

NCHRP 08-36, Task 147

Strategic Mobility Research: Enhancing Mobility, Stimulating Economic Activity, Saving Lives

Requested by:

American Association of State Highway and
Transportation Officials (AASHTO)
Standing Committee on Planning

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EXECUTIVE SUMMARY

The purpose of this research is to develop a comprehensive plan and proposed research agenda for a Strategic Mobility Research Program (SMRP). In addition to laying out a plan and agenda, the objective of the research was to identify opportunities for piloting suggested research and product development from the SMRP. A key characteristic of the SMRP includes a strategy/plan for implementing recommended research that would result in a comprehensive approach to strategic system planning. This research takes advantage of experiences from the National Cooperative Highway Research Program (NCHRP) and the Strategic Highway Research Program (SHRP)-2 on Saving Lives, Reducing Congestion, Improving Quality of Life, in identifying and selecting research projects that help define future mobility-related characteristics of the transportation system.

This research first reviewed past mobility-related research programs and agendas, distilling important mobility issues to weave into an SMRP agenda. The research team developed a stakeholder outreach plan based on the key topics identified in this review and conducted structured telephone interviews with a representative set of mobility stakeholders. The research team then synthesized the results of the research review and stakeholder input to develop an SMRP research plan and implementation strategy, including a possible institutional model for moving forward.

The results of the literature review showed potential research areas in five areas:

- *Transportation Technology*—Evolving nature of mobility technologies and their impacts across stakeholders.
- *Transportation Demand*—Evolving transportation user needs and ways service providers can use new technologies.
- *Transportation Supply*—Infrastructure and services that permit and facilitate the implementation of new technologies.
- *Transportation Context Factors*—How trends and societal factors could affect the way we travel and move goods (if travel is even necessary); this includes the changing socio-demographic factors likely to affect mobility use.
- *Transportation Impacts and Benefits*—How various efficiency, equity, and social effects of new mobility technologies may be captured.

The results of the stakeholder interviews identified four areas where mobility-related research was desired: Automation and New Mobility Impacts and Planning, Reinventing Transportation Planning/Institutional Structures for a Changing Society, Transit’s Role in the New Mobility World, and Freight Mobility and Impacts on Transportation Systems. Note that, although safety (as implied by “saving lives”) is in the title of this research project, interviewees felt that there were adequate resources available in current research programs to address system safety issues.

In addition, review of the literature on strategic mobility topics and input from those interviewed indicates that **research syntheses** provide significant value to the users. This value is particularly relevant for the myriad, rapidly changing research areas this project identified.

The proposed structure of an SMRP has three major research focus areas—Evolving Mobility Options, Changing Society and Mobility, and Creating Institutional Capability:

- *Evolving Mobility Options:* This focus area examines new and evolving mobility options in both urban and rural areas. It includes both passenger and freight mobility topics (the latter especially important given the termination of the National Cooperative Freight Research Program (NCFRP)). The intent is to provide the intellectual and knowledge base for transportation agencies and entrepreneurs to understand the basic characteristics of new mobility options, and the consequences on travel behavior and transportation system design.
- *Changing Society and Mobility:* This focus area investigates the characteristics of a changing society (such as demographics, land use patterns, household characteristics, use of personal technology devices, and such external factors as climate change). The intent is to examine in detail the external (to transportation) characteristics of a changing society that will affect, and be affected by, new mobility options. This includes the equity implications of new mobility strategies and public funding associated with such strategies, new public policy linkages to transportation (such as public health), and the impacts of transformational technology applications (such as 3-D printing) on transportation system performance.
- *Creating Institutional Capability:* The interviewees were unanimous in their observations that the future of mobility in the United States will have to be reflected in new institutional capabilities and relationships. This research area examines topics such as institutional structures, education and training of staff members, application of new work technologies, funding arrangements, and evolving partnerships (e.g., how do transportation agencies interact with what is rapidly becoming an entrepreneurial mobility market?).

Specific research topics identified as the early stages of a multiphased research program included:

1. Mid- to Small-sized Region Mobility Strategies
2. Equity Implications of Evolving Mobility Markets:
3. Future Freight Mobility Needs and Issues
4. Automation and Artificial Intelligence (AI) Strategies and Mobility:
5. System Vulnerabilities
6. Uncertainties and Transportation Decision Making
7. New Land Use Concepts/Patterns and Mobility
8. Global Trade Implications for Freight Movement
9. Modernizing Transportation Agencies
10. Next Generation Transit Agencies
11. New Risk-based Decision-making Frameworks
12. Analysis Capabilities

The recommended model for implementing an SMRP represents a hybrid combination of several of several different implementation models. The ultimate goal for the sponsorship of an SMRP is an F-SHRP-like program focusing on strategic mobility research. The research initiatives that precede this program structure rely on existing institutional research structures that will lay the groundwork for the ultimate SMRP, which include:

1. TRB should provide leadership in concert with AASHTO, AMPO, NARC, APTA, FHWA, and FTA in developing a joint collaborative research structure where individual members of these groups and the federal agencies can contribute to the overall operation of the SMRP and to individual projects. This will require time and effort to reach out to key stakeholder organizations and a willingness on the part of TRB to make the case for the proposed program. This will also require an examination of how different funding sources can be combined into a program budget and research sponsorship under the auspices of the National Academies.
2. The next step is to set-aside some CRP funding for SMRP projects. This could take the form of combined, jointly sponsored NCHRP-TCRP research projects, which have been funded before. The SMRP research projects would be based on the research process characteristics described earlier, for example, including a range of stakeholders in identifying and defining research statements. Given the focus of both CRP programs, the proposed research would have to have perceived benefits to the constituencies of both programs.
3. Depending on the timing of the reauthorization of the federal transportation law (and thus the UTC program), the next step is to incorporate strategic mobility research topics either into the enabling language or in the USDOT guidance implementing the program. The intent is to incrementally influence the type of research conducted in the program.

CHAPTER 1: PROJECT OBJECTIVES AND RESEARCH APPROACH

Introduction

The transportation system consists of many multimodal transportation facilities and services that provide multiple opportunities for user mobility and accessibility to social and economic activities. The system includes different modal transportation networks (including the information communications network) that by themselves allow travelers and goods to move from one location to another. Intermodal connections facilitate transfer among modal networks. In addition, land-use patterns and the institutional structure for providing transportation services affect overall system performance. **This complex set of dynamic interactions requires research focused on how performance-enhancing mobility options can be provided to all users of such a multimodal, multisectoral, and multifaceted transportation system.**

Such a focus is often at odds with many existing transportation research programs in the United States. Many programs, such as the Transportation Research Board's (TRB's) Cooperative Research Programs (CRPs) and research programs funded by many of the state departments of transportation (DOTs), are characterized by modally focused research, although some efforts are made to address multimodal issues. This is not to say that TRB and its CRPs have ignored the need for multimodal mobility research. The National Cooperative Highway Research Program (NCHRP), for example, has funded several projects that could be important inputs to an SMRP. NCHRP Project 08-36, Task 143, *Evolving Transportation Planning Research Needs for the 21st Century*, for example, includes outreach to key mobility stakeholders on important strategic transportation planning research needs. NCHRP's Foresight Series is another good example of an approach for identifying strategic research topics that cross modal boundaries.

Internationally, a Federal Highway Administration (FHWA) scan of research program administration in other countries concludes that strategic and policy-driven frameworks for transportation research are standard practice in other countries. As noted in the report, "transportation research frameworks are developed nationally through a strategic process that is closely tied to national policy goals and objectives. These research frameworks are all-encompassing in that they include broad societal issues, not just transportation" (FHWA, 2009).

The simultaneous, rapid, and inter-related changes in transportation technologies; evolving global, national, and state economic markets; and socio-demographic changes suggest a very different travel market in the future than what exists today. Therefore, TRB and its partners must pursue a long-term, systematic, and comprehensive strategic perspective on evolving transportation mobility systems, and the policy, planning, technical and technological systems that support them.

Research Purpose

The purpose of this research is to develop a comprehensive plan and proposed research agenda for a Strategic Mobility Research Program (SMRP). An additional objective is to identify opportunities for piloting suggested research and product development from the SMRP. A key characteristic of the SMRP will be a strategy/plan for implementing recommended research to result in a comprehensive approach to strategic system planning. In addition to borrowing from the frameworks for research programs developed through NCHRP and the *Strategic Highway Research Program (SHRP)-2 on Saving Lives, Reducing*

Congestion, Improving Quality of Life, this project identifies and prioritizes research topics that help to further define mobility-related characteristics of the transportation system.

A significant challenge in conducting this research was identifying an SMRP that could “link to” the current structure in (1) TRB’s CRPs; (2) federal and state transportation research programs; and (3) the nation’s universities’ research programs. There is an opportunity to develop a valuable SMRP that complements, targets gaps within, or replaces existing research programs, especially where efforts across entities are duplicative but uncoordinated. Overlap in research topics and objectives is already a feature of some of the nation’s research programs; for example, some research topics investigated as part of the U.S. Department of Transportation’s (USDOT’s) University Transportation Center (UTC) program could also be conducted as part of the Cooperative Research Programs administered by TRB.

For this project, the research team sought to develop a program structure like SHRP-2; however, rather than the traditional focus of strategic highway research, the program would investigate topics related to mobility. The model, SHRP-2, was a program that broadly focused on strategic highway research, with four key areas of investigation (TRB, 2009):

- **Safety:** Make a significant improvement in highway safety. The overall research goal is to prevent or reduce the severity of highway crashes through more accurate knowledge of driver behavior and other crash factors.
- **Renewal:** Accelerate the renewal of America’s highways. The overall research goal is to develop a consistent, systematic approach to implementing the results of SHRP-2 forming highway renewal that is rapid, causes minimal disruption, and produces long-lived facilities.
- **Reliability:** Provide a highway system with reliable travel times. The overall research goal is to provide highway users with reliable travel times by preventing and reducing the impact of nonrecurring incidents.
- **Capacity:** Provide highway capacity in support of the nation’s economic, environmental, and social goals. The overall research goal is to develop approaches and tools for systematically integrating environmental, economic, and community requirements into the analysis, planning, and design of new highway capacity.

The SHRP-2 model served as the concept underlying the SMRP presented in this publication. In developing the topical scope and areas of key investigation for the SMRP, special attention has been applied to the development of research categories and frameworks that (1) enable a better understanding of costs, benefits, and impacts of rapidly evolving technology strategies, and (2) enhance the approach to building the institutional models that will likely characterize the future of mobility. In addition, the research team used the most recent list of Critical Issues in Transportation prepared by TRB’s Executive Committee (2019), which included:

- Transformational Technologies and Services
- Serving a Growing and Shifting Population
- Energy and Sustainability
- Resilience and Security
- Safety and Public Health

- Equity
- Governance
- System Performance and Asset Management
- Funding and Finance
- Goods Movement
- Institutional and Workforce Capacity
- Research and Innovation

Each topic could be incorporated into a mobility-focused research program. The following section describes the research approach that guided program development for SMRP.

Research Approach

This research first reviewed past mobility-related research programs and agendas, distilling important mobility issues to weave into an SMRP agenda. The research team developed a stakeholder outreach plan based on the key topics and conducted structured telephone interviews with a representative set of mobility stakeholders. The research team synthesized the results of the research review and stakeholder input to develop an SMRP research plan and implementation strategy, including a possible institutional model for moving forward.

Stakeholders interviewed for this project included representatives from state DOTs, metropolitan planning organizations (MPOs), city transportation officials, transit agency officials, transportation authorities, professional associations, and mobility researchers.

An ongoing challenge for mobility-related research has been a tendency to pursue a diverse set of timely topics without an adequate over-arching strategy or structure, with the result that implementation gaps remain, and topics become obsolete. For instance, early automation research assumed a world of sensors and controls implemented by public agencies. Yet later communication technologies enabled autonomous and connected vehicle futures driven by private investments that required little such public investments. Moving forward, research must be designed that seeks robust insights that are most likely to remain useful as technologies and agency roles evolve.

Transportation agencies and MPOs similarly need research that will help them plan for the future without getting distracted by short-term debates on exactly how car/truck/ride sharing and autonomous vehicles will converge via new service models and providers. Ultimately, what matters most is that integrated, multimodal planning is constantly evolving, and information is made available to transportation stakeholders who must understand how to apply supply, demand, and institutional considerations across modes and service options. The SMRP is a way to address these issues by considering emerging opportunities and alternative future storylines to ensure more robust research findings. In addition, current innovative research programs in other parts of the world provide lessons learned.

CHAPTER 2: REVIEW OF CURRENT AND EMERGING ISSUES IN MOBILITY

The literature review for this research examined current and past multimodal transportation research plans, programs, and studies. Among the research team’s focus areas was identifying other entities that had deployed mobility-related research roadmaps and plans. Research products were sponsored by a variety of organizations, including TRB, USDOT, the American Association of State Highway and Transportation Officials (AASHTO), Association of Metropolitan Planning Organizations (AMPO), National Association of Regional Councils (NARC), and the American Public Transportation Association (APTA). In addition, the team also reviewed research conducted as part of the F-SHRP, SHRP 2, and CRP through Research Results Digests, SHRP Annual Reports, and related project reports.

The research team compiled results into a classification of mobility-related research that is discussed in Chapter 3 of this report; classification incorporates both desktop research as well as stakeholder interviews. The team identified potential SMRP research themes, program options, and opportunities from surveying existing research plans and results, in addition to gathering expert perspectives on current and emerging mobility. In crafting potential research topics, key considerations included: (1) the nature and content of the potential research results; and (2) the feasible application of these results by transportation industry practitioners and transportation researchers.

To conduct a desktop search of existing literature, the research team identified documents and products reviewed through a web-based scan of mobility-related research efforts and programs in the United States and around the world. To identify such documents, the team conducted online searches with keyword combinations such as “research roadmap,” “mobility,” “transportation,” “strategic plan,” and “emerging issues.” The research team’s existing knowledge and experience related to strategic mobility research reports and products supplemented online search results.

The scan identified more than 60 documents that were considered most relevant to the research topic. The team filtered these documents for relevant content and applicability to the current effort. Table 1 lists the documents that were determined to be of the highest potential value to informing the SMRP because they focus on developing a mobility-related research road map. Table 2 shows other documents that were important in helping describe emerging mobility issues. It is noteworthy that many of these resources were white papers from company-affiliated brainstorming centers as well as technology-specific companies (any potential bias of the recommendations from such references has been considered when developing study recommendations).

Table 1 and Table 2 documents all were published within the last 10 years by research agencies, transportation corporations, or academic journals in the United States, Europe, or Australia. They include a mix of research products such as roadmaps, reports, and guidebooks, all of which reveal areas for future mobility research. Although several documents may be considered “multimodal” in their overall perspectives, private vehicles are featured most prominently in the work reviewed, followed by transit and shared vehicles. Few documents referenced bicycle or pedestrian-level activity, except in the literature on the future of smart, sustainable cities (this gap is recognized in the proposed SMRP). Both urban and rural areas are represented among the documents, although urban mobility solutions received more attention from authors.

Table 1: Relevant Research Roadmaps Distilled from Initial Scan of Research Documents

Document Name	Mode(s)	Authors/Agency (Year)	Country of Origin	Type of Publication
ITS for Electric Vehicles – An Electromobility Roadmap	Highway	Hübner, Y. et al. (2012)	United Kingdom	Research Roadmap
Urban Mobility Research Roadmap	Multimodal	European Rail Research Advisory Council (2012)	Belgium	Research Roadmap
Land-use and Transport Interactions: Towards a Research Agenda	Multimodal	Association for European Transport (2013)	Germany	Research Roadmap
Development of Tools for Assessing Wider Economic Benefits of Transportation	Multimodal	Economic Development Research Group, Inc. et al. (2014)	United States	Research Roadmap
Towards the Internet of Cities: A Research Roadmap for Next-Generation Smart Cities	Multimodal	Schleicher, J. et al. (2015)	Austria	Research Roadmap
Shared Mobility and the Transformation of Public Transit	Transit	Shared-Use Mobility Center (2016)	United States	Research Report
Understanding Transportation Resilience: A 2016-2018 Roadmap	Multimodal	Ekern, D. and Fletcher, D. (2016)	United States	Research Roadmap
Broadening Understanding of the Interplay Among Public Transit, Shared Mobility, and Personal Automobiles	Transit / Highway	National Academies of Sciences, Engineering, and Medicine (2018)	United States	Research Report
Critical Issues in Transportation 2018	Multimodal	Transportation Research Board (2019)	United States	Research Report
NCHRP 20-102(19) – Update AASHTO’s Connected Vehicle/Automated Vehicle Research Roadmap	Highway	Booz Allen Hamilton (2018)	United States	Research Roadmap

Document Name	Mode(s)	Authors/Agency (Year)	Country of Origin	Type of Publication
Strategic Transit Automation Research Plan	Transit	Federal Transit Administration (2018)	United States	Research Roadmap
Evolving Transportation Planning Research Needs for the 21st Century	Multimodal	Meyer, M., and Mallela, J. (2019)	United States	Research Roadmap

Table 2: Relevant Non-Roadmap Research Documents Distilled from Initial Scan

Document Name	Mode(s)	Authors/Agency (Year)	Country of Origin	Type of Publication
The Future of Mobility Scenarios for the United States in 2030	Multimodal	Zmud, J. et al. (2013)	United States	eBook
Between Public and Private Mobility: Examining the Rise of Technology-Enabled Transportation Services	Multimodal	National Academies of Sciences, Engineering, and Medicine (2016)	United States	Research Report
Examining the Safety, Mobility and Environmental Sustainability Co-Benefits and Tradeoffs of Intelligent Transportation Systems	Multimodal	Tian, D. et al. (2017)	United States	White Paper
Future of Transportation	Multimodal	AARP Public Policy Institute (2019)	United States	Research Paper
Affordable Housing in Transit-Oriented Developments: Impacts on Driving and Policy Approaches	Transit / Highway	Boarnet, M. et al (2017)	United States	White Paper
Mobility Innovation Hub	Transit	APTA (2018)	United States	Website
From Hyperloop to Flying Cars: Are these Technologies	Multimodal	Ziegler, B. (2018)	Switzerland	Article

Document Name	Mode(s)	Authors/Agency (Year)	Country of Origin	Type of Publication
the Future of Transport?				
Future of Mobility White Paper	Multimodal	Shaheen, S. (2018)	United States	White Paper
Forces of Change: The Future of Mobility	Multimodal	Corwin, S. and Pankratz, D. (2019)	United States	White Paper
Future of Transport 2050	Multimodal	UK Ministry of Defense (2018)	United Kingdom	White Paper
Future Mobility Research Synthesis	Multimodal	Florida Department of Transportation (FDOT) (2018)	United States	Research Synthesis
Future Mobility, Innovation in Transport	Highway	Government of South Australia (2019)	Australia	Website
Three Revolutions Steering Automated, Shared, and Electric Vehicles to a Better Future	Multimodal	Sperling, D. (2018)	United States	Book
McKinsey Center for Future Mobility® (MCFM)	Multimodal	McKinsey Corp. (2018)	United States	Website
Exploring the Relationships Among Travel Multimodality, Driving Behavior, Use of Ride-hailing and Energy Consumption	Multimodal	Circella, G., Lee Y., and Alemi, F. (2019)	United States	Research Report

Much recent literature on the future of transportation mobility focuses on **vehicle automation** and the impact it could have on travel behavior, land use patterns, and a variety of other outcomes. Several documents identify research needs related to automation, with some discussing the interplay among connected and autonomous vehicles, transit, and vehicle electrification. Social, economic, and environmental impacts of new mobility solutions also receive some attention in the documents reviewed. These range from the impact of vehicle automation on commuter travel to the importance of resilience planning for critical infrastructure.

Another interesting concept examined in several references is **mobility service provision or mobility management**, and possible institutional configurations to provide such mobility with the proliferation of new means of transportation seemingly showing up “over night” (e.g., scooters, on-demand motor bikes, on-demand bicycles). The literature search reveals an increasing interest in how to make sense of this changing market; however, much of this literature mirrors publications of the 1980s, when the transit industry began to examine possible roles for transit agencies as being “mobility managers.”

One factor investigated by many authors is the rapid introduction of **new sensor, communications, command/control, and information technologies** into the transportation sector (in particular) and into society (in general). Despite the prevalence of the topic, however, there are relatively few constructive recommendations for managing this emerging trend. As noted earlier, much of the “futures” literature on transportation focuses on connected/ autonomous vehicles with a notable gap in a contemplative, systems-level examination of what impact automation, artificial intelligence (AI), robotics, drones, information systems, and related technologies will have on travel desires and patterns. For example, a 2019 report by the UK Ministry of Defense examined future societal trends to the year 2050, predicting the following:

- “In the next few years, about 30% of the jobs in investment and retail banking will be automated.
- In the future, customers will likely purchase product designs and then go to local 3D printers.
- Machine-to-machine communication will be biggest producer of new data.
- Worldwide, continued urbanization and the pressures of supporting such populations (with water and transportation, in particular) will stress the ability of governments to provide basic services” (UK Ministry of Defense, 2019).

While these investigative statements provide some indication as to what researchers and practitioners might anticipate for the future of transportation, they echo the foundational conclusion from most of these studies: transportation and mobility sectors will likely look vastly different than the current landscape, but transportation professionals have a limited ability to predict what new “societal technologies” will likely be in place 5, 10, or 25 years from now.

Another research project, NCHRP 08-36, Task 143, *Evolving Transportation Planning Research Needs for the 21st Century*, was conducted at the same time as this project. That project undertook a comprehensive review of the literature (in particular, the “futures” literature) and a survey of state DOT planning directors as well as interviews with key transportation stakeholders. The final report recommended strategic planning research projects and an approach for funding. Table 3 shows the projects that were recommended by the NCHRP 8-36 (143) project. **Task 147 research considered the results of the Task 143 project, given that the input from the literature review and stakeholder interviews in the Task 143 project resulted in recommendations directly relevant to this research.**

Table 3: Research Project Priorities from NCHRP 08 36(143)

Category	Research Topics
Technology	<p>Syntheses on Emerging Freight Transportation Technologies/ Environmental Scan</p> <p>Changing freight technologies and implications to transportation planning (e.g., 3D printing)</p> <p>Impact of automation, machine intelligence, drones and robots on travel behavior and transportation</p> <p>Assessment of technology-based vulnerabilities of the future transportation system and how to counteract (e.g., cybersecurity)</p> <p>Evolving impacts of “personal life” technologies on life style and transportation options</p>
Institutional Factors	<p>Implications of more benign transportation technologies on environmental rules/ regulations; impact on decision-making</p> <p>Automation and work place technologies’ impacts on day-to-day operations of a state DOT and on the needed skills of future DOT employees</p> <p>Automation and work place technologies’ impacts on day-to-day operations of a state DOT and on the needed skills of future DOT employees</p>
Planning Process/Tools	<p>Incorporate quantified risks in planning, project designs and program development; linkage to asset management</p> <p>Big data and utilization of data analysis tools/methods to provide insights on transportation system performance and user travel patterns</p> <p>Definition and valuation of the benefits of investing in the transportation system</p> <p>Implications of new vehicle-sharing models on analysis</p>
Planning Context Influences	<p>Considering system disruptions in transportation planning</p> <p>Evolving equity considerations in transportation planning</p>

CHAPTER 3: SYNTHESIZING RESEARCH REVIEW RESULTS INTO A STRATEGIC MOBILITY RESEARCH CLASSIFICATION SCHEME

An effective SMRP could be organized around five general themes:

- **Transportation Technology**—Evolving nature of mobility technologies and their possible impacts.
- **Transportation Demand**—Evolving transportation user needs and ways service providers can use new technologies.
- **Transportation Supply**—Infrastructure and services that permit implementation of new technologies.
- **Transportation Context Factors**—How trends and societal factors could affect the way we travel and move goods (if travel is even necessary), including the socio-demographic changes likely to affect mobility use.
- **Transportation Impacts and Benefits**—How to capture various efficiency, equity, and social effects of new mobility technologies.

Although unique to contemporary transportation planning in some respects, these are consistent research themes across multiple decades of transportation and mobility literature. Demand and supply, for example, has been a fundamental concept in transportation analysis for many years. However, in examining the literature, it is apparent that new and innovative concepts are not reflected in existing or prior research programs. In particular, the literature review identified three, cross-cutting research themes for further examination under the SMRP:

- **System Design and Operation**—Optimization of transportation services across modes; new forms of mobility options; adaptive design strategies for evolving market demands.
- **Institutional Collaboration and Implementation**—Effective organization and implementation of transportation services given changing market structures; new roles and participants in the mobility market; adaptive institutional strategies for responding quickly to rapid changes in travel demand.
- **Feasibility and Desirability**—What is possible and desirable (from user and provider perspectives) and how these might change over time; providing stable funding for new forms of mobility; defining benefits and costs and the equity implications of each.

Thematic Area 1: Transportation Technology

Design and Operation

Vehicle automation is a foremost concern in the literature for design and operation of future transportation solutions. However, several issues relating to automation and related transportation technologies merit further research: potential for labor displacement, risk-aversion by manufacturers and policymakers, financial constraints, and market size (i.e., customer demand for automation technologies). Research is also needed on workforce capability strategies for local governments when automation creates new and specialized job responsibilities.

Future transit system design may include applications of automation technologies, including: advanced driver assistance systems (ADAS); automated shuttles and bus rapid transit (BRT); automated maintenance, yard, and parking operations; and mobility-on-demand (MoD) services. For each application, passenger experience research will be needed to verify service reliability, ride quality, and customer service. Perhaps most importantly, new support technologies might be necessary in determining how traditional transit services must adapt to a new transportation mobility market where many new options are available to the traveling public.

Vehicle electrification is another transportation technology research area. Technologies already incorporated in electric vehicles (EVs) include those that provide information to drivers on energy usage and available driving range. Within a broader intelligent transportation system (ITS), future research and development needs relate to EV charging management services, traffic management tools for large-scale EV introduction, and more accurate range prediction and navigation.

New transportation technologies present opportunities for transportation agencies; at the same time, the rapid proliferation and advancement of new technologies challenges agencies to manage enormous amounts of data generated by a diverse range of transportation providers. The data challenge requires “urban-scale data management” that will allow local governments to use data to improve the overall design and operation of their transportation systems.

Collaboration and Implementation

Implementing future transportation technologies requires effective cross-sector collaboration. With private firms becoming more active players in providing new forms of mobility that leverage the latest communication and web technologies, public agencies must tie into this market to better understand the implications for system performance. Research must support state and local decision-making around vehicle automation, specifically related to design specifications, system design, and deployments that result in user-friendly mobility. Policy research including private sector engagement might focus on technology-based fare payments, labor issues, accessibility, liability and insurance, data collection and management, and technology procurement. Vehicle automation also introduces the need for harmonizing federal, state, and local regulations, while at the same time delineating clear boundaries of responsibility.

Similarly, widespread deployment of EVs is already requiring collaboration among individual auto manufacturers, governments managing ITS operations, and electric utilities. These players will have a more critical role in the future to ensure that electrical grids and communication technologies are designed such that vehicle charging infrastructure is reliable and widely available; moreover, this infrastructure must support a range of vehicle products, from personal to light and heavy-duty vehicles.

The preceding points suggest a need for networks that (1) connect citizens with new technology applications and (2) enable governments to implement smart city technologies. A successful model of technology dissemination also includes one based on information exchange and where lessons learned are easily conveyed to others interested in implementing similar types of technologies.

Feasibility and Desirability

Many questions still exist about the feasibility and overall desirability of emergent transportation technologies. The mobility market has seen rapid changes with the introduction (and replacement) of mobility options. From a public policy perspective, potential risks related to safety, security, and public costs are often unknown and do not become apparent until after introduction of a new mode. For example,

the rapid introduction in many cities of electric scooters caught many city governments off-guard, with many slowly enacting rules and regulations (e.g., no riding on sidewalks or requirements for helmets) long after the scooters were in use throughout the city. Another example is the challenges in many cities on how to regulate transportation network companies (TNCs) such as Uber or Lyft. Unlike the traditional, proactive public sector model based on a prior examination of strategies and options when considering changes to the transportation system, many transportation agencies now find themselves in a reactive mode, trying to determine the desirability and assess the benefits of a new mode of transportation *after* it has already been adopted by a (sometimes niche) set of users.

In many cases, few standards exist to regulate or standardize new technologies. The literature review suggests research is needed in safety and security vulnerabilities relating to vehicle automation including software and hardware limitations, human factors affecting actual or perceived safety, cybersecurity, emergency response, and quiet operations (e.g., safety for visually impaired pedestrians).

Local governments and ITS providers must manage safety-related issues related to emergency handling and warning systems for vulnerable road users (i.e., children, older adults, the visually- and hearing-impaired, people with disabilities). Governments must also remain flexible in their approach to rolling out new communication networks and the “internet of things” if they are to promote innovation and enable the growth of new transportation technologies.

Thematic Area 2: Transportation Demand

Design and Operation

Interactions between transportation and land use may change given new transportation technologies. Such interactions play a significant role in generating and defining transportation demand. For instance, transit demand tends to be higher in areas with supporting land uses, in particular those that provide a dense mixture of residential and commercial development. However, how will changing household and transportation technologies potentially change land use patterns and thus transportation needs? With implementation of new transportation technologies, research is needed to improve the accuracy of land use/transportation interaction models and methods in estimating demand given new transportation performance characteristics.

New forms of transportation technology could also impact transportation network design, construction methods, system operations, and network maintenance. In turn, these impacts could influence travel demand. For mobility management, especially in the area of healthcare-related travel needs, new mobility strategies might have to be tailored to specific travel markets. For transit agencies, new transportation technologies could well influence the demand for their services, both positively and negatively. Fare integration and mobile payment technologies will enhance the convenience of transit services. Given the changing demographics of urban and rural America, more adaptive service provisions will be required that are more flexible in handling travel demands that could themselves be changing over a very short timeframe.

Collaboration and Implementation

A key characteristic of mobility planning in the past has been the primary role played by public agencies in planning and implementing transportation strategies. Given rapidly changing markets, however, this may no longer be the case. In fact, many of the most recently introduced mobility strategies and products largely took place outside of the formal transportation institutional structure. Thus, a fundamental

rethinking of the way collaboration and implementation occurs in the mobility markets of the future is required.

Another important area of research will be continuing investigation of the institutional relationships and collaborative planning efforts relating to the land use/transportation linkage. The literature review identified four specific areas for consideration: (1) integration of land use and transportation planning; (2) collection and analysis of land use/transportation best practices; (3) intergovernmental relationships and responsibilities in the land use/transportation nexus; and (4) trade-offs between land use policies and private real estate development.

Intergovernmental and cross-sector implementation of mobility technologies to satisfy emerging forms of mobility will require partnerships and coordinated transportation planning efforts that engage the public. When estimating the demand for new services, research must consider equity implications, accessibility concerns, and the unique needs of “unconnected” individuals (e.g., those lacking access to internet connections or internet-enabled personal devices), and those in outlying communities that are difficult to serve using conventional modes of travel. Feasibility and Desirability

Given new and unconventional forms of mobility, advance understanding of the feasibility and desirability of various mobility strategies will require a rethinking of how one defines benefits and impacts, and for whom they are being defined. Research on new forms of mobility must address individual determinants of transportation demand and how they are influenced by changing employment, population, and land use characteristics. Such analysis should also incorporate the social determinants of individuals’ mobility behaviors, including changing norms, perceptions, and lifestyle choices (e.g., wanting to live somewhere walkable).

Estimations of transportation demand can be improved by evaluating the performance of transportation systems, the extent to which they meet travelers’ needs, and the likelihood that they will do so in the future. Although current focus is on quantitative performance measurement, researchers can also draw on qualitative measures of customer satisfaction and individual mobility providers’ progress toward meeting certain goals and objectives (e.g., improved accessibility in low-income areas). It is critical that performance measures reflect a “big picture” approach to mobility, ensuring that investments are targeted toward solutions that improve customers’ ability to travel where they need to safely, reliably, and affordably. For example, some new mobility options have potentially significant safety issues that could have been better identified before widespread implementation (e.g., riding electric scooters on sidewalks).

Thematic Area 3: Transportation Supply

Design and Operation

Much future-oriented literature that focuses on transportation supply (in the context of mobility) highlights connected and autonomous vehicle (C/AV) operations, not surprisingly given the emphasis on such technologies in recent years. Thus, for design and operations, such operations lead to important questions on how infrastructure design might have to change (if at all) to provide for a safe mixture of C/AV and non-C/AV vehicle operations. Theoretically, current technology development assumes a mixed operating environment. However, the phasing in of C/AV operations in communities might very well require different operations strategies (e.g., using today’s high-occupancy vehicle lanes as the initial paths for C/AV vehicles).

As noted earlier, much of the transportation supply literature focuses on passenger and transit vehicle operations, with limited attention given to non-motorized modes. However, there is an important trend in transportation policy toward broadening the public policy outcomes that can be tied to transportation system performance (see discussion later in *Thematic Area Changing Society and Mobility*). One outcome is public health, with a major strategy in the transportation/public health nexus promoting more active transportation modes. Thus, it seems likely that there will be significant need for research that focuses on how to design and operate active transportation infrastructure and its associated services, with the explicit goal of building healthy communities.

Transportation service providers are also facing unique pressures on key issues in comparison to their historical counterparts. For example, system resilience has received much attention in recent years as the impacts of climate change and extreme weather on transportation infrastructure has become more visible. To ensure that transportation systems can reliably serve future demand, transportation service providers must better understand how extreme weather events and other “shocks and stresses” (e.g., flooding, financial crises) will affect their assets and their ability to provide quality service.

Collaboration and Implementation

Given the increasing number of mobility providers in today’s transportation landscape, it seems likely that more collaboration will be necessary to optimize the provision of mobility services and, perhaps more importantly, integrate services within the broader transportation system. This collaboration could be strategy-specific or more goal-oriented toward promoting system mobility. It could include formal partnerships between traditional agencies (such as transit agencies) and newer organizational creations (such as transportation network companies [TNCs] like Lyft and Uber). This could also entail new institutional structures such as mobility brokers/managers that oversee a range of services. Doing so could provide critical first/last mile connections that increase the attractiveness of transit. Transit providers can also enhance the attractiveness of transit services by partnering with major travel market participants (such as larger employers) as part of transportation demand management strategies, or by partnering with TNCs to augment existing demand-response services.

Feasibility and Desirability

The feasibility of providing new forms of mobility depends many factors, including institutional capability, finance, cybersecurity, system shocks (such as extreme weather events), level of automation, and future considerations that today might not be apparent or seem relevant. The literature review suggests that service providers must better understand systemic risks and how they are related to system disruptions and know when and how much to invest in resilient infrastructure.

Technology can increase the desirability of mobility services, thereby encouraging providers to expand supply. TNCs, for instance, can co-market their services with transit agencies or invest in mobile app integration that supports multimodal lifestyles. In addition, researchers can focus on the ways land use patterns inhibit or promote transportation service expansion. Doing so will help transportation service providers and policymakers address barriers to increasing the supply of mobility options. Of concern will be providing mobility options in areas that might be “left behind” as new technologies are applied to the transportation system.

Thematic Area 4: Context Factors

Design and Operation

Although the cross-cutting topic of design and operation is less directly relevant to the thematic area of context factors, one clear takeaway from the literature review is the extent to which future mobility systems might have to be designed and operated differently because of changing operating environments. For example, the increasing likelihood of climate change and system disruptions suggest that future infrastructure in vulnerable areas must be more adaptive to changing environmental conditions. Some services might have to provide mobility for unexpected events that could seriously disrupt community activities (e.g., having evacuation contingency plans for those not having mobility). Changing technological characteristics of how people exchange information and purchase goods could also depend on changes in the design and operations of service delivery.

Collaboration and Implementation

Much of the changing context of mobility markets relates to diverse, non-traditional participants and entrants into emerging transportation markets. It seems likely that some form of institutional mobility management capability will be required in cities of the future to provide mobility options for travelers. Many participants will likely be private providers, and/or shared operations among subscribers, suggesting that collaboration, new partnerships, and evolving institutional relationships will characterize the future of mobility in the United States. Research in this area would examine different institutional models for managing and implementing mobility strategies.

Feasibility and Desirability

Research related to feasibility and desirability would be very important for the thematic area of context factors because, in many cases, new institutional relationships and arrangements will cut across traditional ways of doing things. Thus, it will be important to understand how feasible these arrangements are from financial, organizational, and political perspectives. After such assessments take place, the desirability of proceeding along different paths must be determined.

Thematic Area 5: Transportation Impacts and Benefits

Design and Operation

For decades, transportation researchers have been interested in the impacts and benefits of different transportation services. As new mobility options are designed and begin to operate, the expressed impacts and benefits for such options may be drastically different than those that are currently measured and assessed. Impacts and benefits usually span a range of categories related to service design and operation, including transportation system lifecycle costs, cost effectiveness, workforce needs, economic impacts, environmental impacts, and traffic flow impacts. Equity impacts, especially in the face of extreme weather events, which often have an uneven distribution of impacts to a region, must be considered. New forms of mobility also could generate widespread benefits, including safety improvements through vehicle automation or air quality improvements through vehicle electrification.

Collaboration and Implementation

Although not highlighted in the documents reviewed, the research team's experience and knowledge suggest that the impacts and benefits of future mobility investment and initiatives will be strongly influenced by collaboration and implementation. Policy and planning decisions about where, how, and

when to pursue adoption and application of new transportation technologies (e.g., vehicle automation, smartphone-based transit) may have significant equity implications affecting various populations in an urban area or state. Similarly, as noted above, actions to address climate resilience needs and human-created environmental degradation must fully consider equity issues. Strategies for appropriate collaboration and implementation approaches to mitigate inequities across geographies and sociodemographic groups must be seriously explored in addressing future mobility strategies.

Feasibility and Desirability

Measuring the impacts and benefits of vehicle automation technologies is difficult given their relative infancy. Future research must address automation-related impacts on transportation systems, land use patterns, and travel demand to increase the feasibility and desirability of these services. More research is also necessary to measure the reliability, accessibility, and economic performance of transportation systems given changing economic markets. Economic evaluation tools must be improved to measure the value of improved reliability or localized environmental and social impacts. Doing so will improve the ability to prioritize transportation investments and distinguish among different types of impacts and benefits.

Classification of Strategic Mobility Research

Tables 4 to 8 summarize the thematic research identified in the literature review. The research team used these tables in the interview process to illustrate the types of research that could be considered as part of an SMRP. Team members sent the tables to the interviewees before conducting the interviews. In each interview, a research team member asked the interviewee to identify the most important of the five research themes. After proceeding through all five research areas, the team member also asked each interviewee to identify the highest priority research focus. Finally, at the end of the interview, participants were asked to identify the one most important research topic of all those identified during the interview.

Table 4: Thematic Area: Transportation Technology

Research Theme	Focus
Design and Operation	<ul style="list-style-type: none"> • Vehicle Automation – labor displacement, risk aversion, financial constraints, market size, workforce capability • Transit System Design – automation, mobility-on-demand, passenger experience considerations • Vehicle Electrification – charging management services, traffic management tools, range prediction, navigation • Data Management – urban-scale data systems to support overall transportation system design and operation improvement
Collaboration and Implementation	<ul style="list-style-type: none"> • Cross-sector Collaboration – private role in public services, local decision-making vis-à-vis automation impacts, vehicle charging infrastructure availability and reliability • Private Role Approaches – fare payments, labor issues, accessibility, liability, data collection/management, procurement

Research Theme	Focus
	<ul style="list-style-type: none"> • Intergovernmental Coordination – regulatory structures, jurisdictional boundaries, enforcement
Feasibility and Desirability	<ul style="list-style-type: none"> • Safety and Security – software/hardware limitations, human factors, cybersecurity, emergency response, impacts on people with disabilities (e.g., quiet operations), road user safety • Public Sector Roles – new communication networks, internet of things (IoT)

Table 5: Thematic Area: Transportation Demand

Research Theme	Focus
Design and Operation	<ul style="list-style-type: none"> • Land Use – improve accuracy of land use/transportation interaction models and methods • Impacts of New Design and Implementation Options – meeting community needs, financial sustainability • Mobility Management – meeting healthcare-related mobility needs, transit fare/mobile payment options
Collaboration and Implementation	<ul style="list-style-type: none"> • Planning Coordination – transportation/land use, best practices, intergovernmental relations, public/private development trade-offs • New Mobility Services – cross-jurisdictional/cross-sector challenges, system resilience, safety and security standards • Partnerships – equity, accessibility, disadvantaged population impacts, underserved geographies
Feasibility and Desirability	<ul style="list-style-type: none"> • New Mobility – determinants of individual travel demand (economic, geographic, social); Understanding and projecting future user preferences in mode selection. • System Performance – qualitative measures, customer satisfaction

Table 6: Thematic Area: Transportation Supply

Research Theme	Focus
Design and Operation	<ul style="list-style-type: none"> • Resilience – effects of natural and manmade “shocks and stresses” on transportation supply (assets and operations) • Network Characteristics -- Blending and bifurcation of passenger and freight; opportunities for enhancing sustainability and resilience of highway and transportation system investments; considering what transportation services and technologies are best suited for an aging population;
Collaboration and Implementation	<ul style="list-style-type: none"> • Partnerships – increase transit service with limited resources, public/private partnerships, mobility broker/manager concept, employer TDM strategies and partnerships
Feasibility and Desirability	<ul style="list-style-type: none"> • Risk Management – mobility supply considerations in cybersecurity, extreme weather, automation, economics • Tools and Methods – improvements to risk management standards, tools, models, and methods; scenario-based planning as part of a risk-oriented planning process • Inducing Demand – co-marketing transit and TNC services, land use approaches, aligning supply with underserved area needs

Table 7: Thematic Area: Transportation Context Factors

Research Theme	Focus
Design and Operation	<ul style="list-style-type: none"> • Service Design and Operation – flexible and adaptive design and service provision approaches in light of system disruptions • New Mobility Markets – service linkages to changing demographics and markets (e.g., megaregions) • Changing Freight Technologies and Freight Flows – system planning and design implications of changing freight flows; impact of new technologies (e.g., 3-D printing); rise of local markets and need for collection and distribution; information technology substitution
Collaboration and Implementation	<ul style="list-style-type: none"> • New Institutional Arrangements with Market Entrants – mobility providers; mobility managers; role of traditional service providers; financial arrangements
Feasibility and Desirability	<ul style="list-style-type: none"> • Possible Benefits of New Arrangements – assessment of societal benefits and costs associated with new institutional arrangements; implementation partnerships • Impacts -- Emerging public health implications of changing transportation technologies and service strategies

Table 8: Thematic Area: Transportation Impacts and Benefits

Research Theme	Focus
Design and Operation	<ul style="list-style-type: none"> • Service Design and Operation – lifecycle costs, cost-effectiveness, workforce needs, economic impacts, operational impacts, environmental impacts, equity impacts (including equity in access to services for rural as well as urban and suburban travelers) • New Mobility Benefits, air quality improvements, transportation efficiency; coupling transportation system improvements with economic growth and development
Collaboration and Implementation	<ul style="list-style-type: none"> • Equity Impacts (Socioeconomic and Geographic) – implementation of new technologies and mobility services, resilience policies and investments
Feasibility and Desirability	<ul style="list-style-type: none"> • Automation Impacts – system level, land use patterns, travel demand • System Performance – impacts of new mobility initiatives related to reliability, accessibility, economics, society, environment

CHAPTER 4: RESEARCH TOPICS RECOMMENDED BY INTERVIEWEES

Interviews highlighted the following four main areas of initial research priorities:

Automation and New Mobility Impacts and Planning

- Those interviewed generally felt overwhelmed by trying to keep up with changes in transportation and other societal technology applications. There was strong interest for evaluation and decision-making frameworks for formulating sound transportation policy considering rapid and “game-changing” technology change. Prioritization strategies must promote investments that support emerging transportation-supportive technology.
- Automation and AI strategies are usually portrayed as end result applications, but there is little information about the implications or benefits during the early levels or phasing in implementation. This makes engagement with long-range planning exercises difficult because many of the suggested changes are highly speculative.
- Understanding transportation investment and system performance success is an important challenge, especially in an age where relatively rapid changes are occurring in mobility provision. This challenge is especially acute for transit agencies where many of new mobility options can complement existing services, but more likely will compete for certain transit ridership markets.
- Interviewees generally saw a need to more proactively and effectively anticipate and address the impacts of automation not only on transportation itself, but how automation in other societal activities could affect travel behavior (e.g., automation of manufacturing and service industries affecting employee trip generation). One aspect of these impacts that received a lot of attention from the interviewees was the implications of changing technology-based mobility strategies on social and demographic equity (when asked to identify one project topic that was most important, equity implications of changing technology-based mobility strategies was picked by most interview participants).
- Given the uncertainty about what forms of new technology will appear in future years, interviewees expressed interest in examining the need for (federal) standards in areas like data management and cybersecurity. Similar to what occurred during the early years of the intelligent vehicle highway system and ITS technology introduction (where system architectures were required), is there some way to assure compatibility between future technologies and public agency processes and standards? There was a recognition that technology innovation often proceeds outside of structured standards and that not all technology applications would be constricted by such standards, but that unless some consistent framework (especially in data management) was available, potential economies of scale in terms of public and private initiatives would be lost.
- Although there was recognition that much work has been undertaken on cyber security, interviewees acknowledged that a more automated/AI-oriented society will be more vulnerable to outside attack and disruptions to critical transportation infrastructure are more likely in the future. It is assumed that security and enforcement agencies are engaging in studies and research to better protect the nation’s cyber network. However, there was a perception that an important role

for transportation agencies is to prepare contingency plans and strategies if massive disruptions do occur in transportation systems due to cyberattacks. What are the options for such a scenario? How should information be conveyed to the traveling public? How does a community assure the movement of emergency vehicles when the network is gridlocked? How can redundancy be incorporated into transportation networks to provide alternate paths in the event of major facility failures?

Reinventing Transportation Planning/Institutional Structures for a Changing Society

- Like the previous section, interview participants generally felt that the institutional environment for mobility options is changing as rapidly as the technology itself. Introduction of TNCs and other on-demand mobility options, for example, were considered by interview participants to be (to a large extent) outside the purview of traditional institutional structures. Participants expressed a need for new tools to work with private companies and firms to effectively coordinate/integrate what some interviewees referred to as the “value chains” of both public agencies and private entities. This was considered a challenging proposition given that many of new mobility options are based on software or other innovative technologies which are highly proprietary.
- Many transportation ‘futurists’ argue that the next two generations will see a fundamental shift in vehicle ownership patterns (especially true in management consultant studies prepared for investors and the automobile industry reports, which are highly proprietary and thus cannot be referenced). The argument is that whereas previous generations mostly thought automobile ownership was a prerequisite for mobility, today’s (and tomorrow’s) generations will likely face more vehicle-sharing options. This is partly illustrated with the entrance into the market of companies like Uber and Lyft, and car-sharing companies like Zipcar and Car2Go. This trend fundamentally could shake up the automobile industry, transportation planning, facility design (e.g., parking needs), and the transit industry and have significant implications for transportation analysis methods and institutional relationships relating to participation in the planning process.
- Understanding of the “broadening” of transportation-related policy concerns that are likely to become more important in the future must be improved. The relationship between transportation planning and public health was considered an example where a lack of information on what public health benefits could accrue given different transportation investment strategies is hindering a more comprehensive view of the consideration of such benefits in transportation decision making. Other topics included system resiliency (in general) and climate change (in particular), and emerging freight and logistics technologies (e.g., the use of drones in last-mile delivery).
- Given that many of the “new” issues will occur over a timeframe outside the typical long-range plan time horizon (i.e., 20 to 25 years), how should long-range transportation planning consider such issues? For example, climate change is likely to be a significant influence in many US urban areas (especially along the coasts). However, while most predictions do not show widespread significant impacts until the latter half of the 21st century, the effects of many of today’s decisions on land use and infrastructure will be in place when these impacts occur. How should the transportation planning process consider such long-range impacts? And how does one communicate these concerns to decision makers and the public? **There was an expressed need for examples of best practices in ways of doing so.** A notable challenge for interviewees was

finding examples of tangible tools to engage their planning staff on issues that are perceived as too “far out” to warrant immediate or near-term consideration.

- Interviewees thought many of the current transportation demand models are inadequate for assessing and predicting the emerging forms of mobility now being implemented around the country. There is a sense that the models are playing “catch up” to what is happening in the travel market; furthermore, interviewees expressed an issue with models, wherein they do not provide planners with actionable insights. For example, some of the early applications of travel demand models for assessing the implications of connected/autonomous vehicles (C/AV) to transportation system performance used proxies to replicate what C/AV operations might mean to traffic flow and travel demand. Interviewees noted that the need for better models is particularly acute in land use modeling, where many expressed concern about the utility of current models in light of changing mobility strategies and development patterns.
- Interviewees from mid- and small-sized regions expressed interest in research that reflected new and emerging mobility strategies for rural and small urban areas. There was a sense that existing and prior research on mobility has been dominated by an emphasis on larger metropolitan areas, which face very different issues and concerns than found in rural areas. With an aging population and a changing economic base, rural cities and towns are managing a delicate calculus of risk and reward when it comes to navigating their transportation challenges, and emerging mobility will have distinct consequences and benefits for their residents. . For example, transportation access to medical and public health services in rural areas is likely to become a greater challenge as many private medical services are already facing financial pressures. Access to job opportunities is also considered to be a critical need as principles of agglomeration continue to centralize economic activity around key hubs.
- Peer exchanges and anthologies of best practices are considered particularly beneficial to practicing professionals. Interviewees considered the model followed by FHWA and FTA in launching climate resilience pilots/demonstrations to be an excellent example of how strategic mobility options and related planning approaches could be introduced to the profession.

Transit’s Role in the New Mobility World

- Transit service provision is one of the key impact areas of new mobility options. In general, interviewees were concerned about the perceived diminishing role and relevance of traditional transit service given new mobility options being introduced into many transportation markets. Many transit agencies are looking at ways to complement and utilize these new options as part of their service offering; however, there is a sense that many of these options are viewed by some transit riders as substitutes for transit. It was noted that the Transit Cooperative Research Program (TCRP) is available to fund projects that can examine these relationships, but those interviewed did not seem to believe these studies would be attractive for TCRP funding.
- There was a strong desire for research that more carefully examines the existing and new user groups for transit services, as well as how people use transit over the course of their lives. This interest included examining how new mobility options can be integrated into a transit agency-based mobility program from a market penetration perspective. While transit agencies as “mobility managers” is not a new concept, there is a sense that very little has been accomplished to facilitate an effective model of this in the US.

- Interviewees suggested that reconnecting transportation and land use planning, a relationship many identified as “broken,” should be a research priority. This was viewed as more than just strategies to encourage transit-oriented development (TOD). Given that many of the new mobility options, and those likely to be available in widespread application in the foreseeable future (e.g., C/AV systems), make it easier to NOT use transit, successful transit provision might rely even more on linking development patterns around transit services. There is a need to better understand what types of development and population groups are likely to respond to such a development model, and what transit service characteristics are needed to attract such riders.

Freight Mobility and Impacts on Transportation Systems

- Interview participants noted that the National Cooperative Freight Research Program (NCFRP) no longer exists, and thus much of the sponsorship of freight-related research would now have to be funded by freight-related modal agencies (e.g., Federal Railroad Administration—FRA) or as part of other research programs (e.g., NCHRP). There was thus an interest in incorporating freight mobility as part of an SMRP. This was particularly true in understanding the impacts of changing technologies of freight movements on transportation system performance (e.g., ranging from drone pick-ups and deliveries to 3D printing).
- Innovative technologies often evolve and are applied so quickly that it is difficult for transportation planners to understand the implications for near- and long-term transportation system performance. One proven approach for helping planners and others remain informed on current developments, especially for technology applications, is to conduct research syntheses on topics in key areas. Such syntheses provide a “snap shot in time” of the industry’s present status and situation as well as what developments are likely to happen in the coming 10 years. Such syntheses, if conducted on a regular basis, would provide transportation planners with insights on the freight technologies that could affect transportation system performance.
- Global trade patterns are uncertain due to evolving trade markets and use of tariffs (and other regulatory mechanisms) to influence trade flows. Much of the evolving nature of trade and international freight flows occurs outside of the normal state- and metropolitan-level transportation focus; however, interviewees evidenced an understanding that a worthwhile research topic would be to clarify what this means to state and regional economies (or developing tools to allow state and regional planners to determine such impacts).
- Similar to the above “institutional structures” category, there was a strong interest in examining how freight providers, suppliers, and customers can be more effectively engaged in the transportation planning process. This is not a new issue. Engaging freight actors in public-sector transportation planning has been challenging for many years. However, the interviewees suggested that new mobility options for their employees as well as understanding transportation system performance implications of their use would be of interest to motivate such participation.

Research Syntheses

The review of the literature on strategic mobility topics and the input from those interviewed indicated that **research syntheses** provide significant value to the users. This value is particularly acute for many rapidly-changing research areas this project has identified. As stated by several interviewees, by the time a particular topic has been identified and made its way through the traditional research

solicitation/proposal development/project management process, new developments (of perhaps higher priority) may have occurred. The proposed SMRP is thus based on the concept that research syntheses should precede the identification of particular research project statements so as to conduct a scan of what is known about the latest issues facing that category of research. In research categories such as transportation technology, scans might have to occur on a short cycle period, perhaps every 3 to 5 years.

Other comments from the interviewees that became important considerations in the proposed SMRP included:

- The SMRP must be implementation-focused and provide tools to practitioners with immediate applicability.
- Innovation is found in many different agencies—state DOTs, cities, transit agencies, and MPOs. The SMRP must reach broadly into the transportation community for needs and potential research ideas.
- Evidence-based research is key to success, especially in topical areas where rapid change is commonplace.
- Data management is a huge issue, both data collection and handling technology, as well as from the perspective of how the data can (and should) be used.
- Engaging planning partners in long-range planning exercises (like the impact of automation) is an important opportunity that should be emphasized in an SMRP.
- Target audiences need to be more expansive than some of the existing research programs that are perceived as being modally-focused. Including MPO officials in the SMRP would be an important component for program success. MPOs are usually the agency that deals primarily with mobility, not just transportation.
- Anything that deals with sensitivity testing in the various model components is a useful area of research, particularly for new modes entering the market.
- The SMRP should support experimentation in tools development, such as trying new ways of representing mobility in models and analysis tools.

Finally, although “safety” is in the title of this research project, interviewees felt that there were adequate resources available in current research programs to address system safety issues.

CHAPTER 5: PROPOSED STRATEGIC MOBILITY RESEARCH PROGRAM, INITIAL PROJECTS, AND IMPLEMENTATION

SMRP Structure

The proposed SMRP structure is based on three considerations. First, the program is designed to complement existing research programs such that the projects funded in the SMRP could not be funded elsewhere. Thus, for example, although several interviewees identified the need for new transit strategies to reflect changing economic, demographic, and technology characteristics of the ridership market, such research could be funded through the existing TCRP. Similarly, those topics that could be competitive in the NCHRP, FHWA's Research, Development and Transfer (RD&T) and the ITS Joint Program Office research programs, and Federal Transit Administration's (FTA's) research efforts are not included in the proposed SMRP. Relationships with these and other programs (e.g., at UTCs) are discussed in the implementation section of this report.

Second, the research projects included in the SMRP are important topics that can create new knowledge or establish new understandings of the factors defining the mobility environment of today and tomorrow. This focus explicitly considers societal factors that often influence what happens on and to the transportation system, but over which transportation officials have little or no control. The key perspective in the identification of research projects is the word "strategic" in the program's title.

Third, the research projects were identified during stakeholder interviews as of great interest and importance to the stakeholder's agency mandate and responsibilities. The intent of the project identification is to reflect the broadest level of support from a range of potential stakeholders.

Figure 1 shows the proposed structure of an SMRP is shown in Figure 1 based on these considerations and the results of the literature review and stakeholder interviews. As indicated, the SMRP has three major research focus areas—Evolving Mobility Options, Changing Society and Mobility, and Creating Institutional Capability.

Evolving Mobility Options: This focus area examines new and evolving mobility options in both urban and rural areas. It includes both passenger and freight mobility topics (the latter especially important given the termination of the NCFRP). The intent is to provide the intellectual and knowledge base for transportation agencies and entrepreneurs to understand the basic characteristics of new mobility options, and the consequences on travel behavior and transportation system design.

Changing Society and Mobility: This focus area investigates the characteristics of a changing society (such as demographics, land use patterns, household characteristics, use of personal technology devices, and such external factors as climate change). The intent is to examine in detail the external (to transportation) characteristics of a changing society that will affect, and be affected by, new mobility options. Equity implications of new mobility strategies and public funding associated with such strategies, new public policy linkages to transportation (such as public health), and the impacts of transformational technology applications (such as 3-D printing) on transportation system performance are addressed.

Creating Institutional Capability: The interviewees were unanimous in their observations that the future of mobility in the United States must be reflected in new institutional capabilities and relationships. This research area examines such topics as institutional structures, education and training of staff members,

application of new work technologies, funding arrangements, and evolving partnerships (e.g., how do transportation agencies interact with what is rapidly becoming an entrepreneurial mobility market?).

Strategic Mobility Research Program

Evolving Mobility Options

Changing Society and Mobility

Creating Institutional Capability

Figure 1: Strategic Mobility Research Program

The three research focus areas can include cross-cutting research themes. For example, the research team considered including a “planning analysis methods/tools” research focus area but decided that such a focus really cuts across all three proposed focus areas. Similarly, evolving mobility options necessarily leads to an interest in how model and analysis tools can be made more sensitive to such options. The “changing society and mobility” research focus could include new models and tools to reflect such changes in planning and analysis. And the “creating institutional capability” research focus clearly includes developing the tools and methods to provide agencies with the analysis capacity to provide information to decision makers on how investment in the transportation system can best take advantage of changing norms or mitigate the impact of such change on different population groups.

Similarly, a “public policy” cross-cutting theme could be incorporated into each research focus. For example, public health and transportation, an emerging issue in transportation public policy, could have potential research interest in the “evolving mobility options,” “changing society and mobility,” and “creating institutional capacity” research focus areas.

SMRP Proposed Initial Projects

The following research projects are examples of the types of SMRP research that might be supported by the program. Note that the SMRP structure is assuming that the specific definition of research project statements would follow the current approach used in TRB’s CRPs, which is that a project panel will more clearly define specific topics and desired research products.

Evolving Mobility Options (EMO)

EMO-1: Mid- to Small-sized Region Mobility Strategies: Much mobility-related research conducted today focuses on urban mobility challenges. Changing economic and demographic structures (e.g., rural area populations becoming on average older faster than urban areas) raise important questions as to how new mobility options can be provided to mid- to small-sized regions. This has become an acute problem in public policy areas such as access to medical and public health services in rural areas. Access to job

opportunities also continues to be a critical need. This research topic could also be included in a research focus on equity implications of evolving transportation markets.

EMO-2: Equity Implications of Evolving Mobility Markets: Transportation system investment and performance always had equity consequences on different population groups. Equity in this sense could include dimensions such as racial, geographic, age, education level, and jurisdictional (e.g., city versus suburb) factors. Increasingly, as transportation continues to become more technologically savvy, equity implications could relate to one's ability to use such technology. For example, it is hard to imagine older people using electric scooters to move around a community. As noted below, there could also be equity consequences to traditional users of transit if such services suffer from competition from new mobility options that lead to less support for transit funding. This research will examine evolving definitions of equity and the mitigation strategies decision makers could consider.

EMO-3: Future Freight Mobility Needs and Issues: Demand for delivery services that provide on-demand delivery within two hours by connecting shippers, couriers, and consumers via a digital platform is growing around the world, mainly in cities. Further, this e-commerce growth is driving an "explosion" of needs for warehousing and delivery fulfillment space within the "last-mile" of urban centers. On average, in the United States, every \$1 billion in e-commerce sales growth requires an additional 1.25 million square feet of warehouse space. The key question facing transportation planners is whether and how these delivery methods will facilitate or hinder livability and economic vitality as both e-commerce and urban populations grow. Issues include not only freight movement technology advances (e.g., drones, automated delivery vehicles) but also how to most effectively harmonize demand for infrastructure use between people and goods. Planners need better methods and tools to help them understand and anticipate growth and changes in freight movement, particularly in congested urban areas.

Changing Society and Mobility (SM)

SM-1: Automation and AI Strategies and Mobility: This is one of the top concerns of interviewees. There is a recognition that TRB and other organizations are exploring some of the implications of the evolution in automation and AI technologies, along with a sense that how such trends are included in long-range planning efforts is unclear. This research would explore likely characteristics of an automated and AI-oriented future and investigate the implications to mobility options. Importantly, this research would examine not only the impacts of such technologies on the provision of transportation itself, but how they might affect society, how we organize ourselves both spatially and temporally, and ultimately what this means to transportation systems. An example of this is the changing nature of some manufacturing toward automated/robot operations and the implications on employment (and thus on travel demand to certain employment sites).

SM-2: System Vulnerabilities: The federal government and numerous "think tanks" have conducted much research on cyber security. Given project SM-1, a more automated/AI-oriented society will likely be more vulnerable to outside attack. Considering such an expectation, research questions include how transportation agencies can prepare contingency plans and protection strategies to avoid massive disruptions due to cyberattacks. What are the options for different disruption scenarios? How should information be conveyed to the traveling public? How does a community ensure the movement of emergency vehicles when the network is gridlocked? How can redundancy be incorporated into transportation networks to provide alternative paths in the event of major facility failures?

SM-3: Uncertainties and Transportation Decision Making: Many of the “new” issues facing society will likely occur over a timeframe outside the typical long-range plan time horizon (i.e., 20 to 25 years). An interesting question for transportation officials is how should long-range transportation planning consider such issues? Climate change is an example of this challenge. Although most predictions do not show widespread significant impacts until the latter half of the 21st century, the effects of many of today’s decisions on land use and infrastructure will be in place when these impacts occur. How should the transportation planning process consider such long-range impacts? And how does one communicate these concerns to decision makers and the public? Does it make sense to lengthen the timeframe for long-range planning to consider such potential impacts? What are the best ways of including uncertainty and concepts of risk into long-range planning?

SM-4: New Land Use Concepts/Patterns and Mobility: The importance of the land use/transportation relationship will continue in the future. However, a very different pattern of development and land use could result from changes in technology and economic structures. This research topic explores the implications of these changes to development patterns, how land is used, and ultimately what this means to transportation and the provision of mobility. Interviewees were particularly concerned about how to reconnect transit and land use planning. There was a sense that the success of future transit services will be even more tied to linking development patterns to transit services. This research area would examine types of development and population groups that are likely to be attracted to different development characteristics and what mobility options (including transit service) would best serve such a market. Better representing such a relationship in models and thus enhancing analysis capabilities could be part of this research.

SM-5: Global Trade Implications for Freight Movement: In a global economy, shifts in production and consumption sectors could have significant implications on freight movement and logistics, as well on the economic viability of different industries. Interviewees noted that the evolving nature of trade and international freight flows usually occurs outside of the statewide and metropolitan-level transportation planning. However, for many states and metropolitan areas, changes in the global markets could have significant impacts on local economies and on transportation system performance. This research area would examine how such changes and trends could be incorporated into transportation planning and decision making.

SM-6: Mobility and xxxxx: The SMRP must be flexible in design and structure to examine evolving public policy-related issues relating to mobility and different policy areas (and thus the “xxxxx” in the title). An example of this might include public health and mobility. Other areas might reflect changing environmental conditions and how transportation fits within these new parameters (e.g., climate change). The SMRP must provide the research community with an ability to explore the factors, characteristics, and conditions upon which mobility options are considered, designed, and operated.

Creating Institutional Capability (IC)

IC-1: Modernizing Transportation Agencies: Much has been researched and written about the need to rethink long-established transportation institutions and jurisdictional arrangements to more effectively serve mobility needs that often do not align with political boundaries. The growing dominance of metropolitan economies, the emergence of multistate megaregions, and new and different mobility options for people and freight—frequently provided by the private sector—all require careful consideration of whether and how US transportation planning and operating organizations can remain

effective in a rapidly changing world. If needed changes are identified, how would new agencies be structure, governed, and funded? Would they be multimodal operators or coordinators/“optimizers” of mobility services provided by others in the public and private sectors? How would new institutional arrangements address mobility equity concerns and needs?

IC-2: Next Generation Transit Agencies: Many interviewees expressed concern about the future of transit services and transit agencies, especially in light of the emergence of competitive technologies. There was a perceived need to examine how transit agencies can survive (if not thrive) in a rapidly changing environment. In addition, the equity implications of this changing environment could be significant. For example, if transit ridership declines in future years, and political support starts to wane, what does this say about providing services to those who depend on transit? How do transit agencies provide paratransit services to mobility-challenged populations given new mobility strategies and options? As personal/household technologies continue to permeate communities, what will be the impact of “the connected community” and subsequent consequences to transportation mobility? As indicated earlier, some of this research could be supported by the TCRP program, but there is a sense that a strategic perspective on some of these issues could be part of this research focus area.

IC-3: New Risk-based Decision-making Frameworks: Given rapid changes in transportation technology and the uncertainties these changes present to investment decisions as well as societal/environmental changes that could fundamentally change the mobility sector, new risk-based, decision-making frameworks must be developed. Such frameworks would explicitly consider uncertainties in future conditions and the risks associated, for example, with potential disruptions to transportation systems. Interviewees also pointed to the need for prioritization strategies promoting investments that support emerging transportation-supportive technology.

IC-4: Analysis Capabilities: Many research programs currently provide opportunities to develop new approaches to data collection, database management, and analysis tools/methods. Thus, the research team does not recommend a separate research focus area on this topic. However, institutional capacity includes having the analysis capability to examine the benefits and costs of different public investments. There was a sense among the interviewees that current demand models and analysis tools are inadequate for assessing and predicting the emerging forms of mobility now being implemented around the country. In addition, the use of “big data” in supporting decision making will likely evolve as the technology of transportation changes. Analysis tools and methods also must be considered from the perspective of the new transportation professional (e.g., familiar with up-to-date information technology applications). Similar to research topic SM-3, this research area would provide the resources to recommend different data and analysis approaches as the mobility environment market changes.

Implementation Characteristics

NCHRP 8-36(143) recommended an implementation strategy for strategic planning research primarily focused on obtaining research support from within the current AASHTO and NCHRP research program structure. The final report, however, did examine possible funding support from other sources. Figure 2 was also suggested as a way of looking at the research project development/implementation process. Table 9 shows part of the strategy in obtaining support for the NCHRP 8-36(143) recommended research projects.

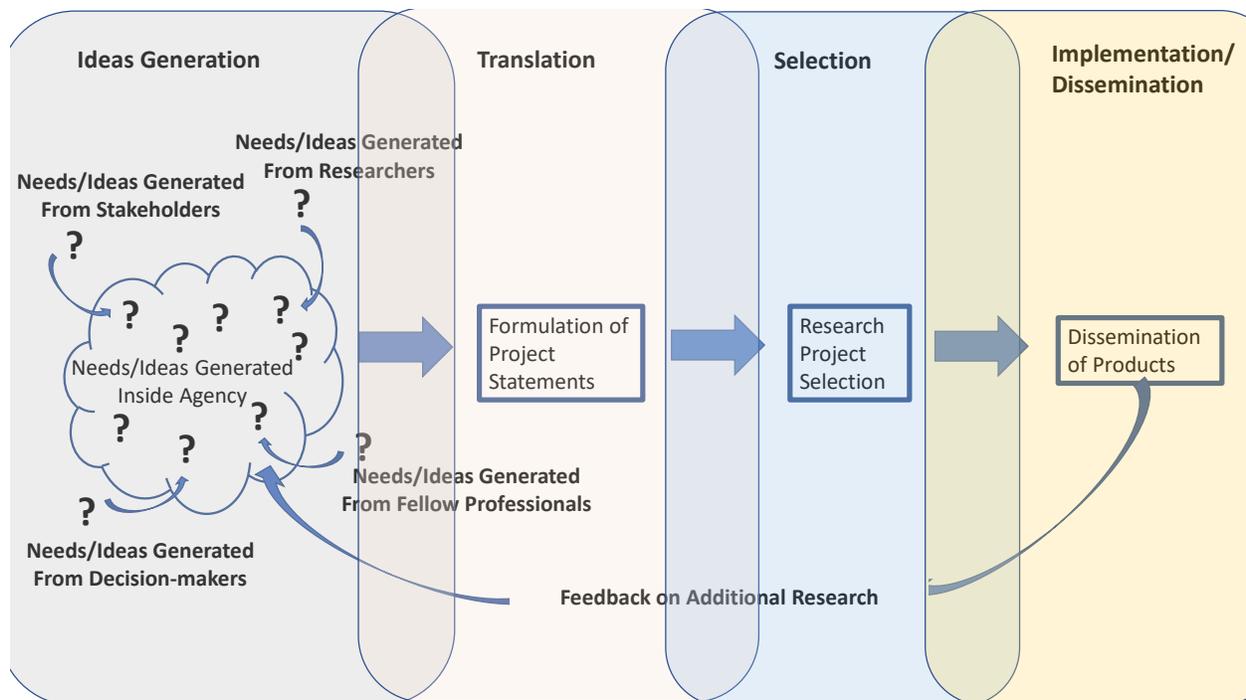


Figure 2: Steps in Development of Research Projects

Table 9: Suggested Steps for Successful Research

Key Characteristics of Effective Research Pathways		
Ideas Generation	Translation Processes	Selection Processes
<ol style="list-style-type: none"> 1. Opportunities for collaborative ideas generation, and alliances in doing so 2. Broadly available “portal” for introducing research ideas into the research process 3. Opportunities for DOT customers/constituencies to provide input 4. Opportunities for research ideas focusing on DOT “contextual” issues 5. Taking advantage of those who are thinking more strategically on future challenges and what that might mean for society, in general, and transportation, specifically 	<ol style="list-style-type: none"> 1. Opportunities for collaborative descriptions of strategic planning research project statements 2. Partnerships and alliances in supporting strategic planning research project statements, and leadership in so doing 3. Some elements of broader research impacts in the guidance provided to researchers on developing problem statements for all research, including applied research 4. Central portal or guidance document that provides centralized information on what is desired in research statement submittals 	<ol style="list-style-type: none"> 1. Opportunities for collaborative selection of strategic planning research project statements 2. Selection criteria that promote strategic planning research projects 3. Obtaining senior executive leadership buy-in into the value and need for strategic planning research 4. Providing planning input and influence in the selection process 5. Assessing the impact of strategic planning research on positioning the agency for soon-to-occur challenges

No matter what form the SMRP takes, these key characteristics of a successful research program are important for its success. Many SMRP program recommendations reflect some of the key concepts listed in Table 9. For example, the concept of collaboration among many different stakeholder groups in identifying mobility topics and in following through with targeted research on these topics is a fundamental foundation of the SMRP. Adopting a strategic perspective on the mobility issues facing (and likely to face) the United States is another foundation principle of the SMRP.

One of the key recommendations that came out of the interviews was that a broad range of stakeholders and constituencies must be involved in each stage of the research process, especially the “ideas generation,” “translation,” and “selection” steps. This means that project panels identified for generating research ideas and translating them into project statements must represent the broad spectrum of participants in mobility challenges and include state DOTs, MPOs, Regional Councils, transit agencies, ridesharing organizations, TNCs, freight operators/users, and other groups relying on a safe and reliable transportation system.

SMRP Phasing

The SMRP should be based on a phasing of research efforts, building off research that precedes each project and providing input into further research project statements. Figure 3 shows, at a general level, three phases to implementing an SMRP.

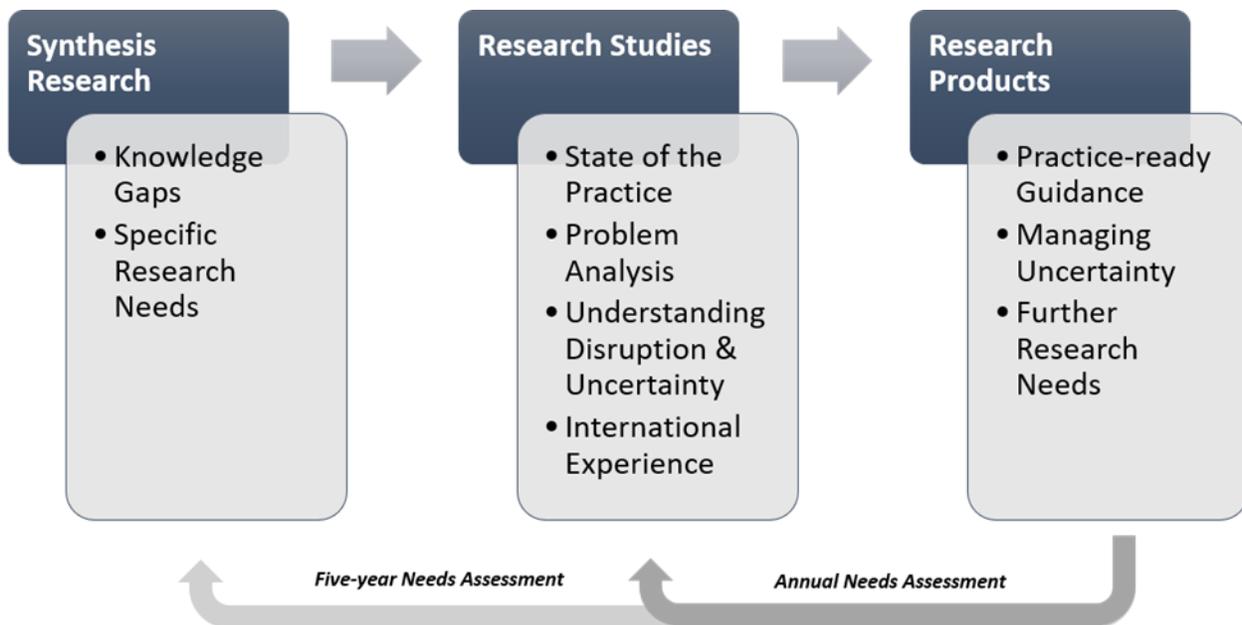


Figure 3: Proposed Phased SMRP Approach

1. *Synthesis Research* – Building on the findings of this initial project, TRB would develop a prioritized list of syntheses for each recommended research focus area that can be completed within 12 to 18 months. By implementing such a series of prioritized, quick-start synthesis projects, the new SPRM would establish a broad foundation of information and insights from which to identify and launch the full-scale research projects that result in both practice-ready products and pinpointing of further research needs.

2. *Research Studies* – The results and outputs of the synthesis research would be used to identify specific research project and product needs that would be addressed through full-scale TRB studies under the new SMRP. Table 10 (next page) could be used as a means of distilling and organizing the sequence and phasing of research projects for each topic and theme to be funded. This approach would also help SMRP decision-makers identify commonalities and overlaps between identified research needs and seek more cost-effective consolidated research studies to address them.
3. *Research Products* – The principal products of research under an SMRP should be practitioner-oriented information and guidance. The stakeholder input obtained in this study pointed strongly to an interest and need for practical and immediately applicable insights and knowledge that can help planners and policy-makers more effectively and confidently make decisions about transportation investments today that will endure effectively into a rapidly changing future. In addition, because the rapid changes in technology, the economy, and society as a whole, SMRP research studies should also seek to identify new and emerging research needs that can be addressed in future year funding cycles through either syntheses, full research projects, or both.

Table 10: Proposed Initial Research Topics and Primary Relationship to Research Focus Areas

Research Topics	Research Themes		
	Evolving Mobility Options	Changing Society and Mobility	Creating Institutional Capability
Mid- to Small-sized Region Mobility Strategies	X		
Equity Implications of Evolving Mobility Markets:	X	X	
Future Freight Mobility Needs and Issues	X		X
Automation and Artificial Intelligence (AI) Strategies and Mobility	X	X	
System Vulnerabilities		X	X
Uncertainties and Transportation Decision Making		X	X
New Land Use Concepts/Patterns and Mobility	X	X	
Global Trade Implications for Freight Movement		X	
Mobility and <u>xxxxx</u> (multiple public policy applications)		X	X
Modernizing Transportation Agencies			X
Next Generation Transit Agencies			X
New Risk-based Decision-making Frameworks		X	X

Research Topics	Research Themes		
	Evolving Mobility Options	Changing Society and Mobility	Creating Institutional Capability
Analysis Capability			X

CHAPTER 6: POTENTIAL RESEARCH FUNDING SOURCES/STRATEGIES

Several models exist for creating an SMRP, some more feasible than others. Note that the following models do not depart dramatically from the current institutional structures for funding research, primarily because of the time and effort it would take to develop an entirely new institutional structure for the SMRP. In addition, current research structures rely on peer review procedures for research identification and project selection, which is a fundamental principle adopted for the SMRP. One could posit, for example, a new non-profit organization dedicated to conducting the research. Putting such a structure together, however, would be challenging, and likely not be supported by existing participants in transportation research.

The institutional models for the SMRP are described in the following section.

F-SHRP Model: One possible strategy for implementing the SMRP is to follow the F-SHRP model, which includes a Congressionally authorized program and funding allocation. Assuming stakeholder and political support for such a program, the benefits of such an approach include: (1) the involvement of a wide range of interests in program operation and (2) targeted and multiyear funding to address the key mobility challenges facing the United States. The challenge of such a model is that one would have to develop a strong consensus among stakeholder groups/organizations to develop a program structure and focus that would garner Congressional interest. Although this project attempted to avoid overlap with existing research programs, there should be some consideration as to why and how a new mobility-related research program could be conducted within existing research structures.

CRP Model: This strategy would model an SMRP after the existing CRP. The NCHRP Foresight Series funded in the late 2000s and early 2010s allocated substantial research dollars to six major research projects considered to be strategically important for the future of transportation. The topics included: freight, climate change, technology, sustainability, energy and fuels, and demographics. These topics originated from collaborative efforts among many of TRB's constituencies. Such an approach could be used here, or a more modest approach might be to simply identify joint NCHRP/TCRP projects that could be funded under an SMRP umbrella. The benefits of such a model include: (1) TRB familiarity with CRPs and thus a fairly "easy" start-up effort, and (2) representation of many TRB constituencies of the mobility stakeholders one would want involved in the SMRP. The challenge is that new funding would have to be found to initiate the SMRP, and the approval of those involved in providing CRP funds must be secured. This might stretch the limited "traditional" CRP funding across even more programs and priorities, potentially resulting in either inadequate funding for individual studies or the ability to fund only a limited number of studies, or both. This model also requires a clear distinction between the research funded from NCHRP and TCRP, and that funded by SMRP (which would have to occur under any model).

Collaborative Joint Funding Model: Many state DOTs already enter into agreements on specific planning/research topics where a mutual benefit is identified. The additional dollars provided by the participants allow much more substantive project(s) to occur than would be feasible otherwise given an individual state's contribution. The concept in this model is that like-minded state DOTs, MPOs, transit agencies, and others would be supporting the SMRP. For the program to work effectively, this contribution would have to provide some base funding to support the operation of the program and

project-by-project participation for individual research statements. TRB would administer the program. The benefits of such a model include: (1) the participation of a range of mobility stakeholders who are committed to the program because they are asked to contribute financially to its success; and (2) depending on the number of participants, this model could provide substantial funding over many years. Firms and/or organizations with a vested interest in a topic or issue could be involved, but TRB would need to ensure a balance of oversight and influence from possible funding partners. The major disadvantage is that the model presupposes a level of participation over many years to ensure success. This also requires a very clear statement on the value-added of the SMRP as compared to existing programs, as well as acknowledgment of challenges in securing funding from a variety of funding sources.

Ideally, such a model would attract the participation of agencies and organizations not directly involved with transportation research but whose interests might be such that there would be interest in participating. Possible candidate agencies/associations that might be logical research partners include municipalities and civic organizations (e.g., think tanks, community advocates, foundations). Other organizations might include: National Chamber of Commerce, National League of Cities, American Public Works Association, American Planning Association, National Association of City Transportation Officials, National Association of Regional Councils, National Association of Development Organizations, National Industrial Transportation League, and similar organizations where transportation is an important, albeit just one, of the topics they cover. It is unknown whether any of these organizations would enter into a programmatic agreement with TRB to fund research, but some might be willing to consider some support on a project-by-project basis.

University Transportation Consortium (UTC) Research Program Emphasis: The UTC program already supports national centers focusing research on mobility-related topics. For example, the national UTCs housed at Carnegie-Mellon University and Portland State University have as their theme, “Improving Mobility of People and Goods”. The focus of the Center at Carnegie-Mellon, however, is primarily on the application of new technologies to transportation systems. Neither provide the range of interest as outlined earlier in the proposed SMRP. The concept of this model is that a new UTC emphasis area would be created for the next round of UTC competition that emphasizes the research topics discussed earlier. The benefits of such a model include: (1) leading researchers on the individual topics would be available to focus on topics directly related to the proposed SMRP; and (2) given the current model of UTC operation, once the grant is given to the host university; identification of research topics and researchers happens rather quickly. The primary disadvantage of this model is that, again, under current administrative operations, the types of research undertaken by universities is defined by the researchers (often with state DOT input if local matching is being provided). The targeted emphasis on the strategic mobility topics identified earlier could very well be lost in such a model.

Recommended SMRP Model

The recommended model for implementing an SMRP represents a hybrid combination of several of the above models, in essence representing a staged implementation of research funding to support an SMRP focused on mobility research. Figure 4 illustrates the concept.

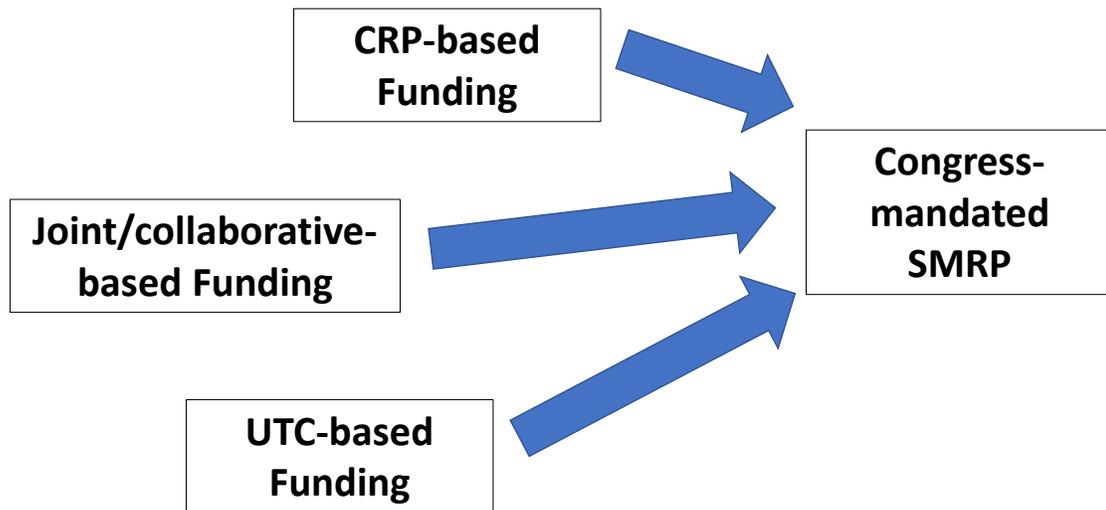


Figure 4: Incremental Strategy for an SMRP

Figure 5 illustrates that the ultimate goal for the sponsorship of an SMRP is an F-SHRP-like program focusing on strategic mobility research. The research initiatives that precede this program structure rely on existing institutional research structures that will lay the groundwork for the ultimate SMRP. These include:

1. TRB should provide leadership in concert with AASHTO, AMPO, NARC, APTA, FHWA, and FTA in developing a joint collaborative research structure where individual members of these groups and the federal agencies can contribute to the overall operation of the SMRP and to individual projects. Such a structure will require time and effort to reach out to key stakeholder organizations and a willingness on the part of TRB to make the case for the proposed program. As noted earlier, this will also require an examination of how different funding sources can be combined into a program budget and research sponsorship under the auspices of the National Academies.
2. The next step is to set aside some CRP funding for SMRP projects, which could take the form of combined, jointly sponsored NCHRP-TCRP research projects, which have been funded before. The SMRP research projects would be based on the research process characteristics described earlier, for example, including a range of stakeholders in identifying and defining research statements. Given the focus of both CRP programs, the proposed research would have to have perceived benefits to the constituencies of both programs.
3. Depending on the timing of the reauthorization of the federal transportation law (and thus the UTC program), the next step is to incorporate strategic mobility research topics either into the enabling language or in the USDOT guidance implementing the program. The intent is to incrementally influence the type of research conducted in the program.

These three steps provide the foundation for recommending an F-SHRP-type research program that is provided for in federal legislation. Using one or all of the three models might enable the goals of an SMRP to be met without seeking such a program. If such is the case, the SMRP can proceed using the funding model that provides the most stable resources for the recommended program.

CHAPTER 7: CONCLUSIONS

This research examined the prospects of an SMRP. The gaps in such research were first examined through a comprehensive research program that identified five categories of literature on strategic mobility:

- **Transportation Technology**—Evolving nature of mobility technologies and the impacts they could have.
- **Transportation Demand**—Evolving transportation user needs and ways service providers can use new technologies.
- **Transportation Supply**—Infrastructure and services that permit the implementation of new technologies.
- **Transportation Context Factors**—How trends and societal factors could affect the way we travel and move goods (if travel is even necessary), this includes the changing socio-demographic changes likely to affect mobility use.
- **Transportation Impacts and Benefits**—How various efficiency, equity, and social effects of new mobility technologies may be captured.

Stakeholder interviews identified four areas of need for mobility-related research: automation and new mobility impacts and planning, reinventing transportation planning/institutional structures for a changing society, transit's role in the new mobility world, and freight mobility and impacts on transportation systems. In addition, the literature review of strategic mobility topics and input from those interviewed indicates that research syntheses provide significant value to users. This value is particularly for the many rapidly changing research areas identified by this project.

A multiphase, multifactor research program was proposed organized around the following initial research projects.

1. Mid- to Small-sized Region Mobility Strategies
2. Equity Implications of Evolving Mobility Markets:
3. Future Freight Mobility Needs and Issues
4. Automation and Artificial Intelligence (AI) Strategies and Mobility:
5. System Vulnerabilities
6. Uncertainties and Transportation Decision Making
7. New Land Use Concepts/Patterns and Mobility:
8. Global Trade Implications for Freight Movement:
9. Mobility and xxxxx (multiple public policy areas)
10. Modernizing Transportation Agencies
11. Next Generation Transit Agencies:
12. New Risk-based Decision-making Frameworks
13. Analysis Capabilities

The recommended model for implementing an SMRP is a hybrid combination of several different implementation models. The ultimate goal for the sponsorship of an SMRP is an F-SHRP-like program focusing on strategic mobility research. The research initiatives that precede this program structure rely on existing institutional research structures that will lay the groundwork for the ultimate SMRP. These include:

1. TRB should provide leadership in concert with AASHTO, AMPO, NARC, APTA, FHWA, and FTA in developing a joint collaborative research structure where individual members of these groups and the federal agencies can contribute to the overall operation of the SMRP and to individual projects. This will require time and effort to reach out to key stakeholder organizations and a willingness on the part of TRB to make the case for the proposed program. This will also require an examination of how different funding sources can be combined into a program budget and research sponsorship under the auspices of the National Academies.
2. The next step is to set-aside some CRP funding for SMRP projects. This could take the form of combined, jointly sponsored NCHRP-TCRP research projects, which have been funded before. The SMRP research projects would be based on the research process characteristics described earlier, for example, including a range of stakeholders in identifying and defining research statements. Given the focus of both CRP programs, the proposed research would have to have perceived benefits to the constituencies of both programs.
3. Depending on the timing of the reauthorization of the federal transportation law (and thus the UTC program), the next step is to incorporate strategic mobility research topics either into the enabling language or in the USDOT guidance implementing the program. The intent is to incrementally influence the type of research conducted in the program.

Given the rapid pace of change in many of the factors influencing mobility and its relationship to economic activity and safety, a research focus on strategic mobility topics is warranted and necessary to prepare the United States for future mobility challenges.

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