. That model is showing promise, but it does face challenges related to public acceptance and administrative cost issues. Those challenges are making many some policymakers reluctant to broadly implement such systems. A DBF applied to car-share fleets and in automated vehicles could mitigate some of those concerns. For instance, compared to using DBF with all vehicles, with this approach: 1) there are fewer payers, which limits tax collection costs; 2) there should be fewer technological installation and management challenges; and 3) the experience for fleet users may be mostly unchanged. This demonstration is focused on the vehicle fleet rather than customers/drivers/accounts. Increasingly, newer vehicles will have built-in technology that can log distances. Therefore, those vehicles won't require major retrofitting or new equipment, as has been necessary with older vehicles. In the not too distant future, vehicle market analysts say that large numbers of Americans may one day be taking advantage of car-share and automated vehicle options because of the reduced personal costs and added safety benefits. They expect that what is currently a relatively

	small share of the vehicle pool will be growing very significantly. Applying DBFs to car share fleets and automated vehicles has not been tested yet. There is much to learn about technological, policy, and public acceptance issues. That learning and the application of the technology and processes developed will be transferable to larger and larger sectors of transportation in the future. With funding from the federal government, a team led by the Minnesota Department of Transportation (MnDOT) will be operating a DBF demonstration project involving car share fleets companies and automated vehicles. The purpose of that demonstration will be to show how the car-share platform can be used as a model for future distance-based fee collections. Two car-share companies and an automated vehicle developer are cooperating with MnDOT on the project. This demonstration is focused on the vehicle fleet rather than customers/drivers/accounts. The demonstration project will be simulating revenue collection. As part of this demonstration, no money will be changing hands. The research will focus primarily on technical issues associated with DBF collection, not public acceptance or user acceptance. The user experience and public acceptance are also important considerations. If misunderstandings about the DBF demonstration project were to grow widespread, they could make it difficult for the demonstration project to be started and/or completed, which would limit important learning about this alternative transportation financing option. If misunderstandings about the project grow widespread, they could cause policymakers to not give fair consideration to the findings of the demonstration project.

	It is important for the public and decision-makers to know that the vision is not transformational, but rather it is a measured and incremental migration away from the current model of reliance on the motor fuel tax. In the mean-time, the motor fuel tax will likely remain in place.
Goal: What do we want to happen as a result of the delivery of these messages?	Ensure the new DBF demonstration project is clearly and accurately understood so that the learning process about the potential for future use of DBFs progresses.
Target Audience. Who do we most need to persuade in order to achieve our goal?	**National DBF Experts.** People outside of Minnesota who follow the DBF issue closely and may be influential in shaping future research initiatives and policies. **National DBF Research Funders.** People outside of Minnesota with the potential to fund DBF research initiatives. **National Shared Mobility Leaders**. Private sector shared mobility leaders whose support would be necessary for implementation. *Note: Separate communications plans will be developed that are at aimed two other target audiences: 1) Car-share fleet customers/users and 2) policymakers and their influencers.
Key Messengers. Who does the target audience find most credible for delivering our key messages?	• MnDOT DBF expert: Ken Buckeye/Chris Berrens or designee. • University of Minnesota Humphrey School experts: Frank Douma, Lee Munnich and Zhirong Zhao. • WSP experts. David Ungemah and Mike Warren.
Key Messages. What will we repeat and stress in all our communications to achieve our goal.	**CAR-SHARING COMPANIES AND AUTOMATED VEHICLES PRESENT A UNIQUE OPPORTUNITY**. Car-sharing and automated vehicle services present a unique opportunity for using distance-based fees. First, more Americans will be using these options in the future. Second, compared to a system focused on all vehicles, distance-based fees focused on car share fleets have the potential to be easier to collect

(Note that these are general ideas that will be phrased differently by various messengers, and are not intended to be used as verbatim scripts.)	and manage when charged via companies that own these maintain these fleets. • On-board and embedded technology will help to ensure user privacy and data security. • Evasion can be reduced or eliminated. Reconciliation of user fees will be managed to ensure that users are not double charged for use of the road. **PROJECT WILL HELP US LEARN WHAT DOES AND DOESN'T WORK**. This demonstration project will help us learn the extent to which the DBF approach applied to car-sharing fleets and automated vehicles is practical and feasible, and how best to structure it if it were used in the future. **WE'LL BE TRANSPARENT**. We're committed to being transparent about this pilot project and our findings. We'll be doing regular public updating events during the project. Among other things, we expect to learn about technical issues for both the government and companies. We'll have a final report available to anyone who is interested, and will be sharing those learnings with interested parties nationally and locally.
Challenging Questions. What are some of the primary challenging questions we should expect? (Unlike key messages, these aren't issues we will repeat and stress in our communications. But we should be prepared to be responsive to them.)	• How was privacy protected? • Did users trust that it was protected? • If you claim it has user acceptance advantages, why didn't you ask users what they thought about it? • Why focus on such a small niche market? • How well did the technology will work? What would you do differently if you did it again? • How scalable is this? Does it get cheaper on a per user basis as the number of users grows? • What do the larger national car-share companies and the automated vehicle sector think about this idea? • Will this cost more to administer than the gas tax? How much more? • Will this be punitive for rural drivers, whose circumstances force them to drive more miles than urban drivers? • Will this be fair for low-income people?

	• Shouldn't there be a variable rate to incent clean fuels, manage rush hour traffic, and/or incent carpooling? • Shouldn't the rate be based on income, or ability to pay? • Should there be a variable rate for larger vehicles that take a larger toll on roads and bridges?
Tone. What should the audiences *sense about us* whey they hear us deliver the key messages?	The target audience will sense that we are: • Adding to the body of DBF learning, not questioning other DBF models. • Fact-based, not speculative. • Respectful, not disrespectful. • Focused on rules for fleet operators, not individuals • Explaining the approach, not cheerleading for it. • Exploring an alternative, not pushing anyone to do anything. • Learning, not just knowing. • Listening, not just telling. • Transparent, not secretive.
Strategies. What communications approaches do we need to use achieve the goal?	All documents and major decisions will be approved by Ken Buckeye. We will avoid the temptation to overload this plan. We will keep the list of tactics relatively short and doable, since we don't have resources to implement extensive communications, and we won't have a lot to say until findings are available. We will have basic information about project rationale and scope publicly available at the outset, but won't communicate more proactively until there are findings. If inquiries are made before the end of the project, we will answer as best we can and note that we will provide more information once the findings are available. Leave no question unanswered. We won't allow misinformation or misunderstandings to spread.

	We will use this plan as a guide, but won't be a slave to it. We will continually reassess the environment and add or remove tactics as needed.
Tactics. What specific actions will we take to most systematically deliver our key messages? (These can be viewed as a menu of options from which to choose. They should not be viewed as an all-or-nothing proposition.)	**<u>Phase I: Pre-launch (Now until April)</u>** **Communications Plan**. Finalize this communications plan so we are clear about which key messages to stress and how to stress them. Lead: Joe Loveland **Website**. Establish a basic website that includes basic information about the project rationale and scope. Lead: Chris Berrens • **Website Promoted**. Email a list of national stakeholders so that they know that the website exists. Lead: MNDOT, perhaps in partnership with the Mileage-Based User Fee Alliance and the federal study team. **First Round Table Event**. Hold a Round Table event for transportation finance stakeholders, partially focused on national DBF projects, but also giving an overview of the MN project. Lead: Humphrey School team • **Share Relevant Presentation**. Email Ken Buckeye's presentation to stakeholder list. Lead: Humphrey School team **Respond Only**. Don't seek interviews during this phase of the project. Only do interviews with leaders, the public or news reporters if they request them. Point to the website and Round Table Discussion to show that the project is public and no secretive. Provide the project one-pager. Lead: WSP/ MnDOT with the Humphrey School **<u>Phase II: Project Being Implemented</u>** **Update Website**. Update website with project specifics as they develop. Lead: Chris Berrens with the webmaster **Respond Only**. Don't initiate publicity. Only do interviews with leaders, the public or news reporters if they request them. Point to the website and Round Table Discussion to

	show that the project is public and no secretive. Lead: MnDOT with Humphrey School **<u>Phase III: Project Results Available</u>** **Draft and Distribute Report**. Draft a report that summarizes the results, with a succinct executive summary. Lead: WSP with Humphrey School • **Email Report**. Email report to list of national stakeholders. • **Email and Offer Briefing**. For private sector car-sharing leaders, email the report and offer to do a webinar briefing to representatives of Uber, Lyft, and anyone who wants it. **Update Website**. Update website with the report and findings summary. Lead: Chris Berrens with webmaster **Second Round Table**. Do a second Round Table discussion after demonstration project results available, and when representatives have more time and attention after the elections. Lead: Humphrey School team • **Share Relevant Slides**. Email relevant presentations to stakeholder list. Lead: Humphrey School team **Speaking Opportunities**. Seek speaking engagements before the Mileage-Based User Fee Alliance (MBUFA), Transportation Research Board (TRB), and relevant other national groups and gathers, such as a national gathering of car-share leaders. Lead: MnDOT/ Ken Buckeye/Chris Berrens • **Share Major Presentations**. Email the stakeholders major presentation slide decks. **Webinar**. Gauge interest among national car share and automated vehicle leaders in participating in a webinar on report findings and potential next steps. Lead: _MnDOT/Ken Buckeye **Commentary**. Option: Ask one of our key messengers to submit an easily understandable commentary to a policymaker-type publication, such as the Star Tribune

	and/or MinnPost, stressing our key messages, demonstration project findings, and areas of future learning needed. Distribute the commentary to key stakeholders, including national stakeholders. Lead: Joe Loveland

__Communications Plan for Shared Mobility Users__

***EACH CAR SHARE COMPANY WILL WRITE THEIR OWN COMMUNICATIONS PLAN. THIS DOCUMENT RAISES MANY OF THE MAJOR ISSUES THEY SHOULD CONSIDER.**

Situation. What is the environment in which the communications will take place?	Minnesota relies heavily on the gasoline excise tax to fund roads and bridges. Increasingly, vehicles are using less gasoline, because they use other energy sources and/or are more fuel-efficient. Therefore, many research projects around the nation, with the support of the federal government, are exploring the feasibility of charging based on the distance traveled, rather than gasoline use. These DBF projects have predominantly been exploring application of DBFs to all types of vehicles. That model is showing promise, but it does face challenges related to public acceptance and administrative cost issues. Those challenges are making some policymakers reluctant to broadly implement such systems. With that backdrop, we also realize that vehicles are changing rapidly and how we use them. We are also becoming less reliant on gas to power our vehicles. Cars today are already coming factory equipped to securely communicate with the "cloud." That capacity allows us to think differently about how fees are collected, how administrative costs can be reduced, and how individual privacy can be protected. A DBF applied to car-share fleets and in automated vehicles could mitigate some of those concerns. For instance, compared to using DBF with all vehicles, with this approach: 1) there are fewer payers, which limits tax collection costs; 2) there should be fewer technological installation and management challenges; and 3) the user experience for fleet users may be mostly unchanged. Increasingly, newer vehicles will have built-in technology that can logs distances. Therefore, those vehicles won't

	require major retrofitting or new equipment, as has been necessary with older vehicles. In the not too distant future, vehicle market experts say that large numbers of Americans will be taking advantage of car-share and automated vehicle options. They expect that what is currently a relatively small share of the vehicle pool will be growing very significantly. Applying DBFs to car share fleets and automated vehicles has not been tested yet. There is much to learn about technological, policy, and public acceptance issues. That learning and the application of the technology and processes developed will be transferable to larger and larger sectors of transportation in the future. With funding from the federal government, a team led by the Minnesota Department of Transportation (MnDOT) will be operating a DBF demonstration project involving car share fleets and automated vehicles. Two car-share companies and an automated vehicle developer are cooperating with MnDOT on the project. This demonstration is focused on the vehicle fleet rather than customers/drivers/accounts. The demonstration project will be simulating revenue collection. As part of this demonstration, no money will be changing hands. The research will focus primarily on technical issues associated with DBF collection, not public acceptance or user acceptance. The user experience and public acceptance are also important considerations. If misunderstandings about the DBF demonstration project were to grow widespread, they could make it difficult for the demonstration project to be started and/or completed, which would limit important learning about this alternative transportation financing option.

	If misunderstandings about the project grow widespread, they could cause policymakers to not give fair consideration to the findings of the demonstration project. If car-share users learn about this through the news media or through peers, rather than from the car-share companies, they may be upset or distrustful about subsequent information from car share companies. Car-share companies may be able to provide users more comprehensive, balanced, and accurate information than the news media. The project team will work with the car-share providers to ensure accurate, appropriate and vetted information is released to customers in a timely manner.
Goal: What do we want to happen as a result of the delivery of these messages?	Ensure the new DBF demonstration project is clearly and accurately understood so that the learning process about the potential for future use of DBFs progresses.
Target Audience. Who do we most need to reach in order to achieve our goal?	**Car-Share Users/Customers.** Minnesotans who use car share fleets participating in the demonstration project. *Note: Separate communications plans will be developed that are aimed at two other target audiences: 1) National stakeholders and 2) policymakers and their influencers.
Key Messengers. Who does the target audience find most credible for delivering our key messages?	• **Car Share Company Leaders**. TBD by companies.
Key Messages. What will we repeat and stress in all our communications to achieve our goal.	**(<u>Companies should take the lead in communicating with their customers, but here are some potential messages for them to consider</u>.)** **HERE'S WHAT IS HAPPENING**. To facilitate learning on an emerging topic, we're partnering with MnDOT and the

(Note that these are general ideas that will be phrased differently by various messengers, and are not intended to be used as verbatim scripts.)	University of Minnesota to learn about the feasibility of collecting taxes (aka user fees) via mileage rather than via gallons. **NO CHANGES IN EXPERIENCE, EXCEPT YOU CAN USE MnPASS LANES FOR FREE.** It's a study only. No laws or policies are changing. As the study plays out, nothing about your experience with us will change. The only thing that will change is that you'll be able to use MnPASS for free. **NO CHANGES IN PRICES.** Nothing about our prices will change. **PRIVACY IS PROTECTED**. All data will be encrypted so that it is not connected to any individual. (These kinds of studies have been done elsewhere and no privacy breaches have occurred.) **LET US KNOW IF YOU HAVE QUESTIONS**. While this shouldn't change your experience, we wanted to be transparent and let you know about it. If you have questions, please let us know.
Challenging Questions. What are some of the primary challenging questions we should expect? (Unlike key messages, these aren't issues we will repeat and stress in our communications. But we should be prepared to be responsive to them.)	Why is this necessary? Shouldn't customers have been consulted first? Can I opt out of the study? How is location data protected? Can you guarantee it? Do I have to do anything differently? If I don't have to do anything differently, why are you contacting me? Will I ultimately have to pay higher rates in the future because of this? Can I see more information about the study? Can I see the final report?
Tone. What should the audiences *sense about us* whey	The target audience will sense that we are:

they hear us deliver the key messages?	• Adding to the body of DBF learning, not questioning other DBF models. • Fact-based, not speculative. • Respectful, not disrespectful. • Explaining the approach, not cheerleading for it. • Exploring an alternative, not pushing anyone to do anything. • Learning, not just knowing. • Listening, not just telling. • Transparent, not secretive.
Strategies. What communications approaches do we need to use achieve the goal?	All documents and major decisions will be approved by Ken Buckeye. We will avoid the temptation to overload this plan. We will keep the list of tactics relatively short and doable, since we don't have resources to implement extensive communications, and we won't have a lot to say until findings are available. We will have basic information about project rationale and scope publicly available at the outset, but won't communicate more proactively until there are findings. If inquiries are made before the end of the project, we will answer as best we can and note that we will provide more information once the findings are available. Leave no question unanswered. We won't allow misinformation or misunderstandings to spread. To limit car-share user misunderstandings and distrust, car share companies may or may not choose to proactively contact users before launch to notify them about the project and stress key messages. This decision about whether to do proactive disclosures will be made by each respective company. We will use this plan as a guide, but won't be a slave to it. We will continually reassess the environment and add or remove tactics as needed.

Tactics. What specific actions will we take to most systematically deliver our key messages? (These can be viewed as a menu of options from which to choose. They should not be viewed as an all-or-nothing proposition.)	**<u>Phase I: Pre-launch (Now until April)</u>** **Communications Plan**. Finalize this communications plan so we are clear about which key messages to stress and how to stress them. Lead: Joe Loveland **Notify Users.** Through a letter, newsletter article or other, car share companies may or may not notify car-share users about the demonstration, stressing key messages. This decision about whether to do proactive disclosures will be made by each respective company. **Develop Company-Specific FAQ document.** To supplement the general FAQ document being developed by the Humphrey School team, car share companies may or may not choose to develop an FAQ to address issues that are more specific to them (see list of questions above). **<u>Phase II: Project Being Implemented</u>** **Update Users.** Through a newsletter article, car share companies may or may not provide an update on the project, even if the information isn't much different from what was known at the time of the first notification. This decision about whether to do proactive disclosures will be made by each respective company. **<u>Phase III: Project Results Available</u>** **Share Findings Summary.** Through a newsletter article, car share companies may or may not provide a summary of the report findings. This decision about whether to do proactive disclosures will be made by each respective company. **Commentary**. Option: Ask one of our key messengers to submit an easily understandable commentary to a policymaker-type publication, such as the Star Tribune and/or MinnPost, stressing our key messages, demonstration project findings, and areas of future learning needed. Distribute the commentary to key stakeholders, including car-share users. Lead: Joe Loveland

APPENDIX B: COSTS OF EXISTING TECHNOLOGY

The Minnesota Distance-Based Fee Demonstration eliminates start-up capital costs by leveraging existing resources. Due to their business model, SM providers already have a fleet of vehicles equipped with the technology to track and transfer VMT data. This includes the development, purchase, and installation of third-party GPS devices. Table B-1 presents the costs of the initial existing technology and the new technology acquired during the transition from one of the SM providers.

Table B-1: Costs of Existing Technology

	Costs (1)
Initial technology	
In-car technology	$1,000 - $1,200 per vehicle
Technology acquired in the last quarter	
In-car technology	$2,000 per vehicle
Monthly service charges	$50 per vehicle

Notes: *(1) The costs exclude installation costs. (2) Charges from the technology provider for ongoing support and histing of the SM provider technology and software.*

APPENDIX C: INFORMATION SYSTEMS MANAGEMENT PLAN

A brief overview or summary of the IT plan including policies, processes, and procedures for managing security, privacy, confidentiality, availability of the data repository that VSI managed for this demonstration are explained below.

- VSI is using DigitalOcean, a cloud infrastructure provider, to host the data repository and web access portal. DigitalOcean has extensive measures in place to secure and protect the data. DigitalOcean's policies are listed at the end of this document.
- Physical security measures are practiced to protect VSI office and VSI vehicle.
- All data stored in the repository is encrypted with AES-256.
- Data can only be accessed through the web portal
    - The web portal can only be accessed by certain users who have been given access to each repository.
    - Every user must use a password to access the web portal, password policy complies to NIST guideline SP 800-63B
    - All communication through the web portal is through https protocol. This encrypts all data though a secure socket layer (SSL) and uses a trusted certificate provider. This is used for all actions on the portal including, creating accounts, signing in, uploading data, and downloading data.
    - Web portal software developed
- Firewalls have been setup to block all unnecessary ports in the operating system by VSI and in the network by DigitialOcean.
- IP addresses are automatically banned from repeated failed attempts to access the server.
- Backups of the server are created weekly by DigitalOcean.
- There is only one system administrator (a VSI employee) who has administrative access to the data repository and web portal.

APPENDIX D: DBF QUESTIONS & ANSWERS

Question	Project Team Response/Observations
TAC members	
We should abandon this "gradual" approach and recognize that this is a radical change! Especially in terms of climate change	The notion of an incremental deployment of DBFs may be necessary especially considering the durability of the gas tax. Equally, a fair and equitable migration to DBFs may have a greater likelihood to win public approval.
What exactly is the scope of the problem? What is the dollar amount of revenue loss for cars no longer paying the fuel tax. The TAC member acknowledges that this is difficult to project, but it is hard to judge a new system when the scope of the problem is unknown.	The scope of the problem revolves around increasing vehicle efficiencies and the seismic shift to EVs, but there is great uncertainty with regard to how rapidly motor fuel tax revenue will decline. In Minnesota, the latest forecast predicts a 0.05 percent decline annually for the next 20 years.
What exactly are we trying to accomplish? Just that the highway fund does not lose money? Or are we trying to do bigger things?	Assuming the notion of retaining the motor fuel tax is viable (although it is declining and in need of rate adjustments) the purpose of the DBF is, at a minimum, is to backfill revenue lost to the trends of improved vehicle efficiencies and EVs. While it is possible to backfill the lost revenue with added and often flat surcharges, in theory, we have the capacity to be very refined and precise in road charging given the computing capacity of modern vehicles. This demonstration project attempts to show how that can be done efficiently and effectively.
Is this an incremental or a more systemic change? Let's consider the merits of both these approaches.	The change being identified is both incremental and systemic, although it will take many years for full deployment to occur.

What are the ultimate goals of this program - revenue generation or larger impacts to the transportation system?	The goals of the program are to implement DBFs in a fair and equitable manner that enables efficient fee collection, ensures privacy, and has low evasion rates. Ideally, DBF should be publicly acceptable, transparent, and scalable.
We need to work on the politics of this issue - what are the interest groups' perceptions on this?	The political dimension of DBFs is hugely important and can be very polarizing among different groups. Congress and state legislatures have begun to address this problem head-on and thus enable projects like Minnesota's DBF Demonstration to occur.
Roundtable Participants	
If not applied to electric vehicles, what are the advantages over simply increasing the current methods for generating revenue for road improvements?	If the belief is that one day all vehicles will be charged by the miles driven, then something needs to replace the motor fuel tax. The assumption in Minnesota's demonstration is that the motor fuel tax should remain in place for internal combustion engines (ICEs), but the Distance-Based Fee should be applied to appropriately equipped vehicles, i.e., those with embedded telematics to enable fee collection. The advantages of using embedded telematics platform to collect distance-based fees, outside of electric vehicles, may include precision in location and rates that are applied; privacy protection; potentially reduced fee avoidance; an enhanced ability to reconcile accounts among states. The Minnesota demonstration is also attempting to address economies of scale with fleets which may enable a far more efficient and cost-effective collection methodology.
It appears that politicians at both the state and national levels have not supported increasing revenue for road improvements during the past 15-20 years. Why do advocates for DBF think politicians will support a new and less efficient form that is not a replacement?	As researchers in this Distance-Based Fee Demonstration, we do not advocate for any policy but rather for the development, testing, and evaluation of ideas, techniques and methods that address identified needs within the context of policy. Our intention is to show decision-makers what the possibilities are. Congress and the states have requested and authorized states to develop alternatives to the motor fuel tax, and as such it is incumbent on decision-makers to advance the ideas and concepts in a fashion that fits their objectives.