HUMPHREY SCHOOL OF PUBLIC AFFAIRS
UNIVERSITY OF MINNESOTA

Evaluation of the Minnesota Distance-Based Fee Demonstration

FINAL REPORT

Prepared by:

Camila Fonseca-Sarmiento
Raihana Zeerak
Meredith Benesh
Jerry Zhirong Zhao

Humphrey School of Public Affairs
University of Minnesota

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Kenneth Buckeye, DBF Project Director, MnDOT

Christopher Berrens, Planning Director, Transportation | Performance, Risk & Investment Analysis, MnDOT

Frank Douma, Director of State and Local Policy and Outreach | Institute for Urban and Regional Infrastructure Finance, Humphrey School, UMN

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LIST OF ABBREVIATIONS

C/AV	Connected and automated vehicle
CCPA	California Consumer Protection Act
DBF	Distance-Based Fee
DOR	Department of Revenue
DPS	Department of Public Safety
EV	Electric vehicle
FOIA	Freedom of Information Act
HD	High Definition
HOV	High Occupancy Vehicle
ICE	Internal combustion engine
MnDOT	Minnesota Department of Transportation
OEM	Original Equipment Manufacturers
SM	Shared Mobility
STSFA	Surface Transportation System Funding Alternatives
TAC	Technical Advisory Committee
TNC	Transportation Network Company
PII	Personally Identifiable Information
VMT	Vehicle Miles Traveled

EXECUTIVE SUMMARY

Introduction

The Minnesota Department of Transportation ran a Distance-Based Fee (DBF) demonstration to demonstrate the feasibility of using embedded telematics to assess DBFs in partnership with shared mobility (SM) providers. The embedded telematics enables the reservation of vehicles and the collection of mileage data to bill their customers for vehicle use. The embedded telematics feature ensures 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 project, researchers at the Humphrey School of Public Affairs conducted an independent evaluation to assess the execution of the Minnesota DBF demonstration based on four revenue-evaluation principles of feasibility, efficiency, adequacy, and equity. This 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. In addition, this 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.

Methodology

This evaluation assesses 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 the data collected from the demonstration partners using quantitative and qualitative methods. The analysis was completed with information coming from demonstration partners including shared mobility (SM) providers, the connected and automated vehicle (C/AV) provider, the Department of Revenue (DOR), Minnesota Department of Transportation (MnDOT), WSP, roundtable participants, and technical advisory committee (TAC) members. The analysis was complemented with a review of relevant documents.

Evaluation Findings

Feasibility - This evaluation criterion assesses the feasibility of a DBF system based on two criteria, administrative and political feasibility. 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, these costs decreased as the processes were internalized, they built internal capacity, and were more familiar on how to meet the DBF requirements. Similarly, the time the C/AV provider spent on completing the tests was minimal after hardware and software were ready with parameters needed for data collection. In addition, the information systems management plan was

successful in protecting data shared by SM providers throughout the demonstration. From the perspective of the DOR, if implemented on SM providers, the costs of collection, enforcement, compliance, and audit of DBFs will be similar to those of the motor fuel tax given the small number of collection points. However, if the DBF is levied on the general public, the costs will likely be larger and depend on the scale of implementation and the pricing structure.

The political feasibility of DBFs will depend upon continued efforts to articulate the purposes and goals of the project, and dedication to developing methods of clearly communicating these to stakeholders and audiences. 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 scale of the implementation, and the reaction of customers to potential changes in prices. Overall, the communication tools used in this demonstration successfully communicated information and helped educate policymakers, stakeholders, and interested public. Further work will be needed in the future to identify and address concerns of the general public.

Efficiency - This evaluation criterion assesses the extent to which DBFs may lead to more efficient use of resources. This evaluation assessed efficiency in operations, efficiency in fee collection, integration with other charges, and efficiency in fee auditability.

In terms of 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 that the TAC members represent. Demonstration partners discussed the potential impacts on their organizational operations if a DBF system is implemented in the future. 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. These include, for instance, changes in the structure of the rate plans to include mileage, type of vehicles offered, and changes in the plans offered. Similarly, if DBFs are levied on C/AVs in the future, it may lead to more efficient use of resources due to automated processes, more sophisticated technology gadgets, and improved internet access. In addition, some TAC members brought up the potential for increased operating costs of their respective organizations as well as the impacts of a future DBF program on cities goals. Overall, there are uncertainties regarding the extent to which DBFs may impact travel choices and the adoption of electric vehicles.

In terms of efficiency in fee collection, some factors that may affect the efficiency in fee collection were identified by various demonstration partners. The SM providers believe leveraging in-vehicle telematics makes the data collection process seamless and keeps the administrative and overhead costs low. They also believe their current practice of disclosing this information in the customers' trip invoice could ease the communications with customers regarding the collection of a DBF. On the other hand, they believe that changes in technology and software and third-party dependency as factors that may limit their ability to comply with a DBF system.

DOR also identified factors that may improve the efficiency in fee collection. First, having a licensing process with an incentive to any intermediary collecting organizations to enroll in the DBF system.

Second, having legislation requiring online filing to fulfill state filing requirements. Third, adjusting the fee collection schedule according to the scale of implementation. Fourth, using the existing taxpayer information across different state agencies. Finally, TAC members also suggested ways to improve efficiency in DBF collection including self-reporting, using a prepaid system, and leveraging the existing technologies among others.

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 believe they could incorporate the payment of a DBF into other tax payments with proper tools in place. However, depending on the fleet ownership model, such integration with other tax payments may require coordination with parent companies. TAC suggestions included a self-reporting method integrated with the license renewal, an annual DBF payment at the time of vehicle registration, integrating DBF payments with vehicle insurance payments every six months, and verification of total miles traveled at the time of vehicle purchase/sale.

Demonstration partners have different perspectives on the efficiency of a DBF auditability. We capture DOR's perspective as the auditor and from SM providers as the auditee. While from the 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, the SM providers believe audit requirements could affect their ability to balance fulfilling those requirements with other high priority operational activities. According to the DOR, administrative and civil penalties may contribute to improving compliance and enforcement under a DBF system. Under a DBF system at the SM provider level, a license clearing program 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. Similarly, substantial late payment penalties can improve compliance and enforcement of a DBF system.

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, 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, various equity considerations including equity perceptions, social, modal, and geographical equity implications of DBFs should be considered for its future implementation.

In terms of equity perceptions, overall, SM providers believe a DBF system would be fair if implemented to all drivers. According to them, if a DBF is implemented at the SM provider level only, it would shift the burden of collecting the fee to them, increase their operating costs, and affect their ability to remain competitive in the transportation market. Similarly, the SM providers believe if a DBF is implemented on fleet owners it would be inequitable to SM providers that own their vehicles as 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 sustainability of SM providers that own their fleet. Additionally, the SM providers believe implementing a DBF only on SM providers would be unfair as their trips provide benefits to the community and the environment.

In terms of 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. According to them, 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. Similarly, SM providers suggested 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 policies outside of the rate structure such as subsidies for low-income individuals, rebates, tax credits, and tax changes as well as improving alternatives to driving and allocating transportation revenues to alternative transportation options under a DBF system to address potential social inequities.

In terms of modal equity, demonstration partners believe that a system based on miles traveled would more accurately reflect the use of the roadway infrastructure. However, 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. According to them, as these vehicles would pay more than they currently do under the motor fuel tax system, this may discourage their adoption. They 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. TAC members also suggested other methods and categories including vehicle capacity to operate safely and peacefully in a neighborhood, innovation, and evidence of damage caused to the road for consideration in a DBF rate design.

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. Those who believe that the DBFs have the potential to become equitable, argue that 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. This coupled with the fact that rural drivers pay more in fuel tax due to longer travel distances and the use of more fuel-inefficient vehicles, should even out the differences in a DBF system. On the other hand, those who believe there will be rural/urban inequities in a DBF, argue that people in these areas travel longer distances to access basic needs and therefore, would be more affected by a DBF system. It was also noted that there may be inequities based on regional income disparities. 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.

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.

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 two factors. First, DBF revenue adequacy depends on the price users and drivers pay for the miles they travel. Second, it 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 roadways, the overall amount of money spent on the roadway system could decline. While others argue that DBF revenues might be adequate if spending is not focused on roadway expansion, but rather on investments on other alternative transportation modes.

In terms of revenue adequacy, 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 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.

Future Considerations

Data collected from demonstration partners during the twelve-month period provided important considerations for future implementation of a DBF 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, some demonstration partners suggested considering other partners to act as the intermediary collector, considering other partners for a DBF pilot to levy DBF charges on other vehicle types, and considering engaging in a national or Midwest pilot.

Summary of Evaluation Findings

Criteria	Strengths	Limitations
Administrative Feasibility		
Ease of administration for SM providers	*Costs related to data-related activities decreased over time - These may vary based on the size of the collecting organization, fleet size, and trip volume. *Ability to customize the existing software and automate the process *Using existing technology - no need for additional capital assets	*Changes in in-car and software technology *Providing information at a certain frequency and explain data errors *Investing engineering resources to customize existing software
Ease of administration for C/AV technology provider	*Using existing technology and software *Ability to customize the existing software and automate the process *Fast data transmission	*Large amount of time spent customizing hardware and software *Additional capital assets depending on data required *Lack of broadband in some areas such as rural areas
Success of data protection	*Having an information systems management plan *SM providers' internal data protection practices *Limited partners' access to repository and data *Data stripped of PII *Low on-going costs for the data repository	*High data repository set-up cost *Large amount of time spent on data sharing agreement *Remaining data privacy concerns for SM providers
Ease of administration for state agencies	*Less costly implementation at the SM provider level than at the individual level *At the SM provider level the compliance, enforcement, and audit processes and costs would be somewhat similar to those of the current motor fuel tax system *Startup collecting costs would depend on the kind of data required	*Complex and costly compliance, enforcement, audit processes if factors such as time of day or lane use data are required
Political Feasibility		
Acceptance from SM providers	*Supportive of paying a lower fee under a DBF system compared to amount paid in MFT	*Increased costs due to fee collection burden *Increased costs due to record keeping requirements *Uncertainty about public/SM customer reaction to the fee

Criteria	Strengths	Limitations
		*Concerns about paying the same amount as paid under MFT or higher
Addressing public concerns	*Increased familiarity with DBFs for roundtable participants and TAC members *A majority of demonstration supported further exploring DBFs	*Limited interaction with the general public and SM customers
Efficiency		
Efficiency in operations	*Improvements in SM providers' internal processes If implemented there is potential for: *Increased efficiency in the SM providers' operations *Change in SM users' driving patterns *More efficient use of resources if implemented on C/AV *Improved mobility options *Improvements in the attainments of climate goals *Reduced number of miles driven and car ownership	*Potential for increased operating costs for state, local, and private agencies involved in the collection *In opposition to the strategy of VMT reduction
Efficiency in fee collection	SM providers: *The use of in-vehicle telematics and the disclosure of VMT in the receipt DOR: *Licensing process with an incentive, legislation requiring online filing, adjusting the fee collection schedule according to the scale of implementation, and using the existing taxpayer information	*Changes in technology and software and third-party dependency may limit SM ability to comply with a DBF system
Integration with other charges	*SM providers would be able to do this with proper tools in place	*The need for more rigorous standards of accounting for calculating the fee *Depending on the fleet ownership model, integration with other tax payments may require coordination with parent companies
Efficiency in fee auditability	*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 *Administrative and civil penalties may improve	*Audit requirements could affect SM ability to balance fulfilling those requirements with other high priority operational activities

Criteria	Strengths	Limitations
	compliance and enforcement *Substantial late payment penalties may improve compliance and enforcement	
Equity		
Equity perceptions	*Equitable if implemented on all drivers	SM providers: *If a DBF is implemented at the SM provider level only, it would be inequitable to them due to increased costs *If a DBF is implemented on fleet owners it would be inequitable to SM providers that own their vehicles *Implementing a DBF only on SM providers would be unfair as their trips provide societal benefits
Social equity	*Variable rate structure could potentially address social equity concerns *Providing better alternatives to driving may address potential inequities of a DBF	*Disproportionate impact on low-income users, those with disabilities, and unbanked
Modal equity	*A DBF would more accurately reflect the use of the roadway infrastructure *Variable rates based on vehicle contribution to pollution, weight, noise level and safety, innovation, and evidence of damage caused to the road may address modal equity concerns	*Potential negative impacts of a DBF on the adoption of electric and more fuel-efficient vehicles
Geographical equity	*DBFs potential to become equitable as rural drivers won't experience increased tax payments *Adjusting the DBF rates based on congestion pricing, vehicle type, and trip location may account for rural/urban equity concerns	*DBF system would generate rural/urban inequities based on regional income inequities
Adequacy		
Revenue neutrality	*Potential to cover roadway expenses if revenue is constitutionally dedicated to the HUTD fund	*High rates may incentivize people to decrease their vehicle travel
Potential to keep up with transportation costs	*Potential to keep up with transportation costs if the rate is increased regularly	

CHAPTER 1: INTRODUCTION

States across the country face a future where motor vehicles are increasingly fuel-efficient, electric, or powered by other alternative fuels. These changes in the vehicle fleet will reduce reliance on gasoline as a fuel, likely resulting in a reduction of revenues collected from the motor fuel tax, which today is a major revenue source for the construction and maintenance of transportation infrastructure. For this reason, many states are pursuing distance-based systems to replace and/or supplement the motor fuel tax system.

The Minnesota Department of Transportation ran a Distance-Based Fee (DBF) demonstration to test the feasibility of using embedded telematics to assess DBFs. This demonstration focused on a potential scenario where cars would have built-in technology that can keep track of mileage and electronically report miles traveled for the purpose of collecting a DBF to fund transportation infrastructure. For this demonstration, MnDOT worked with Shared Mobility (SM) providers because embedded telematics is an integral component of their business model, as it enables the reservation of vehicles and the collection of mileage data to bill their customers for vehicle use. The embedded telematics ensure that users cannot disable or deceive the fee collection technology. In addition, the demonstration project included an autonomous vehicle simulation to understand how a mileage fee might be charged and collected on a self-driving vehicle.

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. Overall, the administrative and political feasibility of DBFs is likely to improve over time. In terms of administrative feasibility, SM providers experienced high operating costs due to data-related activities at the beginning of the demonstration, but these decreased as the processes were internalized, they built internal capacity, and became familiar with the requirements of the DBF. Similarly, if implemented on SM providers, the costs of collection, enforcement, compliance, and audit of DBFs will be similar to those of the motor fuel tax given the small number of collection points. However, if the DBF is levied on the general public, the costs will likely be larger and depend on the scale of implementation and the pricing structure. The political feasibility of DBFs will depend upon continued efforts to articulate the purposes and goals of the project, and dedication to developing methods of clearly communicating these to stakeholders and audiences. SM providers' acceptance of DBFs depends on the potential benefits their customers will receive, the possibility that these fees are levied on the general public, and reactions to potential changes in prices.

In terms of efficiency, this demonstration improved some of the SM providers' internal processes, identified potential changes in demonstration partners' operations (such as their pricing schemes) that would likely impact driving patterns. These changes can lead to more efficient use of resources, and

impact cities' transportation and environmental goals. However, there are uncertainties regarding the extent to which DBFs may impact travel choices and the wide adoption of electric vehicles. Similarly, the demonstration helped identify several factors that may improve and limit the efficiency in fee collection, integration with other charges, and fee auditability.

In terms of equity, there are several equity concerns to consider for a future DBF implementation. First, demonstration partners believe that a system based on miles traveled would more accurately reflect the use of the roadway infrastructure. SM providers believe a DBF system would be fair if implemented to all drivers. A DBF levied only on SM services would shift the burden of collecting the fee to SM providers, increase their operating costs, and affect their ability to remain competitive in the transportation market. Second, demonstration partners expressed social equity concerns related to 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. Third, regarding modal equity, demonstration partners expressed concerns about the potential negative impacts of a DBF on the adoption of electric and more fuel-efficient vehicles. Demonstration partners provided suggestions to address such concerns.

Lastly, in terms of adequacy, DBFs have the potential to raise the same amount of revenue as the motor fuel tax and cover roadway expenditures if the revenues are earmarked for this purpose. Similarly, DBFs have the potential to keep up with transportation costs if the DBF rate is increased regularly through periodic rate adjustments or indexing. Without an adjustment factor, transportation agencies will ultimately run into the same issue they are currently experiencing with the motor fuel tax.

CHAPTER 2: 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, 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 (Federal Highway Administration, 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

CHAPTER 3: 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.

CHAPTER 4: EVALUATION FINDINGS

This section discusses the findings from evaluation of the Minnesota DBF demonstration on the basis of the four revenue-evaluation principles of efficiency, equity, adequacy, and feasibility. In this report, feasibility is discussed first, as it was the focus of this demonstration.

4.1 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 (subsection 4.1.1), while *political feasibility* assesses public approval associated with the collection of distance-based fees (subsection 4.1.2).

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.

4.1.1 Administrative Feasibility

4.1.1.1 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 4.3 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.

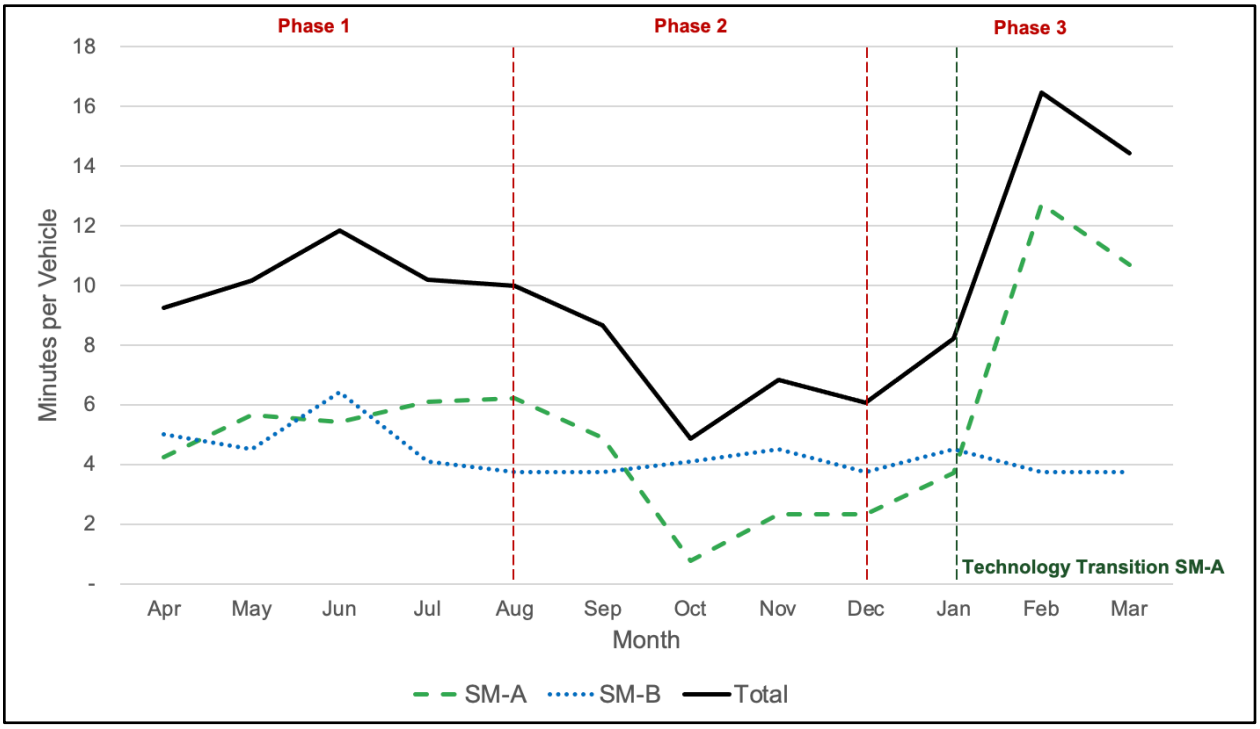

Figure 4.1 Time SM Providers Spent on Demonstration-Related Tasks

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 A 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.

4.1.1.2 Ease of Administration for C/AV Technology Provider

The connected and automated vehicle (C/AV) technology provider conducted two official tests[1] 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 4.2).

Table 4-1 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

[1] 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.

4.1.1.3 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[2] 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

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

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 B.

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.[3] 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.

[3] 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.

4.1.1.4 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 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.[4]

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

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.[5] However, it would largely depend on the size of the fleet, the organization of the company's records, 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.[6] 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 4.3 presents the monthly datasets considered in the mock audits.[7]

Table 4-2 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.

[5] The Department estimates that an audit under the current motor fuel tax typically is conducted in 80 hours or less.
[6] 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.
[7] In addition, the auditor randomly selected unique vehicle IDs to cross-validate the overall robustness of the other monthly revenue reports.

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.
- 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'[8] 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.[9] 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.

[8] '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.

[9] According to the auditor, involving SM providers was not necessary as WSP had sufficient information due to their involvement in the demonstration process.

4.1.2 Political Feasibility

4.1.2.1 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 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.[10] 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 simulated DBF charge based on their total VMT reported and a DBF rate of 2.7 cents per mile.[11] 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.[12]

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.

4.1.2.2 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

[10] 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.
[11] 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.
[12] 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.

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 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 4-3 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 4-3 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 C.

4.2 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.

4.2.1 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.

4.2.2 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.[13] 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,[14] 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.[15] 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.

[13] 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.
[14] 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]).
[15] For example, if the distributor purchases 10,000 gallons on the first of June, the tax is due on July 23.

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.[16] 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.

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.

4.2.3 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.

[16] The state law requires taxpayers to file and pay fuel tax returns electronically.

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.

4.2.4 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.[17] 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.

4.3 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, 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.

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

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.

4.3.1 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,[18] the providers believe arguments can be made in favor or against 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

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

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.

4.3.2 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.

4.3.3 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,[19] 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.

4.3.4 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

[19] 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 – MnDOT (2021)). (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.[20]

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.

4.4 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.

4.4.1 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.

[20] 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.

4.4.2 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.

CHAPTER 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.

5.1 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.

5.1.1 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.

5.1.2 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.

5.1.3 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.

5.1.4 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.

5.2 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 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.[21] 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.

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.

[21] 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.

5.4.1 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.

5.4.2 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.

5.4.3 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.

5.4.4 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.

5.4.5 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[22] 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 vehicle 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.

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

CHAPTER 6: CONCLUSION

The Minnesota DBF demonstration successfully showcased the potential to collect DBF from SM providers. Overall, the administrative and political feasibility of DBFs is likely to improve over time. Similarly, in terms of efficiency, this demonstration improved some of the SM providers' internal processes and identified potential changes in their operations that would likely impact driving patterns. The demonstration also brought up several factors that may improve and limit the efficiency in fee collection, integration with other charges, and fee auditability. In terms of equity, while demonstration partners believe that a system based on miles traveled would more accurately reflect the use of the roadway infrastructure, they brought up several concerns to consider for a future DBF implementation. These include increased operating costs for the intermediary collecting organization (SM providers in this demonstration) as well as social, modal, and geographic equity concerns. In terms of adequacy, DBFs have the potential to raise the same amount of revenue as the motor fuel tax and cover roadway expenditures if the revenues are earmarked for this purpose. Similarly, DBFs have the potential to keep up with transportation costs if the DBF rate is increased regularly through periodic rate adjustments or indexing.

Demonstration partners and participants of roundtable events suggested MnDOT consider other approaches for future demonstrations or pilot projects. The suggestions include considering other partners to act as the intermediary collecting organization such as OEMs and car rental companies; launching a pilot project that collects DBF charges from vehicles such as EV owners willing to swap out the standing EV fee for a DBF; and engaging in a national or Midwest pilot.

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APPENDIX A : 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 A-2 presents the costs of the initial existing technology and the new technology acquired during the transition from one of the SM providers.

Table A-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 B: 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 C: 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.