Integrating Shared Mobility into Multimodal Transportation Planning:

Improving Regional Performance to Meet Public Goals

February 2018

Prepared for:
U.S. Department of Transportation
Office of Planning, Environment, and Realty
Federal Highway Administration

FHWA-HEP-18-033

U.S. Department of Transportation
Federal Highway Administration

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
02/12/2018	Final Report	September 2016 – February 2018

4. TITLE AND SUBTITLE
Integrating Shared Mobility into Multimodal Transportation Planning: Improving Regional Performance to Meet Public Goals

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
McCoy, Kevin; Andrew, James; Glynn, Russell; Lyons, William

5d. PROJECT NUMBER
51HW2LA400

5e. TASK NUMBER
QD347, QB741, RD347, RB741

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Office of the Assistant Secretary of Transportation for Research and Technology
John A. Volpe National Transportation Systems Center
55 Broadway
Cambridge, MA 02142

8. PERFORMING ORGANIZATION REPORT NUMBER
DOT-VNTSC-FHWA-18-13

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Federal Highway Administration
Office of Planning
U.S. Department of Transportation 1200 New Jersey Avenue,
SE Washington, DC 20590

10. SPONSOR/MONITOR'S ACRONYM(S)
FHWA

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
FHWA-HEP-18-033

12. DISTRIBUTION / AVAILABILITY STATEMENT

No restrictions

13. SUPPLEMENTARY NOTES
FHWA Project Contacts Harlan Miller and Corbin Davis, Office of Planning, Email:Harlan.Miller@dot.gov; Corbin.Davis@dot.gov

14. ABSTRACT
New shared mobility services have become increasingly common and important modes of travel in U.S. cities, but transportation planning practices are only beginning to adapt in response. This white paper provides a framework and examples to assist transportation agencies – Metropolitan Planning Organizations (MPOs), local governments, transit agencies, and states - in anticipating and planning for shared mobility as part of a higher-performing regional multimodal transportation system. It synthesizes noteworthy practices in 13 metropolitan areas collected from online research and conversations with planning practitioners, identifies challenges and opportunities, and provides recommendations for future research needed to improve planning practices related to shared mobility.

15. SUBJECT TERMS
Shared mobility, metropolitan planning, transportation planning, multimodal planning, data sharing, bikesharing, carsharing, mobility technology, transportation network companies, TNC, new mobility, ridesharing

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			Harlan Miller
N/A	N/A	N/A	None.	46	**19b. TELEPHONE NUMBER** *(include area code)* (202) 366-0847

Contents

Figures and Tables ..... **iii**
Abbreviations and Symbols ..... **iv**
Executive Summary ..... **v**
Introduction **1**
About This White Paper 2
Themes from Prevous FHWA Ridesharing and TDM Research 2
What is Shared Mobility? 3
Why is Shared Mobility Relevant to Regional Multimodal Transportation Planning? 4
Research Methodology **7**
Nationwide Scan 7
Desk Research 8
Conversations with Public Agency Planners 9
External Review Group 10
Framework for Shared Mobility in Regional Transportation Planning **11**
Framework for Integrating Shared Mobility in Regional Transportation Planning 11
Roles for Public Agencies in Regional Shared Mobility Planning 13
Shared Mobility Issues, Opportunities, and Challenges in Regional Multimodal Transportation Planning 16
Emerging Practices and Strategies **20**
Data Access and Sharing 21
Regulating Use of Public Infrastructure 23
Strategic Planning 24
Operational Partnerships 25
Publicly Operated Shared Mobility Services 27
Integrating Shared Mobility into Modeling and Forecasting 28
Recommendations for Future Research **32**
Overcoming issues with sharing proprietary data 32
Data standards and guidance 33
Shared mobility and travel demand modeling 33
Integration of shared mobility in plans, visions, and performance measures 34
Model agreements between shared mobility providers and public sector agencies 34

Generating revenue from shared mobility for public infrastructure 34
Best practices in investing in and regulating use of public infrastructure 35
In-depth case studies 35
Comparison with international approaches 36
Emissions and air quality programs and shared mobility 36
Impact of shared mobility on freight delivery 36
Multimodal integration through technology 36
Conclusion 37
Acknowledgements 38
Appendices 40
Appendix A: Works Cited 40
Appendix B: Operating Shared Mobility Services in Metro Areas (as of May 2017) 42
Appendix C: Mention of Shared Mobility in Planning Documents (as of May 2017) 43
Appendix D: Definitions 44
Appendix E: Additional Resources 46

Figures and Tables

Figure 1	Illustration of Integration of Shared Mobility with the Multimodal Planning Process	Page 1
Figure 2	Shared Mobility Includes Traditional and Emerging Services	Page 3
Figure 3	Illustration of the Effects of Shared Mobility on User Behavior and the Transportation Planning Process	Page 4
Figure 4	Map of Metropolitan Areas Studied	Page 8
Figure 5	Conceptual Framework for Visualizing Shared Mobility Integration with Regional Multimodal Transportation Planning Process	Page 12
Table 1	Planning Products Reviewed in Desk Research	Page 9
Table 2	Potential Roles for Public Agencies in Shared Mobility Planning	Page 14
Table 3	Transportation Planning Issues, Opportunities, and Challenges Associated with Shared Mobility	Page 16
Table 4	Emerging Practices and Strategies for Shared Mobility in Transportation Planning	Page 20

Abbreviations and Symbols

AV	Automated Vehicle
BART	Bay Area Rapid Transit
CMP	Congestion Management Process
CMAP	Chicago Metropolitan Agency for Planning
DOT	Department of Transportation
FHWA	Federal Highway Administration
GPS	Global Positioning System
HOV	High-Occupancy Vehicle
IT	Information Technology
ITS	Intelligent Transportation Systems
KCATA	Kansas City Area Transit Authority
LA Metro	Los Angeles County Metropolitan Transportation Authority
LRTP	Long Range Transportation Plan
MARC	Mid-America Regional Council
Metro Council	Metropolitan Council of Minneapolis-Saint Paul
MOD	Mobility On Demand
MPO	Metropolitan Planning Organization
MTC	Metropolitan Transportation Commission
PBOT	Portland Bureau of Transportation
P2P	Peer-to-Peer
PII	Personally-Identifiable Information
SCAG	Southern California Association of Governments
SF Bay	San Francisco Bay
STIP	Statewide Transportation Improvement Program
TDM	Transportation Demand Management
TIP	Transportation Improvement Program
TNC	Transportation Network Company
TriMet	Tri-County Metropolitan Transportation District of Oregon
UCSF	University of California-San Francisco
UPWP	Unified Planning Work Program
VMT	Vehicle Miles Traveled
WATS	Washtenaw Area Transportation Study

Executive Summary

New shared mobility services driven by technological advancements have become increasingly common and important modes of travel in U.S. cities but transportation planning practices are only beginning to adapt in response. These innovations show potential to improve mobility and address transportation challenges. However, failure to integrate shared mobility with the established system of roads, public transit, and other modes and services could diminish this potential, create greater challenges, or limit progress toward public goals.

This white paper provides a framework and examples to assist transportation agencies in anticipating and planning for shared mobility as part of a higher-performing regional multimodal transportation system. It synthesizes noteworthy practices in 13 metropolitan areas as of spring/summer 2017 collected from online research and conversations with planning practitioners, identifies challenges and opportunities, and provides recommendations for future research needed to improve planning practices related to shared mobility.

MPOs, local governments, transit agencies, and states are positioned to each play different, complementary roles in shared mobility planning. For example, regulation of shared mobility operations is typically the purview of local and state governments. Transit agencies have shown an ability to form partnerships with shared mobility providers. MPOs are uniquely positioned to lead regional coordination and consensus building activities because of their traditional role as a regional convener.

Each region examined in this research is taking a different approach to addressing shared mobility in the planning process but the white paper provides four general models to conceptualize how this is occurring:

- **Lighthouse Model:** Leadership from an individual or agency to formulate an approach to integrating shared mobility which inspires others to follow a similar path
- **Strategic Model:** Focusing first on a high-level strategic vision intended to drive more specific planning efforts later
- **Operational Partnership Model:** Engaging with shared mobility companies to experiment and pilot innovative approaches to working together to address regional goals
- **Watch and Learn Model:** Focusing on research and thought leadership while seeking more information about how to incorporate shared mobility into planning processes

Transportation agencies in the studied metropolitan areas identified several issues associated with shared mobility, several of which present both opportunities as well as challenges. Many agencies see potential for shared mobility to help improve safety and mobility for people who do not own a vehicle, for increasing transit access, and providing new transportation options. However, many agencies are somewhat uncertain or conflicted on other topics, noting that shared mobility may have either positive or negative consequences for goals such as social equity, congestion reduction, air pollution and climate change mitigation, land-use sustainability, and infrastructure finance (see table below).

The intersection of shared mobility with a broad range of transportation planning goals is in itself a challenge for MPOs and their partners, creating a situation where it is difficult to coordinate, even internally, and to stay connected to everything the agency and partners are doing on shared mobility.

Transportation Planning Issues, Opportunities and Challenges Associated with Shared Mobility

Issues	Opportunity	Challenge
Safety – Reduction of Serious Injuries and Fatalities	☑	☑
Enhanced Mobility for Persons Without A Vehicle	☑	
Equitable Access to Shared Mobility Services	☑	☑
First/Last Mile Connections / Expanded Access to Public Transit	☑	
Congestion Reduction	☑	☑
Reduction of Air Pollutants and Greenhouse Gas Emissions	☑	☑
Sustainable Urban Density and Land Use	☑	☑
Increased Multimodal Transportation Options and Integration	☑	
Sustainable Revenue Model for Public Infrastructure	☑	☑

Several MPOs and their partners are beginning to engage in new practices to approach these issues, and are developing insights about future developments. In general, these emerging practices and strategies, discussed in detail in the white paper, can be grouped in the following topics:

- Data access and sharing between the private and public sector
- Regulation of the use of public infrastructure by shared mobility services
- Implications of shared mobility on strategic and long-range transportation planning
- Operational partnerships for the use of shared mobility to promote public goals
- Publicly operated shared mobility services
- Integrating shared mobility into modeling and forecasting
- Providing technical assistance to local government

Despite uncertainty inherent in these new modes of transportation, MPOs should feel empowered to continue to experiment and explore new approaches to anticipating and accounting for shared mobility in the planning process. Without input from the public and stakeholders, which are established key components of the planning process, changes in the provision of transportation services and infrastructure may not realize the potential to address important public goals. As facilitators of collaborative regional decision-making, MPOs are uniquely situated to play a leadership role in shared mobility planning activities.

Introduction

Metropolitan planning organizations (MPOs), and their state and local planning partners are facing a critical challenge to their responsibilities to plan and deliver comprehensive, high-performing multimodal transportation networks that meet community goals. Shared mobility technologies developed and operated by private sector providers, sometimes in combination or in place of traditional modes of transportation, are becoming increasingly common and popular. These innovations show potential to improve mobility and address persistent transportation challenges. However, failure to integrate shared mobility with the established system of roads, public transit, and other modes and services could diminish this potential and may create greater challenges or erode progress toward public goals.

This white paper establishes a framework for shared mobility integration with regional multimodal planning and provides examples of emerging practices. MPOs, states, cities, counties, and transit agencies can use these to inform their own thinking, to explore potential partnerships with shared mobility companies, and to anticipate and plan for shared mobility as part of the future multimodal system.

Carpooling and public transit have long been important shared mobility modes in transportation planning and system operations, but technological advancements, new business models, and a generational shift in attitudes around shared services may significantly alter future mobility patterns. These changes have far reaching implications for transportation, land use, and development, and should catalyze action by planning agencies. This whitepaper is written with the expectation that if MPOs and their partners act on opportunities to integrate shared mobility into regional transportation systems, regions could potentially address more of the mobility needs of their constituents and improve overall system performance. Advances in technology and resulting travel behavior changes will occur with or without participation by these public sector agencies. However, without the leadership of public organizations like MPOs, an opportunity to help shape the future of regional mobility in service to the public will be lost.

Figure 1 illustrates the potential role multimodal planning can play in delivering a higher performing transportation system in combination with shared mobility. Transit agencies and managers of roadway infrastructure have long been included as part of the multimodal planning process, but as private shared mobility operators capture more travel, there is a need to bring these modes into the planning process to ensure the highest possible performance of the multimodal system.

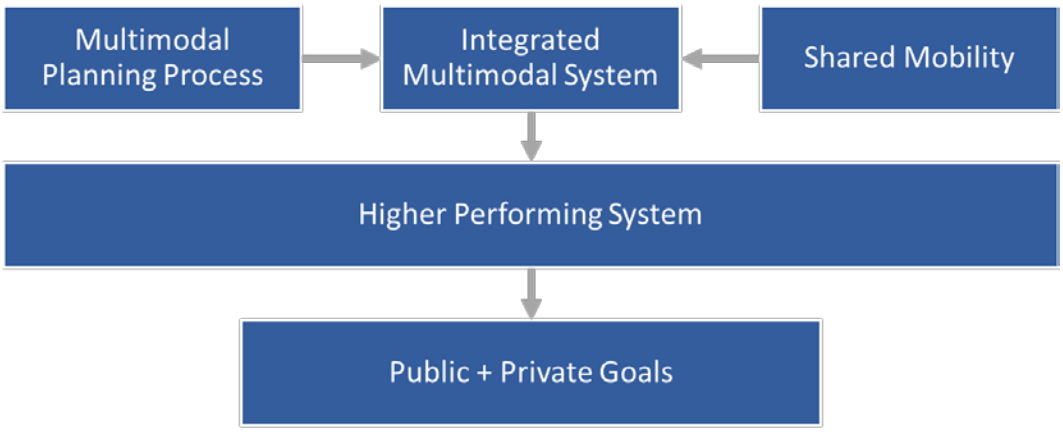

Figure 1: Illustration of Integration of Shared Mobility with the Multimodal Planning Process

About This White Paper

The purpose of this white paper is to support MPOs and their planning partners in exploring how to bring shared mobility technologies and strategies into multimodal transportation planning and project implementation. This white paper takes a particular focus on the activities of MPOs but also discusses regional planning stakeholders that work with MPOs like counties, cities, state Departments of Transportation (DOTs), and public transit agencies. Because this topic is defined by rapidly-changing technology, approaches by MPOs and partners to address shared mobility must be considered as works-in-progress as they experiment and try out new pilot projects, consider important uncertainties and risks, and re-evaluate approaches to regional planning and future multimodal systems.

This white paper synthesizes noteworthy practices in 13 metropolitan areas as of Spring/Summer 2017. It does not provide case studies of successful engagement in shared mobility planning, but instead describes trends and provides examples of specific initiatives MPOs and other public agencies are pursuing related to shared mobility. It also describes observations and recommendations from researchers and practitioners about the challenges and opportunities shared mobility presents to the established goals of the metropolitan planning process. The white paper provides a framework to assist readers in approaching shared mobility and multimodal planning in a comprehensive manner, and includes recommendations for future research to advance shared mobility planning practices.

The research team reached its conclusions using a combination of literature review, discussions with practitioners, and feedback from an external review group. Some examples cited are specific to certain cities or regions, while others are more generalized. The authors are not recommending a specific approach or endorsing one example over others and recognize that there are notable regions and examples not discussed in this white paper.

Themes from Prevous FHWA Ridesharing and TDM Research

This research builds upon topics previously explored through the FHWA Office of Planning's series on ridesharing and transportation demand management (TDM), including the following publications:

- Ridesharing, Technology, and TDM in University Campus Settings: Lessons for state, regional, and local agencies
- Moving Together in the 21st Century: How Ridesharing Supports Livable Communities
- Developing a Regional Approach to Transportation Demand Management and Nonmotorized Transportation: Best Practice Case Studies

FHWA's prior research broadly captured practices across a range of stakeholders in the realm of emerging shared mobility technologies and supportive policies. These white papers presented several case studies of MPOs, university campuses, and other stakeholders that are combining TDM and shared mobility options to support attractive alternatives to single-occupant vehicle travel, in some cases with dramatic results. The research also demonstrated the potential for a "tipping point" beyond which shared mobility options could work in consort with more traditional TDM options (e.g., transit, nonmotorized transportation, parking, pricing, and traditional ridesharing) to support a more dynamic mobility future in some regions. When taken in combination, these modes have the potential to produce greater trip reduction benefits than any could individually ("the whole is greater than the sum of its parts") and to perhaps be considered a notable new transportation option built of numerous constituent multimodal parts. This new option might potentially be considered a "modal equivalent" at a regional scale within the multimodal system, alongside and in combination with traditional transit and road alternatives.

What is Shared Mobility?

For the purposes of this white paper we use the definition in FHWA's Shared Mobility: Current Practices and Guiding Principles. Figure 2 visualizes the shared mobility service models currently captured by the definition, recognizing that new services and models are constantly being introduced, which may require this definition to evolve. Under this definition, shared mobility is "... the use of a motor vehicle, bicycle, or other low-speed mode" in a way that "enables users to obtain short-term access to transportation as needed, rather than requiring ownership."

Traditional shared mobility includes established systems like public transit and taxis, whereas emerging applications implement innovative technologies or service models. These emerging services include carsharing, bikesharing, peer-to-peer or fractional ownership schemes, and on-demand ride services. Ridesourcing, the service offered by transportation network companies (TNCs) like Uber and Lyft, and ridesplitting, the splitting of fares and rides by TNC users, are also included in this definition (Ridesourcing and TNC are used interchangeably in this paper). Courier network services and other flexible goods delivery platforms are also included as well as corporate shuttle buses and dynamic route bus services (sometimes called "microtransit"). Examples that fall in the middle, such as carpooling, are traditional models changed or enhanced but not entirely replaced by emerging technology. Technology-enabled emerging services which pose new opportunities and risks for transportation planners are the focus of this white paper.

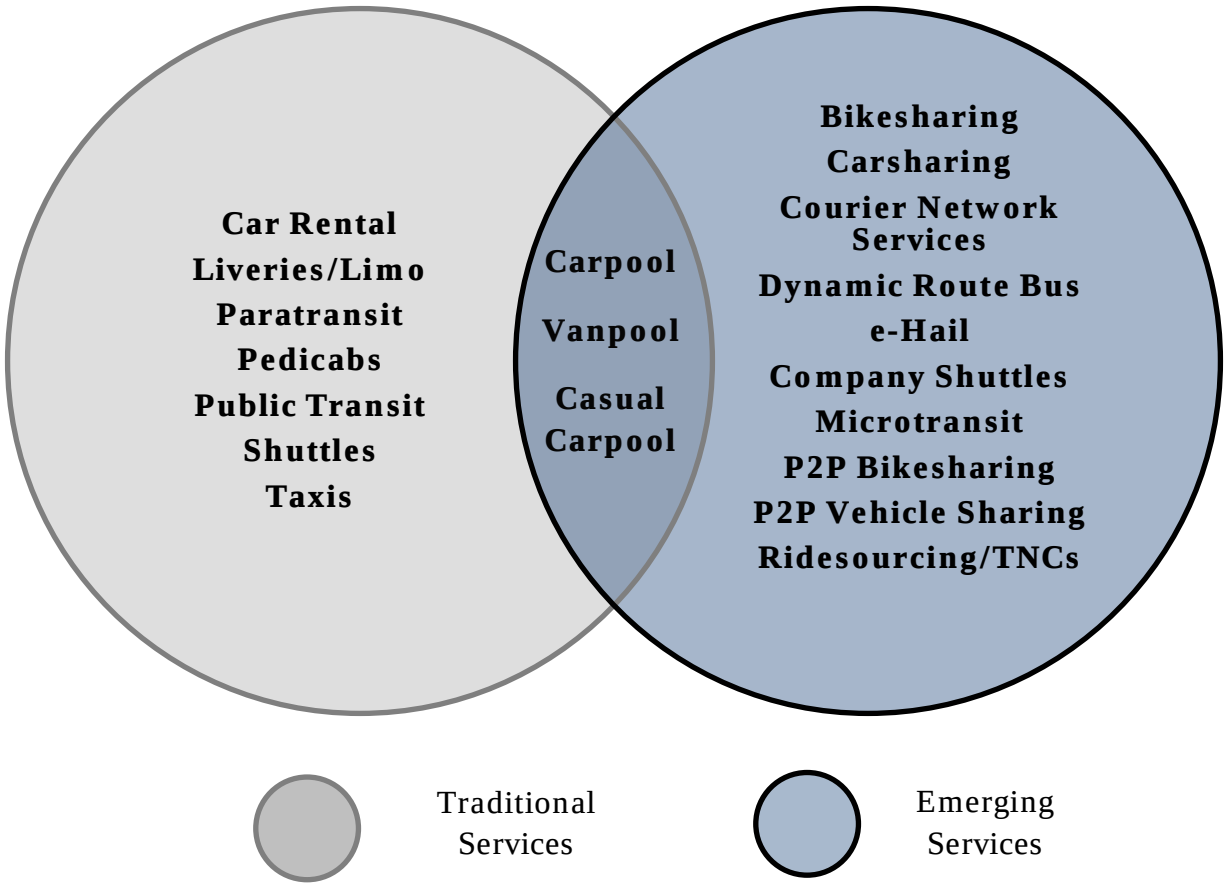

Figure 2: Shared Mobility Includes Traditional and Emerging Services
Adapted from Shared Mobility: Current Practices and Guiding Principles (FHWA)
See Abbreviations Table and Appendix D for definitions

Why is Shared Mobility Relevant to Regional Multimodal Transportation Planning?

While advances in technology are changing the transportation landscape in urban areas nationally and globally, the roles and responsibilities of public agencies remain the same. As reinforced in federal legislation, MPOs are charged to work collaboratively with their partners and stakeholders to play a leadership role in the "continuing, cooperative, and continuous" multimodal planning process.

MPOs are challenged to plan and implement high-performing multimodal transportation systems that guide investments to advance community visions, priorities, policies, and goals. Transportation goals, defined at national, state, and regional or local levels, can include maintaining the condition of vital transportation infrastructure, ensuring public safety, reducing traffic congestion, improving air quality, and providing service to those with limited transportation options, among other goals. Growing evidence shows a relationship between shared mobility and shifts in travel behavior, but the exact nature of the relationship remains unclear. However, it is clear that shared mobility is relevant to the regional planning goals pursued by MPOs.

The relationship between shared mobility and transportation planning is not one way. Plans and decisions of MPOs and their partners shape user behavior through investments in evolving regional transportation networks. Similarly, MPO planning goals and products are shaped by user behavior and preferences. This circular relationship is an important feature that underscores the complexity of incorporating shared mobility into the planning process (Figure 3).

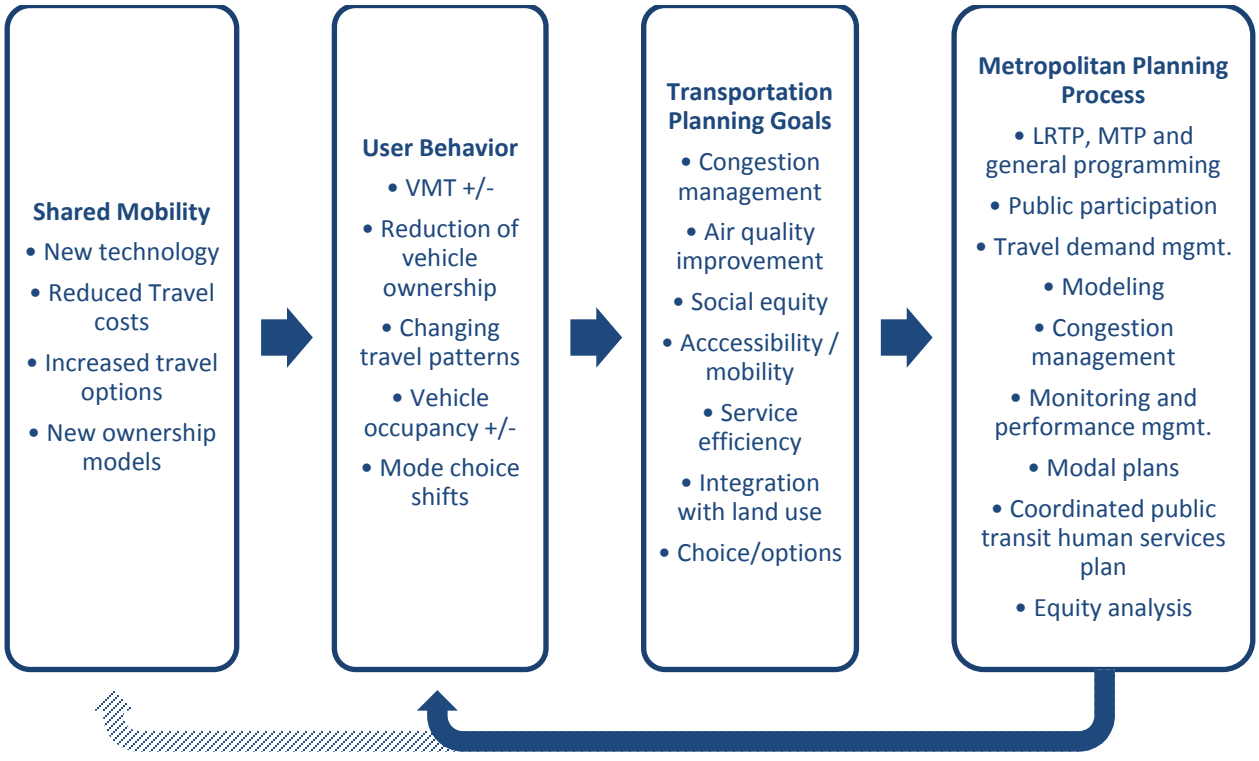

Figure 3: Illustration of the Effects of Shared Mobility on User Behavior and the Transportation Planning Process (see Acronyms list)

Impacts of Shared Mobility on Travel Behavior

Because shared mobility technologies and services are changing so rapidly, researchers and practitioners are only beginning to explore their effects on travel behavior and the body of research is still limited.

Research has demonstrated that the use of shared mobility services can have an impact on individuals' vehicle miles traveled (VMT), though the nature of this impact – whether VMT increases or decreases – is a matter of debate, and the impacts likely vary depending on which type of shared mobility service is used. For example, some studies have found that members of traditional carsharing schemes may cut back their total VMT, eliminating some single-occupant trips and potentially reducing the number of vehicles on the road (see references 1 and 2 in Appendix A). However, recent research on ridesourcing apps has at times both challenged and supported similar findings regarding impact on VMT and greenhouse gas emissions, with some studies finding that ridesourcing increases VMT (see references 3, 4, 6, 8, 9, and 10 in Appendix A).

Similarly, the relationship between emerging ridesourcing and ridesplitting services and public transit is uncertain. While some studies have suggested that shared mobility options tend to substitute for private automobile trips, complementing and perhaps even increasing the number of public transit riders (see references 4 and 5 in Appendix A), others have found that ridesourcing apps support a shift away from fixed-route bus and light rail services towards on-demand shared vehicles (see references 7, 8, 9, and 10 in Appendix A).

While these studies have not produced a consensus within the transportation research community on the particular behavioral shifts and systemic impacts associated with shared mobility, they underscore the importance of the evolution in shared mobility services to planners and public sector stakeholders.

A Quickly Evolving Landscape of Transportation Technologies

The Apple iPhone – the device which popularized and mainstreamed smartphones and the basis for much of the recent technology change in transportation – was only introduced ten years ago (in 2007). The pace at which transportation technology has evolved following the introduction of the smartphone shows how quickly new, unanticipated technologies may appear and further disrupt the way people get around.[1]

The rapid development of these technologies makes it challenging to adequately plan for them with limited resources because we do not know for sure how this landscape will shift in five, ten, or more years. Adding to uncertainty are questions about the sustainability of several of these new technology business models as large and small for-profit shared mobility companies work to establish viability in rapidly changing markets.

Recent Developments in Transportation Technology and Services

Some notable developments in shared mobility include the explosive growth in the use of ridesourcing applications for smartphones from TNCs. These companies continue to offer new types of services beyond the "taxi-like" model of single ride/rider such as Lyft Line and UberPOOL, where customers can purchase a lower-cost trip if they are willing to deviate slightly from their route and ride with others (e.g., "ridesplitting"). Ridesourcing companies have also emerged as potential partners in the delivery of paratransit and first/last-mile services, with the potential to make public transit more accessible and to

[1] For more information on how smartphones have affected transportation see Smartphone Applications to Influence Travel Choices: Practices and Policies (FHWA).

reduce the costs of providing certain services. In some cases, shared mobility is being considered as a replacement or substitute for traditional public transit services, in particular for areas which are difficult to serve well with fixed-route service. Microtransit companies are also entering the market with services much like jitneys, where pooled vehicles operate on a more-or-less fixed route. However, all of these services appear to provide subsidies to customers to keep prices low and to compete with others. Some early TNC and microtransit companies have already folded.

Rapid change in shared mobility is happening in nonmotorized transportation as well; the bikesharing industry may be on the verge of a major paradigm shift in several markets with the advance of free-floating dockless bikesharing systems, expanding flexibility of use. However, these free-floating bikesharing systems are already opening up new complications for transportation planners and generating concerns about cluttering the public realm.

Automated Vehicles and Mobility on Demand

Further innovations are on the horizon, with billions of dollars being invested in developing automated vehicles (AVs) and integrated mobility service delivery models sometimes called Mobility on Demand (MOD).[2] Urban areas in the U.S. and around the world appear to be at the tip of a wave of technology innovation with the potential to disrupt traditional ways we move goods and access jobs, education, recreation, and other services. Shared mobility companies often promote the potential for these new technologies to combine with their services in ways which could improve safety, mobility, and foster a new form of integrated, seamless multimodal travel, in combination with the business models of the private sector.

This future and the promised benefits for the public are far from certain, and perhaps unlikely to occur without an intentional and proactive effort to ensure that shared mobility and AVs converge in an efficient and productive manner. These and other changes in transportation technology may require a proportionate evolution in how metropolitan areas, states, and cities plan and operate regional-scale multimodal transportation systems, in order to ensure that public goals are being addressed. Without understanding and accommodating this rapid evolution, MPOs and partners risk planning for yesterday's transportation system rather than tomorrow's. Incorporating today's shared mobility technologies into regional transportation planning may be only the first of many responses needed for MPOs and other public agencies to adapt and remain effective.

This white paper explores how MPOs and their partners are attempting to account for the potential of shared mobility in their multimodal transportation planning process and in their plans and investment decisions. Automation and MOD are discussed as relevant potential future advancements, however, they are not the focus of this white paper.

[2] Mobility on Demand is an innovative transportation concept, evolving around connected travelers, where consumers can access mobility and goods delivery services on demand by dispatching or using public transit, shared mobility, courier services, unmanned aerial vehicles (UAVs), drones, and other innovative and emerging technologies. For more information on MOD see Mobility on Demand Operational Concept Report (Intelligent Transportation Systems Joint Program Office).

Research Methodology

Our research approach consisted of three primary components: a scan of relevant shared mobility activities in metropolitan areas nationwide, an in-depth desk review of activities within 13 metropolitan areas, and a series of structured follow-up conversations with public agency contacts in several of these metropolitan areas. The research team established an external review group of shared mobility and transportation planning practitioners and researchers at the onset of the research.

Nationwide Scan

Research began with a scan of metropolitan areas across the country for innovative approaches to shared mobility that integrated emerging services into the formal planning process. For the purpose of the initial national scan, integration was understood to include a broad range of planning activities such as vision setting, other strategic long range planning, communication efforts, partnerships, policy development, regulation, and technical analysis. The goal of the scan was to identify promising metropolitan areas for more in-depth investigation, and to begin framing a comprehensive approach that might be of value to peers nationwide.

The research team reviewed media coverage, academic journals articles and reports, and planning agency documents and websites from a range of transportation stakeholders, documenting instances where shared mobility was addressed. Transportation stakeholders investigated included MPOs and their partners in the regional transportation planning process such as transit agencies, local governments, and state DOTs.

From the national scan the research team ultimately identified a list of thirteen metropolitan areas where it observed evidence of planning for shared mobility. In selecting areas for further investigation the research team also weighted factors such as population size, geography, and land use typologies in order to ensure a diverse set of planning contexts across the country.

The thirteen metropolitan areas selected for further investigation included (Figure 4):

- Austin
- Boston
- Chicago
- Columbus
- Dallas-Fort Worth
- Detroit-Ann Arbor
- Kansas City
- Los Angeles
- Minneapolis-St. Paul
- Portland
- San Francisco Bay
- Seattle
- Tampa-St. Petersburg

Figure 4: Map of Metropolitan Areas Studied

Desk Research

The research team conducted an in-depth desk review of the shared mobility context and planning activities within each region in spring 2017. In order to consistently and systematically assess activities within each metro area, the team developed a research guide that outlined specific planning products to review as well as key shared mobility planning themes. The desk research phase provided the research team with a surface-level understanding of what shared mobility looks like in these metropolitan areas (e.g., which options are available from which providers) as well as evidence of how shared mobility is being brought into planning activities at various scales. The results are summarized in Appendix C.

The planning products reviewed originated from a range of public sector transportation stakeholders, including MPOs, city governments, state DOTs, and transit agencies. Examples of planning products included in the desk review are MPO or state DOT Long Range Transportation Plan (LRTP), MPO Transportation Improvement Program (TIP), Statewide Transportation Improvement Program (STIP), transit agency plans, local strategic transportation plans, and special purpose or corridor plans. Table 1 outlines the plans and other resources reviewed as part of the desk research phase.

Table 1: Planning Products Reviewed in Desk Research

Document Type	Agency Types
Vision Plan	MPO
Long Range Transportation Plan (LRTP)	MPO, State DOT, Local
Unified Planning and Work Program (UPWP)	MPO
Transportation Improvement Program (TIP) or Statewide Transportation Improvement Program (STIP)	MPO, State DOT
Congestion Management Process (CMP)	MPO
Transit Development Plans	Transit
Special Purpose Plans	MPO. State DOT, Local, Transit
Corridor Plans	MPO, State DOT, Local
Agency Website	MPO, State DOT, Local, Transit

The research team also investigated the context of shared mobility operators within each metropolitan area. The team tracked the traditional and emerging shared mobility services available in each metropolitan area at the time of the desk research (spring 2017). Examples include peer-to-peer car sharing, traditional TNCs, ridesplitting (e.g., Lyft Line or Uber Pool), experimental TNCs (e.g., wheelchair accessible or assisted), docked and free-floating bikesharing, and others. The full list of shared mobility services, based on limited observations during the desk review is provided in Appendix B. Definitions of shared mobility service types are provided in Appendix D.

Conversations with Public Agency Planners

Following the desk review, the research team contacted transportation planning practitioners in many of the metropolitan areas studied to learn more about how shared mobility planning is evolving or may evolve in their regions. The practitioner discussions served to fill in the gaps not covered by the initial scan and desk review, and allowed the research team to gain further insights on specific planning activities and potential future activities.

The research team arranged informal, structured phone conversations with transportation planners, program managers, and researchers at agencies within several of the studied metro areas in the summer of 2017. When possible, the research team included representatives from multiple departments or agencies in order to foster some dialogue on approaches across the region. Several of these calls included members of the external review group, described below.

While the desk review offered the research team a general understanding of efforts to integrate shared mobility in a given metropolitan area, with follow up calls the research team sought to add context about *how and why* agencies are addressing shared mobility in their work. These follow up conversations often included discussion of roles for MPOs and their partners, data access and sharing issues, potential

benefits and challenges of shared mobility, partnerships with shared mobility providers, and the need to plan for shared mobility across varied geographies and time scales.

External Review Group

The research team and FHWA convened an external group of subject matter experts to provide input on the research and review drafts of this white paper. The review group included staff from MPOs, transit agencies, and city departments of transportation, as well as academic researchers and representatives from peer agencies within the U.S. Department of Transportation (see Acknowledgements for a full list of External Review Group members).

Framework for Shared Mobility in Regional Transportation Planning

This section presents a framework for conceptualizing how shared mobility can be incorporated into the regional multimodal transportation planning process to improve the performance of the network and accomplish goals of the community. It also discusses the likely roles and responsibilities that MPOs, transit agencies, local governments, state DOTs and other planning partners may assume to effectively integrate shared mobility into the planning process, and proposes four models for describing how early stage integration is occurring in U.S. metropolitan areas. The framework is a tool for MPOs, transit agencies, and their local and state partners to use in considering how they might approach integration of shared mobility within their transportation planning processes.

Framework for Integrating Shared Mobility in Regional Transportation Planning

Shared mobility represents a new challenge for transportation planners, one largely driven by technological changes advanced by private sector companies. As such, shared mobility is different than the primary planning challenges of the second half of the 20th Century, which were largely driven by the public sector and characterized by incremental technology changes: expansion of highways and fixed route transit, followed by a focus on better operations and management of existing infrastructure.

Shared mobility technology moves fast and unless public agencies are proactive, public goals may not be adequately reflected in the proliferation and roll-out of shared mobility services. Public agencies, responsible for multimodal transportation planning, investments, and operations, may find themselves planning for an outdated network amidst changes driven by private mobility and technology providers. Public agencies risk weakening of their leadership roles in shaping future transportation to meet complex and changing public goals.

Despite the differences between the emerging high-tech shared mobility world and the more predictable highway planning era, MPOs and their partners will likely rely on established planning techniques to integrate shared mobility into regional multimodal transportation planning. MPOs are logical conveners of stakeholders to develop regional-scale transportation policies and partnerships – these types of planning interventions will likely be how MPOs approach shared mobility planning, at least in the near term. They have long served as the body through which decisions about regionally-significant transportation investments are made. These decisions will increasingly need to account for the effects of shared mobility on travel behavior, consider what public infrastructure may be needed to support shared mobility and related technologies, and identify strategies that maximize equitable benefits for the public good. MPOs are a logical venue through which to study and model the impacts of shared mobility on regional transportation, to identify best practices, and provide technical assistance to member agencies throughout the region. In addition to these more established techniques, MPOs and partners can develop partnerships with shared mobility companies to support regional transportation goals.

Figure 5 provides a framework for visualizing how shared mobility may fit into the regional transportation planning process. This framework is applicable both to passenger and freight movement.

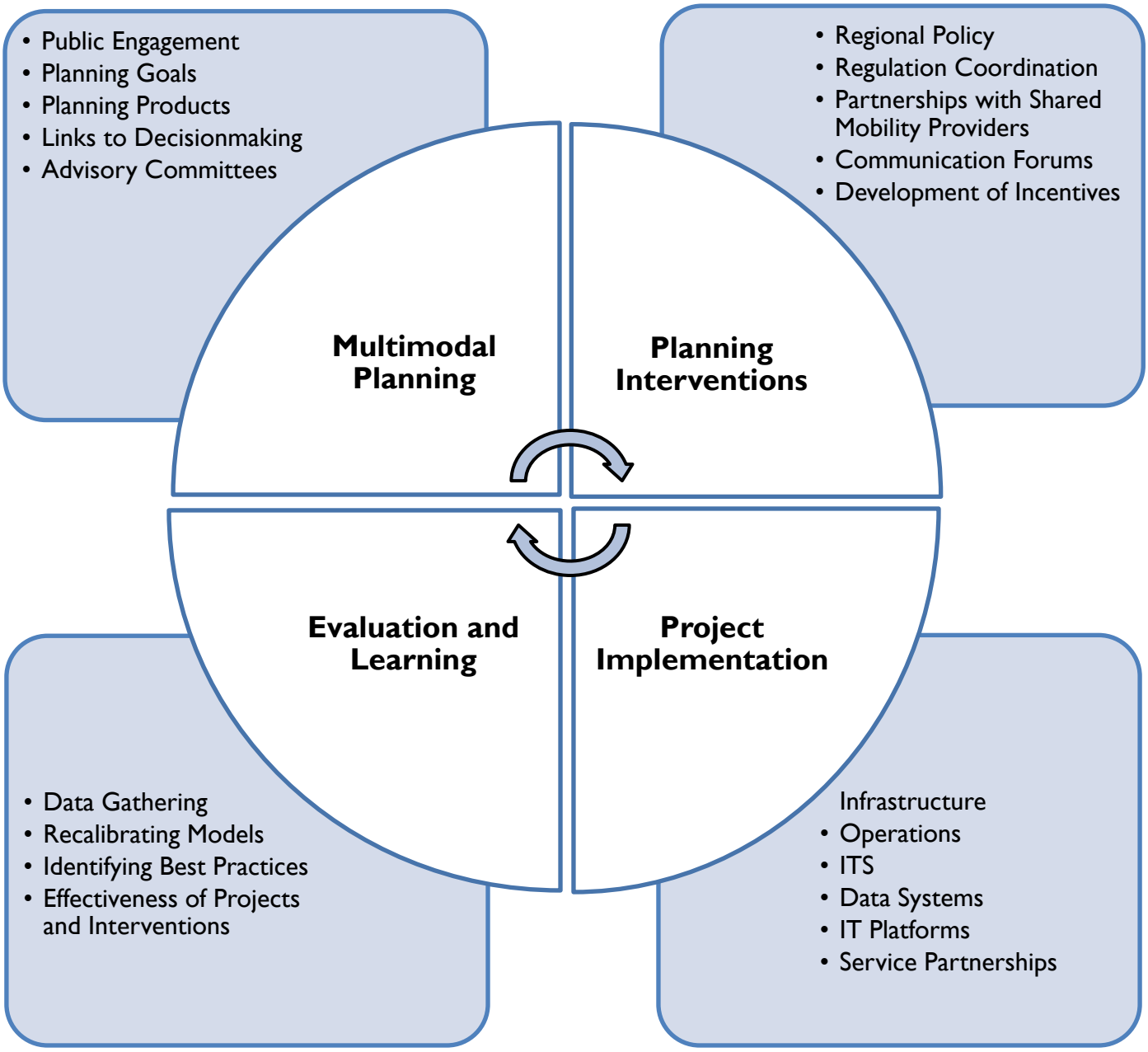

Figure 5: Conceptual Framework for Visualizing Shared Mobility Integration with Regional Multimodal Transportation Planning Process (see Acronyms Table for definitions)

Multimodal Planning

Public planning goals and public engagement are at the core of the regional planning process. It is from this foundation that MPOs and other public agencies collect data, conduct technical analyses, develop project ideas and assessments, define performance measures, and synthesize results into plans. These, in turn, inform a host of decisions about how transportation funds will be invested and the types of planning

interventions and implementation actions the region will pursue. This is no different in a shared mobility context. Planning agencies work to account for shared mobility services as they identify strategies to improve the movement of people and goods, and improve the overall performance of the regional system. MPOs and their partners will approach shared mobility as one of many factors that can help a region achieve its transportation goals, as a risk to be planned for or mitigated, or both. MPOs also often organize technical advisory committees to inform the work of the organization on special topics. MPOs may consider inviting shared mobility providers to participate in technical advisory committees as one way of integrating them into the regional planning process.

Planning Interventions

Planning interventions are the mechanisms through which MPOs and their partners seek to achieve the region's goals. In a shared mobility context these may take a number of different forms, including development of regional policies, coordination of local or state regulations, interagency coordination, partnerships with shared mobility providers, development of new outreach materials, or the development of incentives for shared mobility providers to engage in the regional planning process, to name a few examples.

Project Implementation

Implementation of identified planning interventions is often in the form of options to fund infrastructure, operations and maintenance, or Intelligent Transportation Systems (ITS) projects. Shared mobility opportunities and risks, played out through the planning process, will likely inform future infrastructure decisions – regions may have different infrastructure needs in a high-tech shared mobility future. However, other types of projects may also be needed to ensure that public planning goals are being advanced, either new and innovative projects or enhancement of traditional projects. For example, metropolitan areas are taking creative approaches to the use of publically-owned curb spaces, bus stops, drop-off zones, managed lanes, and enhanced features in mobility hubs to accommodate shared mobility providers under negotiated terms. Non-physical infrastructure investments in data systems, Information Technology (IT) platforms, and service partnerships with shared mobility providers are examples of potential future projects which may come from the integration of shared mobility into the planning process.

Evaluation and Learning

Because technologies are changing rapidly and because MPOs and their partners are still learning how to effectively integrate them into the planning process, it will be important to evaluate the effectiveness of planning interventions and resulting projects. MPOs and their partners are accustomed to monitoring and evaluating the results of plans and investment decisions, and can use data from pilot projects, engagement with shared mobility companies, and regulatory agreements to recalibrate models, identify best practices, and update regional plans and policies to reflect an improved understanding of how shared mobility can successfully fit into regional transportation networks. As technologies continue to change, finding ways to learn and adapt quickly may be increasingly critical for MPOs and partners to remain effective.

Roles for Public Agencies in Regional Shared Mobility Planning

MPOs, local governments, transit agencies, and state DOTs all have roles in regional shared mobility planning, much as they do in most transportation planning activities. Determining the right role for each

agency in each region and agreeing on how to work together to achieve common goals may be the most immediate challenge to effective regional shared mobility planning. In our conversations with planners in regions around the U.S., many expressed that staff are finding it difficult to stay connected with all activities related to shared mobility happening within their own agency– because the impacts to the planning process are so diverse – let alone the activities of their partners and other transportation stakeholders.

To anticipate the potential roles for each agency type, it can be instructive to think through the roles these agencies traditionally fill and the type of influence or control they may have over various factors important to shared mobility planning. In particular, understanding which agencies have regulatory or incentive leverage can help determine the most effective roles for MPOs and their partners.

Table 2 shows likely roles for public agencies in shared mobility planning, although there may be some variation between different regions and states with different planning contexts and enabling laws. For example, the reach, influence, and formal responsibilities of an MPO in one metropolitan area may be significantly different from those in other areas, which may alter the roles, relationships, and general responsibilities for public agencies in shared mobility planning.

Table 2: Potential Roles for Public Agencies in Shared Mobility Planning

	MPO	Local Government	Transit Agency	State DOT
Regulating shared mobility operations		☑		☑
Regulating the use of public right-of-way and curb space		☑	☑	☑
Data collection, analysis and dissemination	☑	☑	☑	☑
Partnerships with shared mobility providers to complement transit or TDM	☑		☑	
Training and technical assistance for regional partners	☑			
Thought leadership and research	☑			☑
Regional coordination and consensus building	☑			
Integration into transportation plans and programs of projects	☑	☑	☑	☑

Models for Describing Early-Stage Development of Shared Mobility Planning in Metropolitan Areas

MPOs and their partners are just beginning to experiment with integrating shared mobility into the regional transportation planning process. There is no one size fits all approach. However, there are some patterns worth exploring to help understand how this is taking place and to help regions learn from each

other. This section proposes four models for generalizing the unique ways in which shared mobility is being integrated into regional transportation planning in the metropolitan areas researched. These models can be seen as developing either bottom-up from the local level and then influencing regional and statewide approaches, or strategically from the top-down.

The following examples illustrate key concepts, with a recognition that every region is unique and that many exhibit characteristics of two or more models.

Lighthouse Model

In many regions we researched a champion has emerged on this topic. In this model, one individual or agency is taking the lead and formulating an approach to integrating shared mobility while also encouraging partners to follow a similar path. The Los Angeles metropolitan area may be an example of this model, where the mayor of the city of Los Angeles has put an emphasis on shared mobility planning, which has inspired others in the region to take it on as a priority topic, such as the Los Angeles County Metropolitan Transportation Authority (LA Metro).

Strategic Model

Some regions appear to be focusing on high-level strategic planning and long-range visioning in their approach to incorporating shared mobility into transportation planning. Chicago is an example of such a region, where the Chicago Metropolitan Agency for Planning (CMAP) is working to organize local governments and planning partners to address shared mobility through the development of a new regional long-range plan. In this model, strategies and projects to address shared mobility might filter down from the regional to the local level and may influence policies at the statewide scale or in other areas of the state.

Operational Partnership Model

Transit agencies and MPOs in several regions are experimenting with pilot projects and partnerships where they work directly with shared mobility providers – TNCs and bikesharing systems in particular. In some of these regions, public planning agencies are learning about shared mobility and building relationships primarily through partnerships that begin to address system operations (i.e., transit first/last mile, ridematching and carpooling services) with less of an emphasis on long-range strategic planning. The Metropolitan Transportation Commission (MTC) in the San Francisco Bay Area (SF Bay Area MPO) may be an example of this approach. MTC has formed no-cost partnerships to expand access to ridematching services and Bay Area Rapid Transit (BART), and is partnering with an on-demand ridesharing company (Scoop) to provide carpooling parking benefits at BART parking structures.

Watch and Learn Model

Transportation technologies are changing rapidly, with further and more extreme changes on the horizon. Many regions are unsure of how to proceed with shared mobility planning, but at the same time, recognize the potential benefits and risks. Several planning agencies are taking somewhat of a watch and learn approach to shared mobility planning, focusing primarily on research and thought leadership roles in the short term with an eye towards how these changes may affect their planning processes in the longer term. The Southeast Michigan Council of Governments, the MPO in the Detroit metropolitan area, and the Washtenaw Area Transportation Study (WATS), a county-level transportation planning agency, are engaged with local partners that are exploring shared mobility services. They are also integrating

discussions of the impact of shared mobility and potential shifts to automated vehicles and MOD business models into plans and work programs. But for the most part they are seeking more information about how to incorporate shared mobility into models, project plans, performance measures, and other core aspects of the planning process.

Shared Mobility Issues, Opportunities, and Challenges in Regional Multimodal Transportation Planning

The potential for shared mobility and related emerging technologies and strategies (e.g., AVs, MOD) to impact the ways in which the metropolitan area, city, or county moves is significant, but MPOs and their partners are also concerned about unintended negative consequences of expanded shared mobility.

In conversations with public sector stakeholders they often identified potential opportunities and challenges to be addressed through integration of shared mobility in the planning process. MPOs are understandably viewing shared mobility as something that may help achieve planning goals if coordinated with the public planning process. However, in the absence of such coordination, MPOs and their partners recognize the potential for shared mobility to make it more difficult for a region to plan for and achieve a desired future.

This section summarizes discussions with regional public agency practitioners and external review group members about shared mobility issues, opportunities, and challenges in regional multimodal transportation planning. Table 3 provides a summary of the topics discussed in this section.

Table 3: Transportation Planning Issues, Opportunities, and Challenges Associated with Shared Mobility

Issues	Opportunity	Challenge
Safety – Reduction of Serious Injuries and Fatalities	☑	☑
Enhanced Mobility for Persons Without A Vehicle	☑	
Equitable Access to Shared Mobility Services	☑	☑
First/Last Mile Connections / Expanded Access to Public Transit	☑	
Congestion Reduction	☑	☑
Reduction of Air Pollutants and Greenhouse Gas Emissions	☑	☑
Sustainable Urban Density and Land Use	☑	☑
Increased Multimodal Transportation Options and Integration	☑	
Sustainable Revenue Model for Public Infrastructure	☑	☑

Safety – Reduction of Serious Injuries and Fatalities

The potential for shared mobility to reduce transportation injuries and fatalities, particularly in combination with anticipated future AV technologies, is often cited as a major opportunity. Shared mobility is often viewed as a potential stepping stone to MOD business models, which several stakeholders cited as a desirable end-goal if paired with shared mobility, and likely to improve roadway safety. Current shared mobility services may also be facilitating a reduction in drunk driving. However, stakeholders also cautioned that information about the safety of shared mobility services is not well-established, and that increases in non-professional drivers for ridesourcing/TNC services may be introducing new safety risks, particularly for cyclists and pedestrians.

Enhanced Mobility for Persons without a Vehicle

Historically, lack of a personal vehicle has been a significant mobility barrier in all but the densest urban areas with quality public transit service. Shared mobility services are providing new options to people who do not own a personal vehicle. Mobility is often a core transportation planning goal for MPOs and their partners, and the potential for shared mobility services to expand residents' personal mobility is a significant opportunity that many of the regional practitioners we spoke with identified. As such, it is logical that MPOs and their partners may adopt expansion of shared mobility services as a strategy to increase mobility in their regions. However, as discussed below, individuals who lack a personal vehicle are more likely to face barriers to accessing and taking advantage of shared mobility services.

Equitable Access to Shared Mobility Services

The most common issues mentioned by transportation planners we spoke with were related to equity. MPOs and their planning partners are concerned that shared mobility services may not be available or affordable for individuals with low incomes or disabilities. Furthermore, if shared mobility becomes a more prominent part of the transportation system and traditional public transit is reduced or replaced, these people will be negatively affected.

Many low-income people struggle with the perception that that new shared mobility services are not for them. Indeed, shared mobility services tend to cater to a middle class or upper-middle class user base, most of whom own smartphones and have credit cards. As private sector companies with investors and a profit motive, many shared mobility services have not prioritized service in low-income neighborhoods or rural areas, or provided wheelchair-accessible vehicles or other accommodations which are required by law for public transit.

Providing equitable access for all residents is often a core goal in the regional transportation planning process. Thus, addressing equity concerns is one of the primary reasons planning practitioners we spoke with considered integrating shared mobility into the regional transportation planning process to be an important topic.

First/Last Mile Connections / Expanded Access to Public Transit

In conversations with regional transportation practitioners, researchers and other stakeholders, the research team consistently heard optimism that shared mobility and MOD could be effectively integrated into transit service and that this could help solve persistent first/last mile challenges many potential riders face. If integrated with transit service planning and operations, shared mobility technologies may expand the number of riders who are able to easily and affordably access public transit options and reduce

their reliance on personal vehicles. However, it is important to note that first/mile connectivity is only one potential use case for shared mobility in partnership with transit – it is possible additional applications may be explored as the relationship between shared mobility and public transit evolves.

Stakeholders expressed greater optimism that these partnerships would be more fruitful for lower density suburban locations than for congested urban ones. In urban areas, taxis and other stakeholders seem more cautious and apprehensive about potential competition from shared mobility services. Stakeholders suggested that the rise of shared mobility and MOD may put suburban transit providers "out of business" in these more difficult and expensive to serve areas. That by itself may not be considered as negative from either the perspective of public agencies or riders, except where the motivations of the private sector do not align with the requirements under the law to provide equitable options. For example, will market-driven shared mobility reduce revenues and support for established bus service that provides essential service to transit dependent populations, without providing affordable new options?

FTA Mobility on Demand Sandbox Demonstration Program

The Federal Transit Administration (FTA) Mobility on Demand (MOD) Sandbox Demonstration Program has been effective at supporting transit agencies in piloting and demonstrating innovative partnerships with shared mobility companies. The MOD Sandbox Demonstration Program seeks to enhance the transit industry's preparedness for MOD services by assisting transit providers in developing the ability to integrate MOD practices and business models with existing transit service. The program provides grant funding to explore these partnerships, identify best practices, and measure their impacts on travelers and the regional transportation system. FTA has also released a set of Frequently Asked Questions related to the eligibility of FTA grant funding to be used for shared mobility partnerships.

Congestion Reduction

The impacts of shared mobility on traffic congestion are far from certain. In a scenario where expanded shared mobility results in more single-user ridehailing (the dominant mode of travel provided by TNCs today), VMT may increase and congestion may worsen. However, in a scenario where shared mobility services result in more carpooling, ridesplitting, bicycle commuting, public transit, and other modes and services which do not increase VMT, shared mobility may contribute to an easing of congestion. This is similar to other technologies often discussed as potentially complementary to shared mobility, such as AVs and MOD. It is unclear if the advent of these technologies and services will increase or decrease congestion. Transportation practitioners and researchers often citied this uncertainty as a reason to pursue greater integration of shared mobility into the regional transportation planning process to improve multimodal connectivity and accomplish congestion relief and other public sector goals.

Reduction of Air Pollutants and Greenhouse Gas Emissions

MPOs we spoke with as part of this research sometimes cited concerns that shared mobility services may result in greater pollution and greenhouse gas emissions through increased VMT, counter to regional goals. Because of the uncertain impacts of shared mobility on travel behavior, carefully constructed models for estimating future tailpipe emissions may not be as valid as in the past. In particular, if shared mobility results in greater VMT, lower carpooling rates, or a decline in public transit ridership, walking, or bicycling, plans released only a few years ago which projected improvements in air quality and reductions in greenhouse gas emissions may need significant revision. However, some planning practitioners we spoke with were more optimistic, seeing expanded shared mobility and other new technologies as potential opportunities to improve future connectivity and usher in a more multimodal transportation

mix, with higher public transit usage, walking and biking, and other modes combining to reduce VMT and associated pollution. Stakeholders also expressed optimism that shared mobility fleets could be an opportunity to expand electric vehicle usage, if incentivized, which would improve tailpipe emissions.

Sustainable Urban Density and Land Use

Shared mobility services may reduce the need for people to own and maintain a personal vehicle. This in turn may affect the built environment in metropolitan areas, which is often dominated with large amounts of land set aside for parking. The rise of shared mobility may result in changes in parking demand which could enable cities to reduce parking requirements and free up valuable urban land for development or greenspace. Many MPO and local government planners identified this as a possible upside to shared mobility. However, others identified the potential for lower-cost transportation options to drive land-use change in suburban and rural areas, opening up new areas for development and potentially increasing commute distances. As with congestion and many other factors, there is much uncertainty in the planning community about how shared mobility and other technologies could influence land-use patterns, and because land use is intrinsically tied with transportation, they expressed the desire to bring shared mobility into regional transportation planning and land use planning in order to work for desirable outcomes.

Increased Multimodal Transportation Options and Integration

Shared mobility services have created new transportation options, which when combined with existing modes, have the potential to result in a more seamless, multimodal suite of transportation services, particularly in cities. The potential for this to generate a tipping point, where a combination of transit, shared mobility, nonmotorized transportation, and other modes become equal or more attractive to vehicle ownership, was explored in the previous white papers in this series. The research team discussed this concept with regional transportation planners during the research for this white paper as well, with many expressing support for the concept, but noting that without proactive planning this level of integration would be unlikely to occur.

Sustainable Revenue Model for Transportation Infrastructure

Many MPOs, state DOTs, transit agencies and other stakeholders are struggling to raise adequate resources to build and maintain transportation infrastructure. However, the rise of shared mobility services presents potential new revenue streams for transportation funding. Practitioners were sometimes optimistic that cities and states could establish fees for shared mobility services – such as usage fees for public infrastructure or congestion pricing schemes – that could help close existing funding gaps for system maintenance.

Others expressed concerns that shared mobility would degrade support for funding public investments in transportation infrastructure and that ridehailing and ridesplitting services may compete with public transit for riders, resulting in a precipitous decline in revenues needed to sustain service. However, some also expressed optimism that partnerships with shared mobility providers could result in lower costs for providing certain types of public transit service, in particular for on-demand public transit or service in low-density, auto-oriented areas.

Emerging Practices and Strategies

The research team, through desk research, conversations with regional transportation practitioners, and input from researchers and experts participating in the external review group, identified several notable emerging practices and strategies for incorporating shared mobility into the regional multimodal transportation planning process (Table 4). In several cases these practices and strategies are still conceptual or in very early stages of development and deployment. They are provided and discussed below to help peer agencies better understand the types of approaches being deployed and considered in metropolitan areas across the country.

Table 4: Emerging Practices and Strategies for Shared Mobility in Transportation Planning

Category	Emerging Practices and Strategies
Data Access and Sharing	• Negotiating access to shared mobility usage data • Involving third-parties to coordinate data sharing • Including data sharing provisions in partnerships and regulatory agreements
Regulating Use of Public Infrastructure	• Establishing guidelines for use of the public right of way • Regulation of pick-up/drop-off zones for ridesourcing/TNCs
Strategic Planning	• Scenario planning and visioning to grapple with uncertainty • Shared mobility planning programs
Operational Partnerships	• Partnerships to enhance public transit service • Partnerships to enhance ridematching, carpooling, or vanpooling services • Policies for public agency promotion of shared mobility services
Publicly Operated Shared Mobility Services	• Public microtransit pilot projects • Public ridesourcing/TNCs to complement or optimize transit
Integrating Shared Mobility into Modeling and Forecasting	• Incorporating shared mobility in travel surveys • Collecting data continuously • Using off-model approaches to estimating shared mobility impacts
Technical Assistance to Member Local Communities	• Developing model templates for regulations and agreements • MPOs as forums for convening local governments and transportation agencies • Connecting shared mobility to land use planning

Data Access and Sharing

A primary role of MPOs is to coordinate data collection and management to inform transportation and land use planning at the regional scale and at smaller scales. Access to private sector data is therefore a major interest of MPOs trying to observe how the ways in which people travel may be changing.

Negotiating access to shared mobility usage data

Generally speaking, cities and transit agencies would benefit from understanding origins and destinations of ridesourced trips at a fairly small scale so they can better understand intra-regional movements and also determine where to intervene with new infrastructure, regulate travel, or provide intermodal transit connections. However, private sector operators are generally not willing to share data with the public sector at a scale that is useful in this way; they say it would reveal detailed information about their operations or their users. In the handful of cities where they have agreed to share data on their operations, they have often made it difficult for cities to share these data and related findings with transit operators and regional planners, thus limiting the impact.

In 2017, Uber Technologies, the largest and best known TNC, began sharing limited data about their services in some cities through an application called Uber Movement. The application provides historical data on average travel times for rides provided by Uber. Data are presented either at the Census Tract or Travel Analysis Zone level. These data may be helpful to transportation planners in better understanding the impacts of transit service disruptions, special events, and extreme weather events. However, the application does not provide origin-destination or pick-up/drop-off data and does not provide detailed geographic resolution, such as the Census Block level. Many transportation planners the research team spoke with expressed frustration that the data TNCs are willing to share are often not sufficient to be integrated into regional modeling and forecasting, and therefore is of limited utility.

The reluctance to share data on the part of private sector operators stems from the concern that it will become public data, and diminish competitive advantages. Several practitioners discussed gaining access to this data as being of paramount importance to learning to navigate this new planning paradigm, and stressed that greater leverage by public sector agencies is needed if public dollars are used to support specialized TNC operations. MPOs are often uniquely situated to work across different jurisdictions to help negotiate data sharing agreements with private sector providers.

Involving third-parties to coordinate data sharing

There have been some advancements in thinking for how to better share data across the public and private sectors. While there has not been a lot of progress in getting TNCs to share their data, other stakeholders have seen benefits to doing so and are looking for ways to gather more data from multiple public and private sources.

Seattle DOT Data Collaborative

One such idea is the concept of a "data collaborative" taking root in the Seattle region. Seattle planners want to get access to Census Block level data on shared mobility usage to better understand block-based impacts (like curb space use). Because of the need to protect personally identifiable information (PII), they know they may not be able to collect exact data on trip origins and destinations of travelers using TNCs, bikesharing or carsharing vehicles, but they expect that block-level data should be precise enough. However, Seattle planners recognize the importance of protecting PII and sensitive information about business operations, which is making sharing of

valuable data difficult, and so they are working with the University of Washington and a third party to create a "data lake." This third party would have a memorandum of agreement with the City of Seattle about how the data can and cannot be used. The data lake concept could have implications beyond shared mobility and may be a platform for other types of data, like energy and land use, and could be shared by all users including the public sector. In transportation, that could mean making traffic operations data like signal timing and parking utilization accessible to the private sector as well. Ideally, the data lake would provide near real-time access to these data.

The data collaborative concept being discussed in the Seattle region is not the only third party model possible. Another possibility is to involve a university research center to oversee and coordinate data sharing for the purpose of research. The specifics of this type of arrangement would need to be worked out between different shared mobility providers but this model could have the potential to be useful to multiple regions throughout the country.

Including data sharing provisions in public-private partnerships and regulatory agreements

Another approach that practitioners in the public sector have expressed interest in is to negotiate data sharing requirements with shared mobility providers as conditions for participation in public-private partnerships. Transit agencies in particular may have some leverage if they are considering contracting out some service to on-demand services like TNCs or private microtransit operators. Requiring those operators to share useful data about trip movements in the terms of contracts may help to pilot new ideas for serving hard to reach individuals and also strengthen the relationship between the public and private sectors.

Public agencies have generally had difficulty negotiating data sharing agreements with TNCs. This may be because the incentives that the public sector is capable of offering are modest in contrast to the overall operations of these often global companies, with large cities having the most leverage to regulate. Bikesharing and carsharing companies, by contrast, have generally been more willing to share data about the use of their systems. Carsharing companies may have an incentive to be more forthcoming in order to get preferential parking and other treatment from cities, and bikesharing organizations are often operating as exclusive non-profit and publically-supported services, and have a more local orientation. They are also less highly capitalized so may be more likely to take advantage of public private partnerships if offered.

Cities often have some power to license and regulate the operations of transportation companies, including TNCs, bikesharing operators, and carsharing companies. While the size of the city's market may influence the leverage it has, cities can use this role to require some data sharing by transportation operators that they regulate. This research has shown, however, that the ability for cities to be able to do this has been met with some resistance from some of the major shared mobility operators. Statewide legislation is also increasingly preempting local regulations related to shared mobility, reducing the ability for cities to negotiate with TNCs and other shared mobility companies on matters important to transportation planning and public safety. For example, some states have passed laws which make regulation of TNCs the exclusive authority of the state government, precluding municipalities and other local entities from taxing, licensing, permitting, or imposing other requirements on TNCs. In some cases, these laws have overruled local ordinances or regulations.

Regulating Use of Public Infrastructure

Many of the agencies researched for this report cited regulatory mechanisms that have allowed or could allow them to exert pressure on shared mobility operators in order to advance transportation planning goals. These mechanisms take a number of forms depending upon the regulatory authority held by the agency and the degree to which regulations are controlled at the state vs local levels. Cities and transit agencies, for instance, often have regulatory tools at their disposal that MPOs do not. Cities in particular may be able to use their authority to regulate use of the public right of way and curb space, as well as on-street parking. While MPOs typically lack direct access to these tools, there may be opportunities for MPOs to coordinate regional approaches to regulating shared mobility use of public infrastructure.

Establishing guidelines for use of the public right of way

In some cases, local governments are exploring issuing guidelines and regulations which grant shared mobility companies a right to operate only under certain conditions. These include planning for loading zones for ridesourcing/microtransit/shuttles, carsharing parking, public bikesharing, and other issues.[3]

Seattle DOT Pilot Permit Programs

Through its New Mobility Program, Seattle DOT has established guidelines for the use of the public right of way by transportation innovators and private companies. The guidelines were published in its New Mobility Playbook, which was informed by the city's strategic planning goals, and are intended to ensure that new entrants to the transportation system advance these goals. Seattle DOT is hopeful that clear guidelines will provide direction to new services without creating excessive regulatory hurdles to innovation in the transportation sector. Some specific examples of how Seattle DOT is regulating shared mobility companies' use of the public right of way include its free-floating bikesharing pilot permit program, free-floating carsharing permit program, and electric vehicle charging permit pilot program.

Regulation of pick-up/drop-off zones for ridesourcing/TNCs

Curb space is becoming an increasingly active area of city streets, with growing demand for access to this space for a variety of different uses, including TNC pick-up and drop-off. Increasingly cities are exploring ways to make more efficient use of curb space.

City of Boston Exploring Curb Space Regulation for TNCs

The City of Boston is exploring ways to regulate curb space along the public right of way, specifically in high volume areas of the city where pick-ups and drop-offs by shared mobility providers at key multimodal hubs are a source of significant congestion and potential safety concerns. Establishing guidelines for the use of curb space may increase the efficiency and safety of transfers from shared mobility services to and from other modes of transportation, such as transit and intercity rail, which may help meet public goals while improving service for users of shared mobility. Such regulations may take the form of designated pick-up and drop-off areas for TNCs.

[3] The American Planning Association publication *Planning for Shared Mobility* provides additional detail on how cities are regulating public space for shared mobility

Strategic Planning

MPOs and their partners have long embraced the value of long-range strategic planning for transportation and the LRTP is a key element of the Federal transportation planning requirements. In our research we found examples of agencies embracing changes in transportation technology, uncertainty and all, and trying to integrate shared mobility into long-range strategic plans and decisionmaking.

However, several stakeholders cautioned against assuming that shared mobility, AVs, MOD and other technologies will become available on any predictable timeline, or assuming that the transportation sector has the ability to know with any precision how these technologies will impact regional travel. From their view, the emergence of rapidly changing shared mobility technologies have called into question the ability of MPOs and partners to effectively integrate them into long-range strategic plans.

This tension has led some agencies to start with high-level visioning and scenario planning, while others have chosen to focus on the more immediate term, in search of a more nimble and iterative near term approach.

Scenario planning and visioning to grapple with uncertainty

In fostering a strategic approach, some agencies have developed scenario plans and visions intended to influence potential trajectories of the transportation system by articulating possible benefits, challenges, and barriers associated with emerging technologies, and relating these to public goals. These planning tools may be well-suited to deal with shared mobility because of the uncertainty, risk, and opportunity associated with transportation technology change. As the focus of transportation planners has shifted from planning for infrastructure investment and construction over a long-term time horizon to a performance management, operations, and maintenance focus, some agencies are imagining new ways to approach thinking about the future.

CMAP develops alternative futures

In developing its next long range strategic plan, ONTO 2050, the Chicago Metropolitan Agency for Planning (CMAP) is using a scenario planning approach which asks regional stakeholders to consider five possible alternative futures. One of these alternative futures imagines a 2050 where innovative transportation technology will have fundamentally changed the ways in which people move around the region.

The scenario articulates potential opportunities, challenges, and barriers this future may introduce to mobility within the region and things the region may wish to begin planning for now. The innovative transportation technologies future is being considered alongside other scenarios that deal with other potentially transformational changes which would affect the region and its multimodal transportation system, such as accelerated climate change, a shift to preferences for walkable communities, transformational economic growth, and challenging resource constraints.

Shared mobility planning programs

In some of the metropolitan areas we researched, public agencies and regional stakeholders have developed special purpose plans and guidance documents specific to shared mobility and other emerging transportation technologies. Seattle DOT released a New Mobility Playbook which articulates a strategic approach to shared mobility and other new mobility technologies. Los Angeles and Minneapolis-Saint

Paul both have shared mobility action plans developed by the Shared Use Mobility Center that can be used as a resource for local and regional planners engaging with shared mobility.

While not always directly related to the above plans, a new strategic focus on emerging technologies and strategies is evident in their organizational structures. For example, the Seattle DOT established a New Mobility Program that is wholly focused on emerging technology in mobility. LA Metro founded an Office of Extraordinary Innovation, which is responsible for delivering on several objectives including improving access to new mobility options. These new offices both have dedicated staff whose responsibilities include planning for shared mobility.

Operational Partnerships

Transit agencies and MPOs in many metropolitan areas are forming partnerships to pilot ways of working together to improve the efficiency and cost of providing transportation services, and to take advantage of shared mobility. These partnerships are most often focused on enhancing public transit services. In some cases, MPOs have also partnered with shared mobility companies to enhance regional ridematching, carpooling and vanpooling services. MPOs and their partners are grappling with establishing internal policies for how and when to partner with shared mobility companies.

Partnerships to enhance public transit service

There is a lot of optimism that shared mobility companies may help improve public transit access and reduce the cost of providing transit services. Many transit agencies have established pilot programs with TNCs or private microtransit services to explore this potential; these often focus on improving first/last mile connections, supplementing or replacing demand-responsive services, or both. Some examples from the metropolitan areas we researched include:

BART, MTC, and Scoop Technologies

BART received a $358,000 FTA MOD Sandbox Demonstration Program grant to develop a pilot program to integrate with Scoop's real-time ridematching and carpooling application. BART is working with MTC and Scoop to match potential riders and drivers on the fly based on destination, so they can carpool to the BART Dublin/Pleasanton station. Participants are provided a guaranteed parking space before 10am, and with the ability allow users to pay for parking through the app. The pilot was launched in December 2016 and has since been expanded to three BART stations.

Kansas City Area Transit Authority and Bridj

The Kansas City Area Transit Authority (KCATA) launched a pilot with private microtransit service provider, Bridj, in March 2016. The pilot was designed to test how an on-demand, algorithm-optimized microtransit service like Bridj could integrate into the existing transit service and other mobility options in the Kansas City Region. The pilot concluded after one year; the Transportation Sustainability Research Center at the University of California at Berkeley conducted an evaluation of the pilot program. Although Bridj closed down its business shortly after the pilot ended, the pilot provided KCATA with a valuable source of information about user demand for microtransit services, among other benefits. Since the Bridj pilot, the KCATA has rolled out RideKC Freedom and Freedom on demand. These services provide traditional ADA paratransit services using a TNC-like model. In addition to paratransit users, non-paratransit customers can also use the service and pay retail prices for the use.

Pinellas Suncoast Transportation Authority and TNC/Taxi Partners

In the Tampa Bay metropolitan area the Pinellas Suncoast Transportation Authority has formed a partnership with Uber, United Taxi, and others (Lyft may be added later) to provide first/last mile connections to selected bus stops. The program provides a $5 subsidy towards the cost of the TNC/taxi trip, with most riders paying $1 out of pocket. The program, called "Direct Connect," can also provide wheelchair accessible options.

Partnerships to enhance ridematching, carpooling, or vanpooling services

MPOs in many metropolitan areas provide regional ridematching services to support residents in carpooling, vanpooling, and other ways of ridesharing. With the rise of new shared mobility services, MPOs and partners are experimenting with partnerships to enhance their ridematching and ridesharing support activities. Some examples from the metropolitan areas we researched include:

MTC, Waze Carpool, University of California-San Francisco, and Kaiser Permanente

Waze Carpool is a variation on the popular turn-by-turn navigation software for people who wish to carpool. The software matches "wazers" based on their route and destination, helping them connect in real-time and share the costs of carpooling through the app. MTC worked with Waze, the University of California-San Francisco (UCSF) and Kaiser Permanente to promote carpooling in the San Francisco Bay Area. MTC incurred zero costs and promoted Waze Carpool as part of its Bay Bridge Forward initiative to reduce traffic congestion in the San Francisco-Oakland Bay Bridge corridor. Waze provided the service and two free rides, and both UCSF and Kaiser Permanente helped promote the launch of the service by providing an additional free ride for employees.

Policies for public agency promotion of shared mobility services

Shared mobility companies are increasingly approaching MPOs, transit agencies, and state and local transportation agencies with ideas for cross-promotion and marketing via public agency websites, social media, and other communications. This creates a situation in which MPOs and their partners must make decisions about which, if any, services to promote to the public. The following example from our research illustrates how one agency is grappling with this emerging issue:

MTC Zero-Cost Partnerships

In 2014 MTC began to be approached by technology companies facilitating real-time carpooling about using their apps as the region's ridematching tool. To avoid sole-sourcing and to ensure that MTC would promote viable products, the agency developed zero-cost partnerships that require the apps to demonstrate some measure of stability and provide some data to MTC. In return, MTC promotes the apps through its 511 SF Bay ridesharing and TDM outreach and programs. 511 Carpool staff interface with commuters, employers and other public agencies to demonstrate the apps, encourage employers to promote app usage, and provide incentives to commuters to take carpool trips using them.

Lessons learned are that strong marketing is required for the apps to gain traction and that most are having success where traditional matching also has had success. More work is needed to attract travelers who have not historically been carpoolers and to sustain a critical mass of users. Several apps, even some with good design and financial backing, did not last long in the market. MTC has also not had success negotiating agreements with all apps to get the data needed to

support its reporting requirements. In the last three years, MTC has worked with six carpool matching apps, and currently has just one partner: Scoop.

MTC sees both promise and challenges in what the apps offer. What is promising is their better technology, flexible and convenient carpool scheduling, potentially richer data, and private investment. What they do not yet offer is guaranteed staying power, service to all markets, free service, open data, critical matching mass and acceptance by all types of potential users.

Publicly Operated Shared Mobility Services

Technologies and platforms used by TNCs and other shared mobility companies are not necessarily the exclusive domain of the private sector. In some cases public agencies and their partners are experimenting with adapting technologies and business models from the private sector to expand or improve public sector services. Transit agencies are beginning pilots of their own dynamic microtransit services to fill service gaps and some regions are exploring the possibility of adding optimized TNC-like services to their service offerings.

Public microtransit pilot projects

Private sector companies like Chariot, Via, and Bridj have pioneered microtransit concepts, which seek to dynamically route shuttle services from origins or to destinations that are not well-served by existing fixed-route transit service. The technology dynamically routes smaller buses or vans, creating a customized route based on user demand. As these private sector services are becoming more common, some transit agencies are developing their own similar services and adapting similar technologies to add microtransit to their suite of offerings. The following example from our research illustrates how transit agencies may be adopting microtransit business models and technology:

Capital Metro Microtransit Pilot – "Pickup by Metro"

In Austin, Texas, Capital Metro is experimenting with a pilot project to provide a microtransit, on-demand transportation service through a customized application. The service is called "Pickup by Metro" and is a partnership with Via, which licensed the technology for the pilot. Pickup replaced a different pilot service called MetroFlex which was a community shuttle to shopping destinations, with the potential to "flex" off the designated route to drop off riders at home. The Pickup service takes advantage of ridehailing technologies to dynamically route a small Capital Metro bus based on user requests. Riders without a smartphone can call a phone number to request Pickup service.

Public ridesourcing/TNCs to complement or optimize transit

TNC services are based on technology that dynamically matches customers (i.e., riders) with drivers. While the technologies used by popular TNCs may be proprietary, the overall concept of using smartphones to connect riders and drivers is not and some organizations are exploring the possibility of building their own ridesourcing technology to complement or optimize transit services. While this emerging strategy has not yet been implemented by a public agency, the following example from our research demonstrates the potential for "public TNCs" to be developed in partnership with large employers and transit providers, and for such a service to be brought into a regional transportation planning process.

University of Michigan Optimized On-Demand Transit Pilot

In Ann Arbor, Michigan in the greater Detroit metropolitan area, the University of Michigan's transit system and a team of academics is planning to launch a project called "Reinventing Public Urban Transportation and Mobility." The concept for the system is to use ridehailing technology to connect users to frequent fixed route bus service provided by the university transit system. Many trips will be provided by small on-demand vans or cars with drop-offs at university transit system bus stops. Short trips or routes that are not well-served by fixed routes will be point-to-point much like popular TNC services.

The pilot project envisions using a fleet of 50 on-demand shared shuttles to get riders to and from fixed-route drop-off and pick-up points. These shuttles may replace less efficient, lower frequency fixed route service and will expand service to cover areas which are currently not served. The university, the Ann Arbor Area Transportation Authority, and WATS have discussed possible expansion within Washtenaw County if successful, which would help address mobility and accessibility goals.

Another approach that shows some potential is to use an existing regulated taxi fleet to pilot quasi-public TNC services. As taxi fleets modernize their technology to better compete with TNCs, they might make more natural partners for public agencies.

Integrating Shared Mobility into Modeling and Forecasting

MPOs use sophisticated travel demand models to estimate and forecast travel behavior on the existing regional network and to project changes which may result from major infrastructure investments. MPOs use models for:

- Scenario Planning
- Long-range transportation investment programming
- Air quality analysis
- Transportation Improvement Programs
- Subregional planning (corridor studies, local transportation plans)
- Performance management

While there are many types of models that MPOs employ for this work, they all mostly rely on a combination of census data, population and employment projections, and the results of travel behavior surveys the MPOs conduct on a regular basis (often after the decennial census). These models estimate how trips are distributed between zones in the metropolitan area, what modes are likely being taken, and at what time of day. These models are calibrated to make sure they fit and mimic observed local conditions as accurately as possible.

Once a travel demand model has a calibrated existing transportation network, it can be used to project future performance on the system and reflect changes in the use of the system due to demographic shifts, population growth, real estate development, and new transportation infrastructure such as new public transit lines, freeway lanes, congestion pricing, or even bicycle trails. Travel demand models are not perfect predictors of how use of the transportation system responds to various changes, but they are the most powerful and scientific tool available to regional planners to evaluate policy directions and investment plans.

Shared mobility services pose challenges to the architecture of these models. The reason for this is that these models project future travel behavior based on existing or past behavior as observed from the

results of travel behavior surveys. These surveys capture how people make travel decisions reflecting the available modes, trip purpose, and land-use distribution. Because new shared mobility technology has just begun to significantly alter travel behavior in core urban areas, the existing models do not account for them. In several regions we researched travel forecasters understand this and are working toward ways to account for shared mobility induced travel behavior changes.

Incorporating shared mobility in travel surveys

One way to account for shared mobility in forecasting is to incorporate these new modes and make them explicit in new travel surveys as MPOs begin their next cycle of model updates.

Portland Metro Incorporating Shared Mobility in Household Travel Survey

Portland Metro is gearing up for its next household travel survey and intends to ask respondents about their use of different shared mobility modes. This would allow Metro to use its model to analyze how shared mobility users might respond to changes in pricing, expansion in service areas, new transit services, or new bicycle and pedestrian facilities. Given that TNCs and bikesharing are already in wide usage in the Portland region, Metro has also been exploring current data sources so that it can begin to analyze shared mobility travel patterns before the next travel survey, which is scheduled for 2020.

Two government agencies in the region, the Portland Bureau of Transportation (PBOT) and the Port of Portland, collect data on TNCs for regulatory purposes, and PBOT also coordinates with Motivate, which operates Portland's bikesharing system, to analyze usage data. Metro has been exploring the potential to use this data for planning purposes, but the data agreements that PBOT and the Port have with TNCs place strict limits on how those agencies use and share data on TNC trips. Metro is also in discussions with different private data providers about the potential to purchase data on TNC usage.

In anticipation of updating the survey to account for new modes of travel, Portland Metro is also hoping to work with the transit provider, Tri-County Metropolitan Transportation District of Oregon (TriMet), as well as the City of Portland, who have agreements with ridesourcing companies to gain access to some data that helps them analyze for what modes TNC trips might be substituting.

Collecting data continuously

The pace of change that shared mobility has so far enabled in travel behavior calls into question the wisdom of simply adding new questions to travel behavior surveys. If travel surveys are collected this year, they will only reflect decision-making at this point in time with only those services that are currently available. Some MPOs are considering more fundamental changes to how they collect and use travel survey data to respond to the increasing pace of change in transportation technology.

Portland Metro Considering More Frequent Travel Survey Collections

Portland Metro has begun to consider changing the frequency at which they collect data, possibly substituting the 5-10 year travel survey with something more akin to the American Community Survey that combines data from multiple annual surveys with smaller sample sizes to keep results up to date. At the time we conducted this research, Metro had not developed a specific plan to change data collection for their travel demand model but it has begun discussing these challenges internally, which could lead to significant changes to the way it manages its modeling activities.

Using off-model approaches to estimating shared mobility impacts

Modeling often benefits from the addition of off-model analysis to account for things the models are not equipped to work with. The following examples from our research show how two MPOs are experimenting with off-model approaches of accounting for shared mobility services.

Southern California Association of Governments and MTC Off-Model Analysis

One MPO that has begun to approach modeling the effects of shared mobility is the Southern California Association of Governments (SCAG), which developed a white paper examining the effects of emerging mobility innovations in 2016. SCAG analyzed bikesharing and carsharing through off-model analyses of regional transportation model results, using a methodology developed by MTC in the San Francisco Bay Area.

SCAG also analyzed ridesourcing by modifying the carsharing methodology based on land use characteristics derived from the scenario planning model and proprietary data provided by one of the two major TNCs. These off-model analyses informed the development of policy recommendations in its metropolitan transportation plan including choosing emissions targets informed by observed data on travel behavior.

Metropolitan Council of Minneapolis-Saint Paul Off-Model Sensitivity Tests

The Metropolitan Council of Minneapolis-Saint Paul has also used off-model sensitivity tests to analyze its model results reflecting potential impacts from new technologies and strategies like shared mobility and autonomous vehicles in their long-range planning. The Metropolitan Council plans to continue refining its model as it prepares its next metropolitan transportation plan, taking into account the latest estimates about the impact of new technology including shared mobility. Sensitivity analysis allows consideration of different potential effects and scenarios.

Other possible additions to traditional modeling would be to collect data directly from volunteers using their handheld devices or from third-party intermediaries with access to detailed movement data (cell phone companies, advertisers, and their data brokers who already sell movement-related datasets to the private sector). These potential tools have not yet been tested in a major way in the United States but have been used globally to analyze mobility.

Technical Assistance to Local Communities

MPOs offer technical assistance to member communities and agencies on a host of issues related to transportation planning. Although many agencies say it is an increasingly frequent topic of conversation, in our research we found few examples of MPOs providing active technical assistance in the area of shared mobility. However, several regions have begun to coordinate in such a way that they see an increased role for the MPO to identify and adapt best practices at a regional scale.

Developing model templates for regulations and agreements

MPOs can help their member jurisdictions develop appropriate regulations for shared mobility companies and agreements between private operators and public sector agencies. Although none of the MPOs we researched are actively engaged in this strategy, several practitioners and researchers identified this as a logical role for MPOs to take the lead on, and it is consistent with the technical assistance role that many MPOs currently play on a broad range of other topics.

Seattle DOT and King County Metro Coordination on Shared Mobility

One example of different jurisdictions sharing methods with one another is in the area of regulation in Seattle. Seattle DOT regulates TNCs and permits carsharing and bikesharing operations. King County Metro regulates TNCs in the communities within King County outside of Seattle. The two jurisdictions coordinate closely on a variety of topics, including ensuring their regulations mirror one another so that there is a consistent approach region-wide. As a regional entity with members from local jurisdictions, MPOs could play this role of ensuring a consistent and streamlined approach to issues like regulation of TNCs, street design that incorporates dedicated curb space, or the regionalization of bikesharing systems beyond individual cities.

MPOs as forums for convening local governments and transportation agencies

MPOs are the primary regional forum for discussing transportation issues of regional importance and for sharing ideas across jurisdictions. MPO staff can take the direction from this discourse and develop technical approaches that can be put into practice by cities and transportation agencies in their regions.

CMAP Thought Leadership on Emerging Transportation Technology

The Chicago Metropolitan Agency for Planning (CMAP) is a thought leader in the area of emerging technology in transportation planning. Through engagement with regional stakeholders and transportation experts, CMAP determined several alternative futures (e.g. walkable communities or new innovative technology) that may change transportation and land use in the region as part of its regional transportation plan update.

For each future, CMAP is authoring a strategy paper describing what the future might look like, its impacts on the transportation system, and several recommended strategies that local communities and transportation agencies can start to work on today. One of these futures is an innovative transportation future, and the strategy paper has specific recommendations related to shared mobility technology. While CMAP does not have the ability to implement most of these recommendations itself, it is using its role as convener of local jurisdictions and public transit agencies to develop and share informed ideas about how public agencies can respond to and anticipate changes to transportation from new technology. The cities and transit agencies within the Chicago metropolitan area will review and refine the strategies.

Connecting shared mobility to land-use planning

Land-use planning is conducted at the local level in almost all cases. However, MPOs strategically consider transportation investments and land-use planning together to maximize the impact of those investments and to develop holistic plans focused on regional goals like economic development and environmental stewardship. MPOs often provide some technical assistance to local communities on aspects of implementing the land-use components embedded within the regional plan, such as participating in small area plans like transit-oriented development districts.

Several MPOs contacted in this research have begun to think about how technology innovations in transportation, like shared mobility, may be changing the assumptions for land-use planning. For instance, while definitive data is still lacking, a future with more trips made by shared modes or with less car ownership enabled by shared mobility may reduce the overall need to supply parking in congested locations. On the other hand, a future with easier and lower-cost vehicle travel may result in an expansion of development at or beyond the current urban fringe, increasing driving distances and traffic volumes.

MPOs will be grappling with questions of how shared mobility might influence future development in the coming years. Together with their role as a forum for policy discussion and research, MPOs can lead their regions in revising assumptions as new technologies alter previous patterns of travel behavior and consumer choices and their resultant impacts on land use.

Recommendations for Future Research

This report identifies many unexplored and unanswered questions because the transportation landscape is changing so quickly. Transportation planners contacted as part of this study often expressed desire for additional research and guidance. This section summarizes a number of topic areas that researchers and practitioners identified as being particularly important to explore further, to enhance broader understanding of the challenges and potential of bringing shared mobility into multimodal planning and decisionmaking, and to enhance the performance of the regional multimodal transportation system.

Overcoming issues with sharing proprietary data

There are more transportation and travel behavior data available today than at any point in history due to the use of information technology. These data, which include things like global positioning systems (GPS) information from smartphones as well as trip logs from the use of TNCs, are almost entirely owned by private companies. Users of these services allow companies to collect information about how they use the service, including travel origins and destinations, in return for the convenience of the service. However, these data are often unavailable to public sector agencies to inform the planning process because of proprietary concerns.

Public sector agencies could greatly benefit from these kinds of data because they could inform decisions about regulating public infrastructure use or planning for future transportation investments. These companies are, after all, using public infrastructure to operate, and so it would make sense for public sector agencies to have data on the use of this infrastructure. Private companies, however, do not readily share information with the public sector due to a number of issues. The primary issue is that the data these companies have are proprietary and at the heart of their business. If they gave away access to data on how their services are used, they feel they could be giving away important information about how they do business, which could theoretically hurt their competitive edge. Additionally, the public has concerns about the government having access to private information like where and when they travel, and businesses that possess the data may be reluctant to make it broadly available.

The practitioners contacted as part of this research indicated that this is an incredibly important and complex issue that needs to be addressed soon. If shared mobility data were to be made broadly available to transportation planners it would improve their ability to optimize the performance of the multimodal system, make investments which would provide the greatest benefits to all users, and monitor the results of investments. Transportation planners are seeking more research on existing and potential models for data sharing to improve decisionmaking by both government and the private sector, while maintaining the security of private information and PII.

Data standards and guidance

This research identified barriers to transportation agencies accessing data from shared mobility services that they believe would be valuable to the planning process. One of these barriers is a general lack of understanding about the scope of data shared mobility companies are collecting and how these data might be used to inform planning, operations, and the management of the multimodal system. Another barrier is that local jurisdictions typically develop their own individual agreements and data sharing requests with shared mobility companies, which may result in missed opportunities to enable the sharing and interoperability of data at regional or statewide scales.

There could be value in developing a standard data request form for use when MPOs, cities, or transit agencies engage TNCs and other shared mobility providers. This could help smaller agencies and local governments know what to ask for when dealing with shared mobility providers, which in turn would ensure that datasets are compatible at a regional or statewide scale. It could also be valuable to identify available templates for successful memorandums of agreement between public agencies and shared mobility companies, including standard terms for sharing data. These would ideally be structured to provide the greatest possible value to the planning process while mitigating risks to privacy, proprietary information, and other common concerns of shared mobility companies, and could be set up to provide incentives for cooperation.

It may be useful to establish standard data formats, interchange systems, and anonymizing techniques for shared mobility data. These standards would make it easier for common tools and analysis models to emerge, and would likely lower the burden for shared mobility companies to participate in data sharing. Data standards would also simplify the inclusion of sharing provisions in regulations and agreements; local jurisdictions could adopt existing standards instead of having to develop the expertise to create their own.

Shared mobility and travel demand modeling

MPOs use travel demand models to help estimate and project transportation patterns, costs, and impacts from major projects. It has been one of the primary tools that regions use for this purpose, but MPOs and others who operate these models have only begun to work on integrating shared mobility travel into their models. One of the issues standing in the way of integration is that proprietary data are not available to public agencies. But there are several progressive agencies working on this problem that are developing potential approaches to improving the capability of travel demand models to more accurately estimate travel behavior considering the changing way people are making travel choices.

Indeed, this may be the beginning of a revolution in travel demand modeling as we anticipate the advancement of other technologies like AVs on the use of the transportation system. A key challenge with making long-range projections using models is that these models have traditionally used travel surveys and other information about the use of the existing system to project travel in the future. Generally speaking, models are not designed today to anticipate major paradigm shifts in how people make travel decisions. Additionally, modeling may be enhanced by the availability of open source and shared data sources. If the long-term future includes more shared mobility and AVs, travel demand modelers will need to understand how these modes will affect transportation choices by individuals and firms, as well as any implications they might have on land development.

Integration of shared mobility in plans, visions, and performance measures

Discussions with practitioners for this research revealed a problem with the timescale of some regional planning activities due to the rapid pace of change in transportation from private sector built technology. It is less easy to predict the impact of future projects or to develop long-range plans when the advance of shared mobility and other technologies like AVs is happening so quickly.

The traditional 20-year planning horizon was established during an era of major infrastructure expansion but today most transportation agencies must focus on performance management, asset management, and operational improvements. This new focus, together with rapid advances in technology that may influence how people make travel and life decisions, raises questions about whether shorter-term planning efforts for topics such as shared mobility might be an important complement to long-range planning. At the same time, there may be more of a need to think about the transformational potential of shared mobility and other technologies over longer time horizons in vision and scenario planning activities. This is a topic with wide-ranging implications which calls for a careful and well-researched approach to developing best practices for examining different time horizons in transportation planning and programming.

The recent emphasis on performance-based planning and programming for state DOTs and MPOs would be a very useful focus for shared mobility research as these technologies and strategies become critical connected elements of the multimodal system. For example, how may shared mobility services impact the ability of state DOTs and MPOs to achieve performance targets for safety and system performance? How can state DOTs and MPOs better account for potential changes in traveler behavior related to shared mobility trips or other emerging technologies when setting performance targets? Should performance measures be revised or added to account for the rise of shared mobility services, including as part of connected transit trips?

Model agreements between shared mobility providers and public sector agencies

Public sector agencies, including MPOs, would benefit from more sharing of best practices in developing agreements of mutual benefit with private sector operators. The shared mobility and AV technology industries are so far almost entirely managed by the private sector. However, public sector agencies are in charge of the public infrastructure that these services use, like curb space, access to transit stops, parking lots, and high-occupancy vehicle (HOV) lanes. Finding ways to better share data, develop beneficial regulations, and improve both public and private transportation services will rest on the ability of the private and public sectors to coordinate and cooperate more easily through agreements, and to formalize incentives to cooperate. Such research would benefit from the active participation of shared mobility providers working with the public sector.

Generating revenue from shared mobility for public infrastructure

Although private sector companies need to make money in order to operate and further develop their businesses, they also will likely have an expanding impact on public resources and require responses from public sector agencies to help them operate more effectively, and to ensure that the transportation system continues to function well and meet broad public goals from safety to congestion relief and air quality improvement. New patterns of travel are sure to have an impact on traditional sources of public revenue

from transportation like the gas tax, tolls, bus fares, and parking revenues. Additionally, public-private partnerships like combining a TNC ride with bus transfers introduce complex challenges about how revenues from that trip are allocated.

It may be valuable to understand how existing revenue models might be affected by changes in transportation technology like shared mobility, and examine some emerging practices and ideas for improving revenue generation that public sector agencies could apply to manage the impact of shared mobility, such as financial incentives.

Best practices in investing in and regulating use of public infrastructure

The transportation disruption caused by shared mobility services has placed new demands and challenges on the use of public infrastructure. For example, as bikesharing systems move toward dockless free-floating systems, they introduce a host of issues for cities that need to ensure that sidewalks and other public right-of-way remain unobstructed and shared by all users. Also, the rapid increase in the use of ridesourcing for travel has placed increased demand on the use of curb space, which is a scarce commodity in dense urban centers.

The changing use of road space as a result of more shared mobility services has implications for on- and off-street parking provisions, interactions with other modes like bike lanes, and may create new areas of congestion and general dysfunction of road networks designed without these modes in mind. Cities and agencies in charge of busy locations, such as airports or event centers, are having to respond to these new challenges quickly. It would be beneficial to develop case studies and related assessments of various approaches to altering the use of public infrastructure to accommodate this changing mobility pattern and ensure optimal performance of the overall multimodal system.

Practitioners would benefit from the development of screening tools to help identify the types of shared mobility services most important for a given corridor, subarea, or region, and how to support the most appropriate infrastructure investments.

Similarly, shared mobility may be affecting the operations of transportation demand management programs aimed at reducing single-occupant vehicle trips and parking requirements in congested areas. Parking management strategies as well as land use and transportation assumptions may be due for re-evaluation as residents and visitors of congested areas of metropolitan areas make new types of choices because of the shared mobility options available.

In-depth case studies

This white paper only scratches the surface of what MPOs and other public sector agencies are doing in response to the expanding prevalence of shared mobility. As these agencies continue to develop their programs, more in-depth case studies could be useful to disseminate information about what works and does not work in various contexts. With many shared mobility application developers active in urban markets globally, comparative international case studies of multimodal integration in international contexts could also broaden the knowledge base. This kind of research would be most useful if it looked at several distinct urban contexts to see how shared mobility and other new technologies affecting surface transportation affect different regions, place types, and transportation service contexts.

Comparison with international approaches

Shared mobility services are being deployed worldwide. The U.S. would benefit from more sharing of ideas and experiences with planning organizations in other countries, including how they coordinate and cooperate with private sector developers and operators. By conducting rigorous technical analysis of shared mobility approaches in Europe, Asia, and elsewhere, we can expand the knowledge base of innovations which U.S. public sector agencies may consider. Such international research may focus on infrastructure needs for shared mobility services, supportive policies and regulatory approaches, or technological solutions. As apparent from recent activities with international peer agencies, the U.S. can also offer substantial insights based on the well-established approach to multimodal planning in metropolitan areas and states.

Emissions and air quality programs and shared mobility

As shared mobility technology and programs change mobility, efforts to reduce emissions and improve overall air quality may deserve new attention. For example, could policies and infrastructure projects designed to incentivize electrification of the shared mobility fleet reduce the potential negative emissions impacts of shared mobility services?

Impact of shared mobility on freight delivery

Public agencies are grappling with changes in how goods are transported within metropolitan areas. Some shared mobility providers have entered the goods delivery market, which, along with the increase in home delivery shopping, is shaping mobility in new ways. MPOs and local governments could benefit from research on how to account for the impacts of shared mobility on urban freight and package delivery, in addition to passenger transportation, which was the focus of this research.

Multimodal integration through technology

Several companies are working on a technology solution that takes further the tipping point concept discussed earlier in this white paper, in which technology is enabling parity or attractive competitive alternatives to single-occupant car travel in many new urban contexts. Introducing common payment systems and information on the availability of all modes of shared mobility (public transit, carsharing, bikesharing, ridesourcing, etc.) through smartphone applications would make use of all of these alternatives simpler and provide information to customers about the cost of travel. This type of approach to transportation treats all mobility options as a single, unified service, where people can pay to have access to all choices and only pay for the extent they use the system, giving them full information about how their choices influence how much they spend. Public agencies like transit operators, cities and MPOs would benefit from research on the development of common payment systems and MOD applications across public and private operators, which may have great implications for how individual travel decisions are made in the future.

Conclusion

MPOs and their partners are facing a critical challenge: to bring shared mobility into the transportation planning process, in order to develop higher performing regional multimodal systems. Private sector companies are quickly becoming important providers of transportation services in many urban areas, and it is still unclear how people will use increasingly ubiquitous shared mobility options and related technologies in the near future. However, this rapidly changing transportation environment calls for integrating shared mobility into transportation planning to ensure that the public has a voice, to ensure public goals are being considered and addressed in parallel with business goals, and for transportation plans and programs to remain effective.

Shared mobility technologies and strategies have the potential to help address transportation planning goals such as congestion reduction, improved safety, and greater accessibility, among others. However, if the expansion of shared mobility services is not coordinated with regional goals in mind, communities may experience unintended consequences such as increasing congestion, worsening pollution, inefficient land-use patterns, and inequitable access for people with low incomes or disabilities.

Many transportation agencies are beginning to experiment with bringing shared mobility into the regional multimodal transportation planning process. Although MPOs, cities, counties, and transit agencies are just beginning to develop practices and techniques for integrating shared mobility, these agencies will likely use many of the same tools they apply to address other topics. Different agency types will assume different roles based on their missions, regulatory authority, and staff capacity. However, effectively addressing shared mobility at a regional scale may require a new paradigm of cooperation between agencies to coordinate actions at all levels, identify incentives to collaborate, and establish new relationships with transportation providers.

Consistent with findings from previous FHWA research, the greatest benefits from shared mobility at the regional scale may come from more seamless integration with complementary modes (e.g., transit, nonmotorized transportation, and carpooling), enabled and enhanced by supportive policies and incentives. Because no single state, regional, or local agency controls the built environment or transportation network in metropolitan areas, closer regional cooperation and partnership may be needed to fully seize the opportunity of shared mobility to develop a package of multimodal options which competes with or outperforms owning, driving, and parking a personal vehicle.

MPOs are uniquely situated to lead efforts to coordinate planning activities of multiple partners on shared mobility because of their long-standing role as conveners and facilitators of regional decisionmaking. Achieving a more coordinated planning process for shared mobility at a regional scale calls for leadership from MPOs and partners. MPOs should feel empowered to continue to experiment and explore new approaches to working with private sector shared mobility companies and new ways of anticipating and accounting for shared mobility in the planning process.

Without input from the public through the planning process, changes in the provision of transportation services and infrastructure may not address important considerations like safety, equity, accessibility, and affordability. Significant uncertainties remain about how shared mobility and other new technologies will change the way we move. Additional research is needed to increase our understanding of how best to approach shared mobility in regional multimodal transportation planning. As we enter a new era of transportation technology, one thing seems certain: public planning agencies and their partners must continue to evolve and improve the planning process, to keep pace with innovation and keep a focus on the ultimate goals of providing a safe and efficient transportation system for the public.

Acknowledgements

The Federal Highway Administration and research team would like to thank the following external reviewers and U.S. DOT colleagues for helping refine the research questions and approach, and for commenting on drafts of this white paper.

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Matt Carpenter, Sacramento Area Council of Governments

Jascha Franklin-Hodge, City of Boston

Amanda Graor, Mid-America Regional Council

Erick Guerra, Department of City and Regional Planning, University of Pennsylvania

Elizabeth Irvin, Chicago Metropolitan Agency for Planning

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Martin Rivarola, Mid-America Regional Council

Caroline Rodier, National Center for Sustainable Transportation, University of California-Davis

Dolores Roybal Saltarelli, Los Angeles County Metro Transportation Authority

Susan Shaheen, Transportation Sustainability Research Center, University of California-Berkeley

Marla Westervelt, Los Angeles County Metro Transportation Authority

The Federal Highway Administration also thanks the MPO, local government, and transit agency practitioners who participated in conversations with the research team about their regions. The contributions of these individuals provided insights into how shared mobility might successfully be integrated within the metropolitan planning process and lessons learned in each metropolitan area.

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Appendices

Appendix A: Works Cited

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Appendix B: Operating Shared Mobility Services in Metro Areas (as of May 2017)

	Traditional TNC	Ridesplitting	Experimental TNC	Traditional Commuter Shuttle	Microtransit	Employer Shuttle
Austin	✓	✓	✓	✓	✓	✓
Boston	✓	✓	✓	✓	✓	✓
Chicago	✓	✓	✓	✓	✓	✓
Columbus	✓			✓		
Dallas-Fort Worth	✓	✓		✓		
Detroit-Ann Arbor	✓			✓		
Kansas City	✓	✓		✓	✓	
Los Angeles	✓	✓		✓		✓
Minneapolis-St Paul	✓	✓		✓	✓	✓
Portland	✓	✓		✓	✓	
San Francisco Bay	✓	✓	✓	✓	✓	✓
Seattle	✓	✓	✓	✓		✓
Tampa-St. Petersburg	✓	✓	✓			

	Traditional Bikesharing	Free floating Bikesharing	Traditional Carsharing	Peer to Peer Carsharing	Electric Carsharing	Free floating Carsharing
Austin	✓	✓	✓	✓	✓	✓
Boston	✓		✓	✓		
Chicago	✓		✓	✓		
Columbus	✓		✓			✓
Dallas-Fort Worth	✓		✓	✓		
Detroit-Ann Arbor	✓		✓			
Kansas City	✓		✓	✓		
Los Angeles	✓		✓	✓	✓	✓
Minneapolis-St Paul	✓		✓	✓		
Portland	✓	✓	✓	✓		✓
San Francisco Bay	✓		✓	✓	✓	✓
Seattle		✓	✓	✓	✓	✓
Tampa-St. Petersburg	✓	✓	✓			

Appendix C: Mention of Shared Mobility in Planning Documents (as of May 2017)

	MPO Vision	MPO LRTP	MPO UPWP	MPO TIP	MPO CMP	MPO Special Purpose Plans
Austin		✓			✓	
Boston			✓			
Chicago	✓	✓	✓			✓
Columbus	✓	✓	✓	✓		✓
Dallas-Fort Worth		✓				
Detroit-Ann Arbor						✓
Kansas City			✓			✓
Los Angeles		✓	✓			✓
Minneapolis-St Paul					✓	
Portland	✓	✓	✓			
San Francisco Bay			✓			
Seattle			✓			
Tampa-St. Petersburg	✓	✓	✓			

	MPO Corridor Plans	State LRTP	STIP	Transit Plans	Local Corridor or Special Purpose Plans
Austin				✓	
Boston				✓	✓
Chicago		✓			✓
Columbus				✓	✓
Dallas-Fort Worth				✓	✓
Detroit-Ann Arbor					✓
Kansas City				✓	✓
Los Angeles		✓		✓	✓
Minneapolis-St Paul		✓		✓	
Portland				✓	✓
San Francisco Bay	✓	✓		✓	✓
Seattle		✓		✓	✓
Tampa-St. Petersburg				✓	✓

Appendix D: Definitions

Traditional TNC*	Transportation network companies (also known as ridesourcing or ridehailing) provide prearranged and on-demand transportation services for compensation, which connect drivers of personal vehicles with passengers. Smartphone mobile applications are used for booking, ratings (for both drivers and passengers), and electronic payment.
Ridesplitting†	Ridesplitting enables riders to share rides and split the cost of a ridesourcing/TNC-enabled ride with someone traveling a similar route. Examples of this service include Lyft Line and UberPool. These shared services typically charge less than regular ridesourcing offerings and allow for dynamic changing of routes as passengers request pickups in real time.
Experimental TNC	Other TNC services which do not fit into traditional or ridesplitting definitions. These may include ridesourcing variants which provide additional services such as wheelchair-accessible vehicles and vehicles where the driver can assist passengers who are older or disabled.
Traditional Commuter Shuttle	Traditional shuttle on a fixed route, either free or with fares, may be provided by a transit agency, transportation management organization, or for-profit service
Microtransit*	Includes both fixed route and fixed schedule microtransit (e.g., Chariot) and flexible route and on-demand microtransit (e.g., Bridj, Via). **Fixed route and fixed schedule microtransit** occurs where the routing and arrival/departure times of the shared vehicles are fixed. The alignment of routes, however, can be "crowdsourced" (i.e., users can request origin-destination points on a tech-enabled platform that can inform the operators of which routes to introduce). Users of **on-demand microtransit** can request shared vans or buses real time through a tech-enabled application, and the vehicle will deviate from its route to somewhere within walking distance of the requester. These services can range in how dynamic they are—from routes that change over the span of a few days to fully dynamic routes that adjust in real time based on traffic and demand.
Employer Shuttles	Employer-sponsored shuttles that ferry employees between residential neighborhoods and suburban workplaces. In some regions these shuttles pick up at specially-designated public transit stops.
Traditional Bikesharing*	Users access bicycles on an as-needed basis for one-way (point-to-point) or roundtrip use. Station-based bikesharing kiosks are typically unattended, concentrated in urban settings, and offer one-way station-based access (bicycles can be returned to any kiosk).
Free-floating Bikesharing*	Free-floating bikesharing offers users the ability to check-out a bicycle and return it to any location within a predefined geographic region. These systems do not typically use kiosks or stations.
Traditional Carsharing*	A program where individuals have temporary access to a vehicle without the costs and responsibilities of ownership. Individuals typically access vehicles by joining an organization that maintains a fleet of cars and light trucks deployed in lots located within neighborhoods, public transit stations, employment centers, and colleges/universities.

Peer-to-Peer (P2P) Carsharing*	This model employs privately-owned vehicles or low-speed modes made temporarily available for shared use by an individual or members of a P2P carsharing company. Expenditures, such as insurance, are generally provided by the P2P organization during the access period. In exchange for providing the service, operators keep a portion of the usage fee. Members can access the automobiles or low-speed modes through a direct key or combination transfer from the owner through the operator-installed technology that enables "unattended access."
Electric Carsharing	Carsharing systems that use a provided fleet of electric vehicles (e.g., Car2Go).
Free-floating Carsharing	Free-floating carsharing services enable shared-use vehicles to be picked up and dropped off anywhere within a designated operating area.

*Adapted from FHWA Shared Mobility: Current Practices and Guiding Principles

†Adapted from Stocker, A. & Shaheen, S. (2016) Shared Automated Vehicles: Review of Business Models

Appendix E: Additional Resources

FHWA Office of Planning

- Ridesharing, Technology, and TDM in University Campus Settings: Lessons for State, Regional and Local Agencies
- Moving Together in the 21st Century: How Ridesharing Supports Livable Communities
- Developing a Regional Approach to Transportation Demand Management and Nonmotorized Transportation: Best Practice Case Studies

FHWA Office of Policy & Governmental Affairs

- Travel Behavior: Shared Mobility and Transportation Equity

FHWA Office of Operations

- Shared Mobility: Current Practices and Guiding Principles
- Smartphone Applications to Influence Travel Choices: Practices and Policies
- Integrating Demand Management into the Transportation Planning Process: A Desk Reference

FTA

- Mobility on Demand Sandbox Demonstration Program
- Shared Mobility Frequently Asked Questions

ITS Joint Program Office

- Mobility on Demand Operational Concept Report

Additional Scholarly Resources

- Notes from Automated Vehicle Symposium, July 19-21, San Francisco, Caroline Rodier, UC Davis and Marco Anderson, Southern California Association of Governments BREAKOUT SESSION 11: Early Implementation Alternatives: An Interactive Scenario Planning Session
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