AASHTO Council on Active Transportation
Research Roadmap

July 2021

Acknowledgments

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Disclaimer

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Overview

This Research Roadmap aims to assist the AASHTO Council on Active Transportation (CAT) implement its 2018 Strategic Plan, which includes goals and strategies related to research. The Roadmap was developed through the National Cooperative Highway Research Program (NCHRP) Project 20-123, which provides support to any AASHTO committee or council to help advance and implement its strategic goals. The Roadmap and supporting documents were developed by a consultant team from the Transportation Research and Education Center (TREC) at Portland State University and Toole Design Group, with guidance from the NCHRP Project Panel and the CAT Steering Committee. To identify and define research priorities, the team reviewed existing and on-going research, identified research needs from a wide range of sources, and held several outreach activities with practitioners.

The Research Roadmap project consists of three products:

- **The Roadmap** (this document). Section I of the Roadmap provides an introduction and description of the process and methods used to develop the Roadmap. Section II consists of a set of 110 prioritized research needs, as well as an explanation of the information provided for the needs. The top six needs are in the form of Research Problem Statements (RPSs) which are suitable for submission to the NCHRP. For each of the next 40 needs, the Roadmap provides a Research Need Brief to help guide the CAT on how to advance this research need in the future.
- A **Research Review** (separate document) that summarizes the existing and ongoing research on 22 topics. These summaries were prepared to inform the Roadmap. They can be used by the CAT to help implement the Roadmap and to inform other activities, including communicating the value of active transportation, and provide a quick reference of existing research. The Review will also be of use to others practicing and doing research in active transportation.
- A **Continuity and Implementation Plan** (separate document) that provides the CAT with tools and steps to implement the Roadmap. The plan includes both a written document and electronic files with the research needs and an inventory of ongoing research projects for the CAT to monitor.

The need for improving active transportation safety and mobility is clear. In 2019, 20% of all traffic fatalities were pedestrians, cyclists, and other people not in or on a motor vehicle, up from 15% in 2010 (NHTSA, 2020). In 2016, the U.S. Department of Transportation (USDOT) set a goal to reduce pedestrian and bicycle fatalities and serious injuries by 80% in 15 years, with a reduction to zero in 20 to 30 years. At the same time, they aimed to increase the share of short trips by these active modes to 30% by 2025 (USDOT, 2016). State departments of transportation (DOTs) play a crucial role in reducing such injuries and fatalities as well as increasing the use of active transportation.

The implementation of the Roadmap should lead to more research that will advance active transportation safety and mobility throughout state DOT functions, from planning and environment to design and construction to operations and maintenance. Implementation will rely on the CAT partnering with other entities, both within AASHTO and externally. The Roadmap is designed to lead to active transportation research that will address the most important needs of state DOTs and similar transportation agencies. The priorities identified in the Roadmap are based on a comprehensive outreach effort as well as the focused review of existing and ongoing research.

Research Needs

The Roadmap includes 110 research needs that are divided into four priority groups. The priority level reflects both the need for research in this area to assist state DOTs in advancing active transportation safety and mobility and whether there are current, ongoing research projects that may address the need substantially. These needs are also assigned to one of six topical areas, though several crossover areas exist.

The six highest-priority needs are written as Research Problem Statements (RPSs). They include:

A1. Applying and integrating active transportation data into planning and operations;

A2. Using minimum accommodations vs. alternative approaches to increase active transportation;

A3. Determining context-driven optimal spacing between marked crosswalks;

A4. Addressing barriers to integrating active transportation throughout planning and engineering practice;

A5. Racial and economic disparities in pedestrian and bicyclist safety; and

A6. Speed management solutions and strategies to improve pedestrian and bicyclist safety on arterial roadways.

These RPSs are a starting point for the CAT to advance the research need in the NCHRP funding process and can be further refined as needed.

For each of the high-priority (9) and medium-priority (31) needs, the team prepared a Research Need Brief. The brief provides information to help guide the CAT in its next steps to advance the research need.

The lower-priority needs (64) are included in tables with information about the relevant summary in the Research Review, the most relevant ongoing research projects, and relevant Research Need Statements (RNSs) and RPSs prepared by other organizations.

I. Introduction and Methods

Introduction and Methods

Overview: Using the Roadmap

This Research Roadmap aims to assist the AASHTO Council on Active Transportation (CAT) implement its Strategic Plan, which includes goals and strategies related to research. The Roadmap was developed through the National Cooperative Highway Research Program (NCHRP) Project 20-123, which provides support to any AASHTO committee or council to help advance and implement its strategic goals. The development of the Roadmap is described in detail later in this section.

The Research Roadmap project consists of three products:

- **The Roadmap**. Section I of the Roadmap provides an introduction and description of the process and methods used to develop the Roadmap. Section II consists of a set of 110 prioritized research needs. The top six needs are in the form of Research Problem Statements (RPSs) that can be a starting point for submission to the NCHRP. For each of the next 40 needs, the Roadmap provides a Research Need Brief to guide the CAT on how to advance this research need in the future. Before the needs are presented, Section II explains the information provided for the needs, along with overall themes for the Roadmap.
- A **Research Review** that summarizes the existing and ongoing research on 22 topics. These summaries were prepared to inform the Roadmap. They can be used by the CAT to help implement the Roadmap and to inform other activities, including communicating the value of active transportation, and provide a quick reference of existing research. The Review will also be of use to others practicing and doing research in active transportation.
- A **Continuity and Implementation Plan** that provides the CAT with tools and steps to implement the Roadmap. The plan includes both a written document and electronic files with the research needs and an inventory of ongoing research projects for the CAT to monitor.

This Roadmap should be considered a starting point. Active transportation research and practice is a fast-changing field. As new research is released and practice and policy advances, the research needs identified here will need to be revised, updated, and expanded. While the Roadmap was developed with the input of many voices from the CAT and state DOTs, it undoubtedly misses some valuable information and ideas, and the priorities listed here are likely not the same for everyone. In particular, the Roadmap was developed focusing on the responsibilities of state DOTs, which differ from other decision-making bodies such as cities, MPOs, and transit agencies.

The implementation of the Roadmap should lead to more research that will advance active transportation safety and mobility throughout state DOT functions, from planning and environment to design and construction to operations and maintenance. Implementation will rely on the CAT partnering with other entities, both within AASHTO and externally. The Roadmap is designed to lead to active transportation research that will address the most important needs of state DOTs and similar transportation agencies.

Background

Why is a Roadmap Important?

Every year, people in the U.S. make over 42 billion trips on foot (including wheelchairs and other mobility devices) or bicycle, representing 11.5% of all person trips (2017 National Household Travel Survey). These active modes of transportation are playing an increasingly important role for transportation agencies striving to improve safety, reduce emissions, enhance resiliency, and support economic development. In 1992, the Federal Aid Highway Program supported just 50 pedestrian and bicycle projects. In 2018, there were 1,123 projects, representing a 22-fold increase.

In 2019, 20% of all traffic fatalities in the U.S. were pedestrians, cyclists, and other people not in or on a motor vehicle, up from 15% in 2010. That year there were 6,205 pedestrian and 846 cyclist fatalities. These numbers were down slightly from 2018, but up significantly from 2009 when there were 4,109

pedestrian and 628 cyclist fatalities (NHTSA, 2019; NHTSA, 2020). That represents increases of 51% and 35%, respectively. The U.S. Department of Transportation (USDOT) set a goal to reduce pedestrian and bicycle fatalities and serious injuries by 80% in 15 years, with a reduction to zero in 20-30 years. At the same time, they aimed to increase the share of short trips by these active modes to 30% by 2025 (USDOT, 2016). Achieving these goals will require a continued increase in investment in infrastructure and programs, as well as policy change.

Given constrained budgets and multiple policy objectives, transportation decision-makers and practitioners need reliable and meaningful research focused on active transportation to help make better decisions. However, effectively synthesizing and using research in everyday practice is not easy. In 1992, there were just 13 journal articles or book chapters in the Web of Science on bicycling and 133 on walking or pedestrians. By 2018, the number of publications on those topics had risen to 2,488, a 17-fold increase (Figure 1). The Transport Research International Documentation (TRID) database has over 15,000 English-language publications from 1992 to 2018 under the "Pedestrians and Bicyclists" subject area; 1,374 were published in 2018 alone.

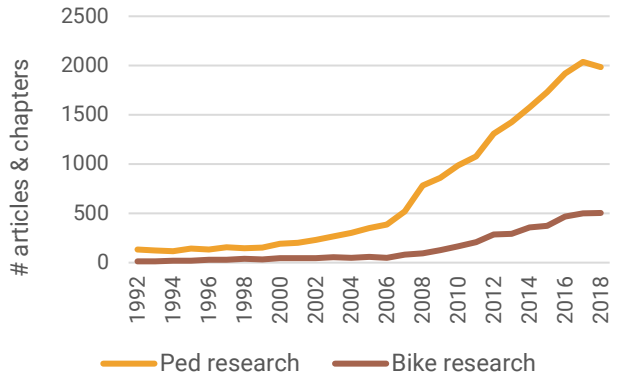

Figure 1 Pedestrian and bicycle research from Web of Science

Despite the significant increase in the volume of published research on pedestrian and bicycle topics, major gaps in our knowledge remain. The Federal Highway Administration (FHWA) *Strategic Agenda for Pedestrian and Bicycle Transportation* assessed current and ongoing research in 2016 and found over 200 identified research needs. Although that effort also found 128 ongoing research projects, there were clear gaps in specific areas, and the volume and focus of research had not kept pace with needs.

The Role of the AASHTO Council on Active Transportation

The AASHTO Council on Active Transportation (CAT) was established in 2017 to "address issues related to bicycling, walking, using portable personal and assistive mobility devices, and other active transportation modes." The purpose of the committee includes recommending needed research. This Research Roadmap aims to help the CAT fulfill this purpose and implement its Strategic Plan, which includes six goals:

> Goal 1: Safety: support the reduction in pedestrian and bicyclist serious injuries and fatalities.
>
> Goal 2: Communication: broadly communicate the value of active transportation to the transportation system, the environment, and communities.
>
> Goal 3: Data: define voluntary systematic and consistent approaches to collecting, managing, analyzing, and monitoring pedestrian and bicyclist safety, mobility, cost, facilities and system utilization data.
>
> Goal 4: Partnering, Publications, Research and Member Resources: within existing funding limitations or controls, support the appropriate inclusion of active transportation in transportation program and project development and delivery.
>
> Goal 5: Policy: provide policy leadership on active transportation.
>
> Goal 6: Technology: monitor and share information related to new technologies that may impact active transportation.

Research is part of the strategies to implement Goals 1, 3, and 4. In particular, Strategy 4b aims to ensure that priority research needs are met through the following efforts:

- Develop priority research needs related to safety, data, communication, policy, network analysis, and other important active transportation topics; develop research statements and guide research statements through the various research funding programs.

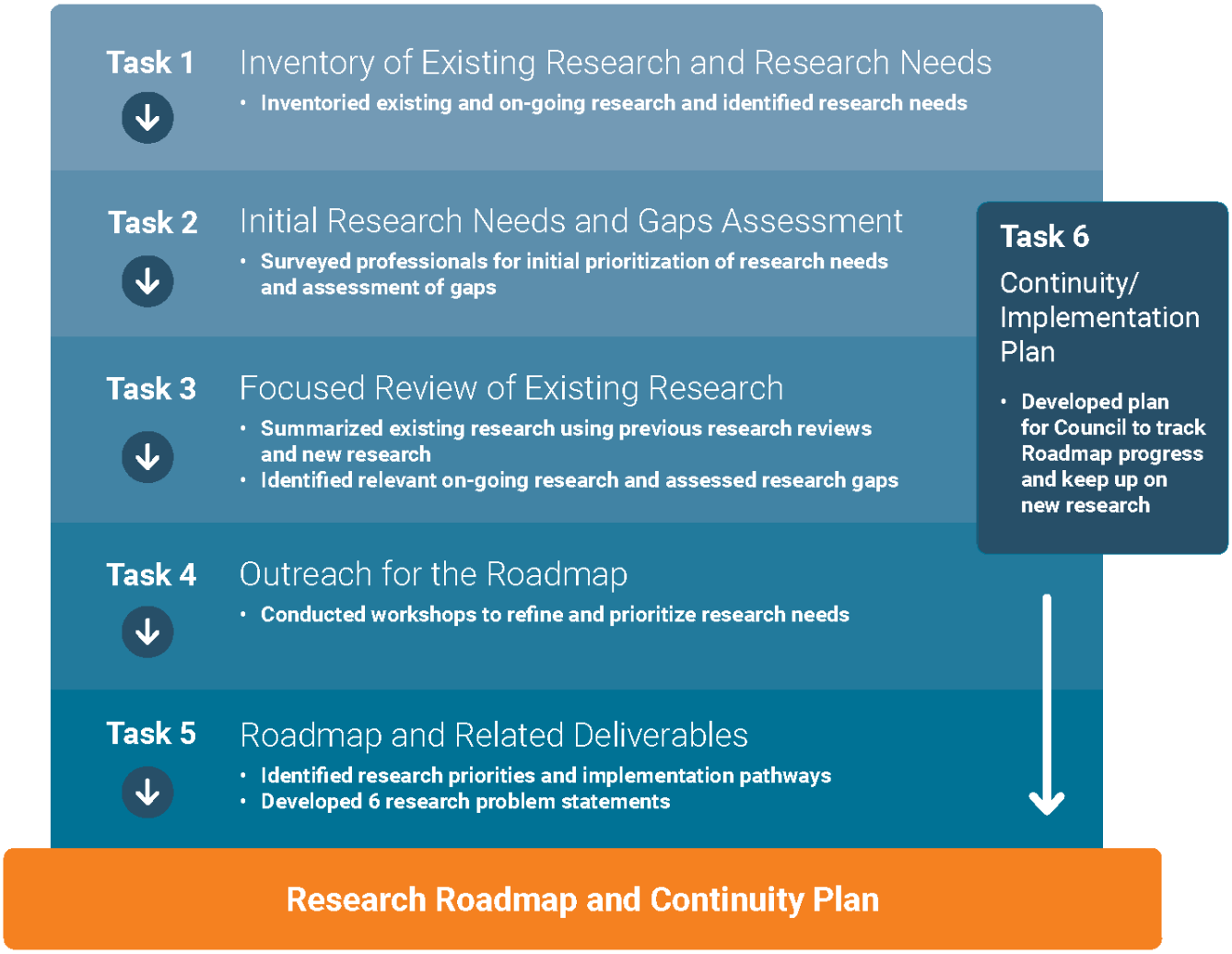

Figure 2 Overview of the Research Roadmap Development

- Work with other committees/councils to include active transportation needs in their research needs statements.
- Review AASHTO publications and identify areas of needed research for inclusion in future publication updates.

Methods

Overview

The Roadmap project consisted of six tasks, as shown in Figure 2. Given the timeline of the project, parts of some tasks were conducted simultaneously. Tasks 1 and 3 focused on existing and ongoing research and identifying research needs identified in existing sources. Task 1 cast an expansive net to inventory research and research needs. The outputs from this task were used to start the outreach process, which was the focus of Tasks 2 and 4. Task 2 surveyed professionals to provide an initial prioritization of needs. While this was underway, the team proceeded to prepare the Task 3 focused review of existing research. The outputs from Task 2 and 3 were used in the Task 4 workshops, which further prioritized and refined the needs. The team used all of these outputs, as well as input from the Project Panel and the CAT Steering Committee, to prepare a draft Roadmap and Continuity and Implementation Plan. After feedback from the Panel and Steering Committee, the team revised and finalized the Roadmap and Plan.

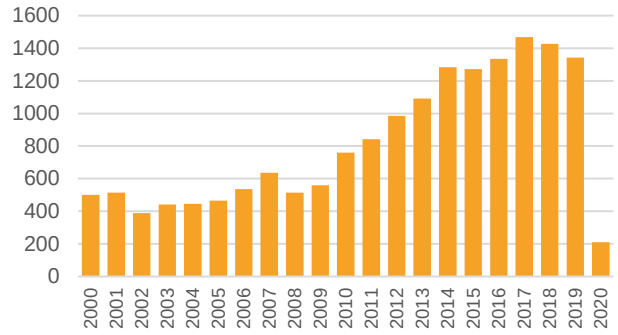

Figure 3 Number of research publications in TRID under the "Pedestrians and Bicyclists" subject area, by year

Existing Research Needs and Gaps

Inventory of existing reseach and needs (Task 1)

To provide a foundation for the Roadmap, we inventoried the existing research, ongoing research, and research needs that had already been identified by other sources.

Our inventory of the existing research encompassed over 17,000 publication records from the TRID database under the subject of Pedestrians and Bicyclists, published from 2000 to 2020 (Figure 3). The initial search was conducted in April 2020 and limited to publications in English. Each TRID record has index terms (similar to keywords) that help describe the research. These terms allowed us to understand, at a high level, the content of this large amount of research. Many of these terms are from the Transportation Research Thesaurus (TRT, https://trt.trb.org) maintained by TRB. Each record in our database had from zero (just one record) to over 40 index terms. Nearly 75% of the records had five to nine terms. The analysis based on these terms was used to conduct the more focused research review (Task 3), identify possible research gaps, and develop tools to use with TRID for the CAT to remain current on research in the future.

Our inventory of ongoing research projects came from the Research in Progress (RIP) database within TRID, using the same Pedestrians and Bicyclists subject area. Of the 420 projects that started between 2000 and 2020, there were 227 listed as being active.

We identified 340 research needs from 165 documents from a range of sources:

- FHWA 2016 *Strategic Agenda for Pedestrian and Bicycle Transportation;*
- Key AASHTO guidance documents;
- TRB Bicycle and Pedestrian committee documents;
- FHWA guidance documents and research reports;
- Reports from NCHRP, TCRP, and NHTSA related to active transportation;
- TRB Research Need Statement database, including a new database on research needs related to pandemics;
- Requests to FHWA to experiment with traffic control devices not in the Manual on Uniform Traffic Control Devices (MUTCD);
- A CAT survey of state DOTs; and
- Research review papers and reports from academic sources that identify gaps in pedestrian and bicycle research.

This research and need inventory revealed insights that guided our work on the Roadmap and provided the foundation for the outreach and research review tasks. Key findings from the review of gaps and needs included:

- There is a growing body of research on active transportation since the year 2000, with two-thirds of that research published in the past 10 years. While pedestrian-focused research outnumbers that focused on bicycling, the difference is disappearing as bicycling-focused research increased at a faster rate (Figure 4). There were also more research needs focused on bicycling than walking.

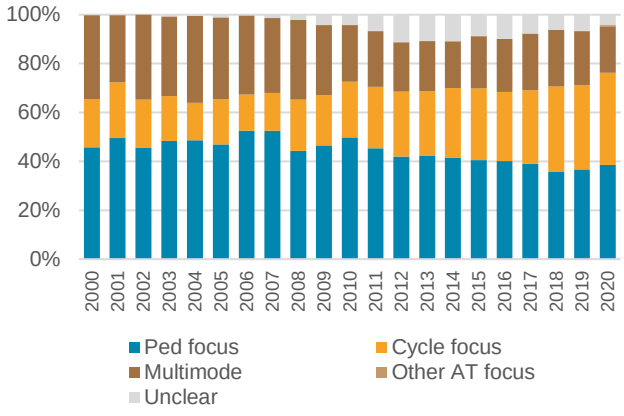

Figure 4 Modal focus of inventoried research by publication year

- The large majority of the research projects are being led by universities. However, there is evidence that the research universities are conducting does not align well with the identifed needs of practitioners, particularly in the area of design. Increased coordination and outreach by the Council, guided by the Roadmap, could help address these possible mismatches.
- Most of the research and research needs fall into the traditional categories of safety and design, followed by data, travel behavior and health/environment. There is far less research and identified research needs on topics such as equity, communications, policy, education, and maintenance/operations.
- The inventory revealed some potential gaps between needs and existing research, particularly in the areas of bicycle safety, crash risk forecasting (for both bicycling and walking), and data topics.
- In general, the existing pedestrian research tends to focus more on safety topics, while bicycle research focuses less on safety and more on demand and related topics, though safety and perceptions of safety is usually part of that research.
- The amount of research focusing on particular demographic groups varies depending on the topic. Research explicitly focusing on race/ethnicity and equity topics is limited and appears to be a growing research need.

Focused review of existing research (Task 3)

To focus the more in-depth review of existing research, we mapped the inventories of existing research and of identified research needs to broad topics and subtopics. Input from the Project Panel on research area priorities, and from practitioners via the Task 2 research needs survey, was then used to adjust the list of topics to ensure that subjects of key interest were included in the research review process. In some cases, identified topics were removed because it was determined that they were not areas of high interest to AASHTO or the CAT. In other cases, topics or research needs that were deemed high priority through input from the Project Panel or practitioner survey merited expanding or adjusting our list of topics to ensure the high-priority topics were covered.

The research review process started with identifying key research on each topic. As a first step, we identified existing reviews of research. Next, we identified key terms associated with each topic, and searched for relevant publications identified in Task 1. In some cases, the search for key terms yielded hundreds of records for a given topic, in which case the project team prioritized results via a scan of document titles and abstracts, and placed higher priority on research conducted subsequent to one of the existing reviews, more recent documents produced between 2015 and 2020, and research from North America. From these sources, the project team identified highlights and key findings, along with gaps in existing research. Building off the list of documents identified in the TRID search, the project team in some cases added in additional research that was cited in other documents. We also conducted targeted additional searches to fill observed gaps. Each draft review was reviewed by up to three other members of the project team to help improve clarity and ensure adequate topical coverage. The reviews were updated in spring 2021 with new research.

For each topic, the research summary first answers the question—what do we know?—which highlights the most relevant key findings. Next, we identify the research gaps using both gaps identified in the research and by the team from assessing the existing research findings. The next section explains how research on the topic is conducted. This information was useful in developing research problem statements and strategies for identifying possible pathways to getting the research initiated.

The summary then lists relevant ongoing research projects. We found over 80 such projects, with over 40% being lead by University Transportation Centers (UTCs), about 25% by state DOTs, and nearly 20% by NCHRP. Several of these projects may help fill gaps we identified in the existing research. A large share of this research is expected to be completed by the end of 2021.

The sources used in the review appear at the end of each review topic. About 60% of the sources are peer-reviewed journal articles (including *Transportation Research Record*), and about 25% are reports from USDOT, universities, NCHRP, or state DOTs.

Outreach for the Roadmap

Practitioner survey (Task 2)

As a primary first step to prioritize research needs for the Roadmap, the research team conducted a survey of practitioners. The survey asked for feedback on 113 research needs (identified through Task 1). The objectives of the survey were to:

- Gauge the utility of and demand for the research needs found in Task 1 among practitioners;
- Identify needs that would not be explored further;
- Distinguish a set of priority needs; and
- Engage practitioners in the Roadmap.

The survey was distributed to several AASHTO councils and committees, TRB committees, state DOT pedestrian and bicycle coordinators, the Institute of Transportation Engineers (ITE) Pedestrian and Bicycle Standing Committee, Association of Pedestrian and Bicycle Professionals (APBP) member listserv, and the National Association of City Transportation Officials (NACTO) City for Cycling Network. We received 226 responses; 77% percent of respondents worked for a transportation agency, including federal-level or state-level DOT, metropolitan planning organization, or county or city agency. On average, respondents have been working in the field of active transportation for more than a decade (approximately 14 years). Approximately 64% of respondents currently apply research findings sometimes or frequently in their work, and 61% have applied some or many research findings in the past.

All of the needs were assigned to at least one of seven subject areas and respondents could choose which of those areas to respond to. This made the survey a reasonable length for most people and allowed them to focus on the areas with which they were most familiar. The categories with the most responses were Policy and Practice (68%), Safety (65%), Planning (64%), and Design (63%). A similar share of respondents (44%) selected Equity and Accessibility, and Data. The least commonly selected category was Technology and Micromobility (29%).

After analyzing the results of the survey, we distilled the following key findings:

- Technology and Micromobility-related research needs were generally unpopular. The category was selected the least among all seven subject areas and the average score for the category was also the lowest. This finding, along with an understanding of the job sectors of respondents, suggested that Technology and Micromobility-related research needs are a low priority for the Research Roadmap.
- Policy and Practice was the most commonly selected subject area, but none of the research needs in this category were in the top 10th percentiles. In fact, the research needs had the lowest average scores (with Technology and Micromobility). Therefore, this subject area could be considered a lower priority for the Roadmap.
- Although fewer respondents felt that they were familiar with Equity and Accessibility or that it related to their work, those who did select this category felt strongly that research needs in this area should be included in the Roadmap. Equity and Accessibility had the highest average score and research needs in this category were generally rated highly. The three highest ranked needs were in this category.
- Similarly, the Data category was selected less frequently than other categories but received a high average score.
- Pandemic-related research needs were not rated high enough for inclusion in the Roadmap.
- Research needs that were listed in multiple categories received a similar response in each of their categories with slight differences. This suggests that regardless of the categorization, the ratings were consistent.
- Respondents supplemented the research needs in the survey through the open-ended questions. Most of the suggestions aligned with the research needs the research team has already identified.

With input from the Panel, the results were used to narrow the focus of the workshops to the 50 highest priority research needs.

Outreach workshops (Task 4)

To prioritize and refine the top 50 research needs for the Roadmap, the team held a series of workshops with practitioners. Over the course of three workshops,

the research team presented research needs and facilitated discussion to solicit feedback from participants on needs prioritization based on their experience and perspectives.

Task 4 was originally intended to consist of one in-person workshop to be held concurrently with another AASHTO meeting in the late summer or fall of 2020. To adjust to COVID-19 restrictions, the project team devised an alternative approach; in lieu of an in-person workshop with up to 50 participants, we held a series of virtual workshops targeting 15-20 participants each. This change of format presented some benefits such as engaging more participants, holding a longer working session, and holding separate sessions to achieve focused goals. The workshops were conducted online using the Zoom conferencing platform and employed a combination of presentations from the research team, small group breakout sessions, and full group discussion.

The three workshops involved different sets of participants, pulling heavily from the CAT membership for the second and third workshops. The participants for Workshop 1, which focused on the Task 2 survey findings, were recruited from the survey respondents.

Engaging practitioners throughout Task 4 validated the results of the survey and helped the research team determine research priorities for the CAT and other practitioners. The series of ranking exercises held in the workshops directed the research team to the most critical research needs and topics. Additionally, broader conversation on the needs, gaps in research, and concurrent projects and initiatives provided valuable insight to the research team for the next task of developing the Research Roadmap.

Roadmap Development

Roadmap

The team used the rankings and notes from the workshops and the findings from the Task 3 research review to place all 113 research needs into three priority levels. We presented summaries of the 15 highest-priority research needs to the Panel and the CAT Steering Committee to help decide on the six RPSs. With their input, we developed a survey that asked each respondent to rank their top six research needs from the list of 15. The survey, along with the memo discussing each of the 15 needs, was shared with all members of the CAT, as well as members of the Joint Technical Committee on Non-Motorized Transportation (JTCNMT), Technical Committee on Geometric Design, and Local Programs Peer Exchange (LPPE) Forum. We received 29 responses from CAT members and 23 from the other groups.

We used the rankings to develop several scoring measures and examined input from CAT members separately from the whole group of respondents. This revealed five clear priority needs. The CAT Steering Committee reviewed this list and identified the sixth need from the next highest ranked needs.

In addition to developing RPSs for the top six needs, the team developed research need briefs (RNBs) for the next 40 needs. This group of needs includes the remainder of the top 15 (high-priority) and 31 medium-priority needs. At this stage, the team also clarified the scope of some needs and merged some needs to ensure that each need was as distinct and clear as possible, with little overlap. The RNBs provide an overview of the need and research objectives based on the gaps identified in Task 3 and the workshop input. They also identify the type of research needed, link to the relevant summary in the Research Review, identify possible funding pathways, a timeline, potential research partners, the most relevant on-going research projects, relevant RNSs, and RNSs prepared by other organizations. The intent of these briefs is to provide the CAT enough information to advance the need in the near future, either through the NCHRP process or another mechanism, possibly in collaboration with other AASHTO councils or committees or outside partners. The RNB should provide enough information to more easily prepare a full RPS.

The lower-priority needs (64) are included in the Roadmap with information about the relevant summary in the Research Review, the most relevant ongoing research projects, and relevant RNSs and RPSs that have been prepared.

Throughout this process, the team was monitoring two important parallel processes that will also help address active transportation research needs. First, the FY2022 NCHRP process was underway, with the AASHTO Special Committee on Research and Innovation (R&I) meeting in mid-April to prioritize new projects. That process included several problem

statements related to active transportation. Second, FHWA was in the process of developing a Pedestrian and Bicycle Safety Program Strategic Plan. Outreach for that project occurred in August and November 2020. The Roadmap consultant team participated in the workshops for that project and communicated with the staff and consultants on the plan to coordinate as much as possible. However, the final plan was not released before the Roadmap was completed. Interim references are included in the Roadmap, but the final outputs are not.

In addition, in April 2021 TRB released Circular E-C270 *Opportunities for Research on Transportation and Equity,* which includes 21 problem statements. Six of these explicitly include active transportation. Four of the 21 statements are the basis of new NCHRP projects anticipated in upcoming year. References to these problem statements or projects were added where relevant.

Continuity and Implementation Plan

Throughout the Roadmap project the team gathered insights and information to develop the Continuity and Implementation Plan, which aims to help the CAT effectively implement the Roadmap and track ongoing research. The work in Task 1 on the inventory of existing research using TRID and the Task 3 focused research review helped inform the development of more customized searches for the CAT to use to keep up on new research. The team also examined options for how the CAT could track progress on implementing the Roadmap, including replicating an online tool used by the AASHTO Committee on Transportation Asset Management (TAM). The team talked with the AASHTO staff and contractor working on that tool and discussed it with the CAT Steering Committee, which indicated that it would be useful.

II. Research Needs

Research Needs

Introduction

This section includes information on all 110 research needs. Before those are described, we explain how the Roadmap addresses the CAT Strategic Plan and discuss some larger themes we identified in preparing the Roadmap. The following sections explain the type and amount of information provided for the needs, which varies by priority level.

Connections to the CAT Strategic Plan

The Council on Active Transportation's 2018 Strategic Plan outlined six primary goals, along with strategies to guide each goal. The Roadmap can help support the CAT in making progress in achieving these goals, as described below. Table 1 provides additional detail on how the research needs in the Roadmap and the Research Review supports each goal and strategy in the Strategic Plan.

Goal 1: Safety: support the reduction in pedestrian and bicyclist serious injuries and fatalities.

One-third of the needs in the Roadmap (37) are assigned primarily to the Safety category, though many of the Design needs include major safety elements.

Goal 2: Communication: broadly communicate the value of active transportation to the transportation system, the environment and communities.

Strategy 2b for this goal focuses on communicating the value of active transportation. The Research Review includes some of the existing evidence to support this strategy, including on the economic benefits of active transportation. Several of the research needs would provide additional evidence of that value.

Goal 3: Data: define voluntary systematic and consistent approaches to collecting, managing, analyzing and monitoring pedestrian and bicyclist safety, mobility, cost, facilities and system utilization data.

The three strategies for this goal focus on identifying data needs and gaps and working collaboratively to fill those gaps, including developing data tools. Eleven of the needs in the Roadmap, including one RPS, are about data. In addition, there are four topics in the Research Review on data (Emerging user-based data, Location-based counts, Safety, and Surveys).

Goal 4: Partnering, Publications, Research and Member Resources: within existing funding limitations or controls, support the appropriate inclusion of active transportation in transportation program and project development and delivery.

Strategy 4a aims for the CAT to collaborate with other AASHTO committees on active transportation topics. In the research need briefs (high- and medium-priority needs), the Roadmap identifies potential AASHTO councils and committees as partners for advancing the need. Strategy 4b is to "ensure priority research needs are met." This Roadmap is the primary tool to make that happen. The Roadmap assigns a priority level to each of the 110 needs, provides RPSs for six needs and information for 40 additional needs that can form the basis of an RPS. Strategy 4c focuses on training, knowledge transfer, and capacity building. Several of the research needs in the Roadmap identify best practices or technology transfer projects as an appropriate mechanism to advance the research.

Goal 5: Policy: provide policy leadership on active transportation.

The Research Review provides existing evidence that can assist the CAT in providing this policy leadership. In addition, 12 of the needs in the Roadmap are focused on Policy and Practice.

Goal 6: Technology: monitor and share information related to new technologies that may impact active transportation.

The Research Review summarizes existing evidence on three technology-related topics: Autonomous and connected vehicles; Bike share; and Micromobility,

including e-scooters. The Research Review also identifies current, ongoing research on these topics. These research projects are included in a supplemental electronic file as part of the Continuity and Implementation Plan. In addition, 12 of the needs in the Roadmap are focused on Technology and Micromobility.

Table 1 Connections between the CAT Strategic Plan, Research Roadmap, and Research Review topics

CAT Strategic Plan	Research Roadmap	Research Review
Goal 1: Safety: support the reduction in pedestrian and bicyclist serious injuries and fatalities. Strategy 1a: Communicate pedestrian and bicyclist safety in appropriate AASHTO publications and initiatives.	• 37 needs are in the Safety category. • At least 14 additional needs in other categories include a major focus on safety	• Autonomous and connected vehicles • Bicycle and pedestrian data: Safety • Bicycles at intersections: Design and safety • Bikeways: Safety and design • Distraction and impairment: Impacts on pedestrian and bicyclist safety • Equity and bicycling • Equity and pedestrian travel • Equity and personal safety • Pedestrian crossings: Design and safety • Speed management and active transportation
Goal 2: Communication: broadly communicate the value of active transportation to the transportation system, the environment and communities. Strategy 2a: Develop a definition of "active transportation" that will be used by AASHTO. Strategy 2b: Communicate the value of active transportation.	• Research need brief C8 (Economic benefits of active transportation infrastructure) addresses research that would further demonstrate the value of active transportation. • Communicating the value of active transportation depends on better data on use and methods to predict future use. 11 needs focus on data. Five of the needs in the Planning category focus on methods to better predict active transportation use.	• Economic benefits of walking and bicycling • Bicycle and pedestrian data: Emerging user-based data • Bicycle and pedestrian data: Location-based counts • Bicycle and pedestrian data: Surveys • Bikeways: Ridership and demand • Modeling and traffic impact analysis
Goal 3: Data: define voluntary systematic and consistent approaches to collecting, managing, analyzing and monitoring pedestrian and bicyclist safety, mobility, cost, facilities and system utilization data. Strategy 3a: Identify data needs and gaps. Strategy 3b: Work with the states and appropriate Federal agencies to develop a State transportation department voluntary approach for collecting, validating, analyzing, and updating pedestrian and bicyclist data. Strategy 3c: Support the development of tools and resources to assist State, regional, and Federal agencies to collect, validate, manage, analyze and monitor active transportation related safety, mobility, facilities, cost (quantitative and qualitative), and system utilization data.	• Research Problem Statement A1 (Applying and integrating active transportation data into planning and operations) • 10 additional needs focus on data • The Continuity and Implementation Plan includes guidance for the CAT on how to keep track of new research, including data	• Bicycle and pedestrian data: Emerging user-based data • Bicycle and pedestrian data: Location-based counts • Bicycle and pedestrian data: Safety • Bicycle and pedestrian data: Surveys

CAT Strategic Plan	Research Roadmap	Research Review
Goal 4: Partnering, Publications, Research and Member Resources: within existing funding limitations or controls, support the appropriate inclusion of active transportation in transportation program and project development and delivery. Strategy 4a: Collaborate and coordinate with appropriate AASHTO committees on active transportation topics. Strategy 4d: Communicate/ coordinate with external stakeholders on active transportation activities.	• The matrix on page 20 identifies potential AASHTO and TRB committees for collaboration. • The Research Problem Statements and Research Need Briefs identify possible partnerships to advance each need, including external stakeholders. • The Continuity and Implementation Plan includes a tracking sheet to help coordinate and advance research needs.	
Strategy 4b: Ensure priority research needs are met. Develop priority research needs related to safety, data, communication, policy, network analysis, and other important active transportation topics; develop research statements and guide research statements through the various research funding programs. Work with other committees/councils to include active transportation needs in their research needs statements. Review AASHTO publications and identify areas of needed research for inclusion in future publication updates.	• The Roadmap assigns a priority level to each of the 110 needs, provides RPSs for six needs and information for 40 additional needs that can form the basis of an RPS. • The needs are organized by the following topics: data, design, equity and accessibility, planning, policy and practice, safety, and technology and micromobility. • The Roadmap identifies other committees/councils to work with on the higher priority needs. • In developing the Roadmap, the team reviewed AASHTO publications for research needs.	• The Research Review covers 22 key topics, relying on over 420 sources.
Strategy 4c: Seek Opportunities to support active transportation training, forums for knowledge transfer, and general capacity building for planners, engineers, and other transportation practitioners.	• Several of the research need briefs identify best practices or technology transfer projects • Research Problem Statement A4 (Addressing barriers to integrating active transportation throughout planning and engineering practice) addresses these topics	
Goal 5: Policy: provide policy leadership on active transportation. Strategy 5a: Lead AASHTO policy activities related to active transportation.	• 12 of the needs focus on Policy and Practice.	• The Research Review provides existing evidence that can assist the CAT in providing this policy leadership.
Goal 6: Technology: monitor and share information related to new technologies that may impact active transportation. Strategy 6a: Monitor and evaluate the impacts of new technologies/business models on active transportation.	• 12 of the needs focus on Technology and Micromobility.	• Autonomous and connected vehicles • Bicycle and pedestrian data: Emerging user-based data • Bike share • Micromobility, including e-scooters

Themes

While developing the Roadmap, a few themes or overarching findings emerged after reviewing existing active transportation research, conducting surveys and workshops for the Roadmap, and in discussions with the CAT Steering Committee and project panel.

Equity

Nearly every research need in the Roadmap has direct equity implications. There are several needs that focus on equity, particularly racial equity. Other needs include equity dimensions in their objectives. The FY2022 NCHRP projects include several projects focused on equity that will address active transportation directly or indirectly.

Equity is a term that encompasses many concepts. Moving forward, it is important to be explicit and specific about equity in research. Equity can be examined for different population groups: race/ethnicity, gender identity, income, immigrant background, disability, and age. For some research topics, including all of these dimensions in a single project may result in a shallow understanding for any one group. It is also important to consider intersectionality. For example, a disabled Black person or an immigrant woman may face different safety threats while walking, bicycling, or rolling. Often, race and income are conflated, though some research indicates that these factors may have different roles in how people experience active transportation.

Addressing equity in active transportation research also requires moving beyond traditional realms of traffic safety research. For example, the research included in the Research Review section "Equity and personal safety" finds that women and transgender people face higher levels of street harassment, which reduces their use of active transportation. Racialized populations in the U.S. face different safety threats while walking, bicycling, and rolling compared to white people – from other road users and from law enforcement. The traditional tools our industry has used to address safety, including many traffic laws and regulations, can be problematic because of bias during enforcement (Aevaz, 2020; Barajas, 2020). Research that collects data to understand these problems and identify effective solutions may seem outside the scope of typical transportation research but would help in making active transportation more equitable.

Research on Practice and Policy

In many cases, there is relevant research on effective solutions to active transportation safety and mobility issues. For example, there is solid evidence regarding the safety effectiveness of medians, beacons, and enhanced markings for pedestrian crossing safety, and that increased separation (e.g., protected bike lanes) is correlated with higher rates of cycling. However, solutions such as these are not implemented extensively. Some additional research may be helpful, such as for spacing of enhanced pedestrian crossings or the design of protected bike lanes at intersections. Still, our discussions with practitioners during the workshops and other forums reveal that the bigger challenge is often institutional. Staff may not have knowledge of these tools or their effectiveness, relying on outdated information. The tools may not be in official guidance documents, so staff are reluctant to employ them. Agency leadership may not be supportive. Policymakers may not be allocating funding for active transportation. Members of the public or business community may express concerns. Often, the solutions may appear to be outside of an agency's purview (e.g., education programs, alternatives to traffic enforcement, etc.).

Research can be useful in identifying how to change institutional practices to overcome these implementation barriers. This research is conducted differently than much of the research reviewed for the Roadmap. It relies on disciplines such as public administration, public policy, and organizational development. The data may be qualitative and rely on case studies. The NCHRP has a strong history of conducting projects that identify best practices, which are one form of research that can help change practice. The Roadmap includes several needs where best practices research may be powerful. There is also an RPS on "Addressing barriers to integrating active transportation throughout planning and engineering practice" that proposes research to address this larger issue.

Some Older, Inadequate Research and Assumptions are Barriers

As shown earlier, the volume of research on walking and bicycling has increased significantly from nearly nothing in the early 1990s. However, the speed at which practice and guidance responds to new research is often slow. For example, design decisions may be based on old or inappropriate assumptions for bicycle speed, acceleration, deceleration, sight distance, and operating space. Though more recent research has addressed the notion that crosswalks should not be used because they give people a "false sense of security" (e.g. Mitman, Ragland, & Zegeer, 2008; Mead, Zeeger & Bushell, 2014), that conclusion appeared in a study from the 1970s and still gets used. Research on bicycling on sidewalks has been applied to protected bike lanes, though the facilities are distinct and more recent research draws different conclusions (DiGioia et al., 2017; Marshall & Ferenchak, 2019). Past research also places the vast majority of blame for crashes on user behavior, though more recent research reveals that facility design may be a key factor (Dumbaugh & Li, 2010; Marshall & Ferenchak, 2019). Design practices are often inconsistent between active and motorized transportation. For example, designing for bike lanes often assumes people riding single file, but people in motor vehicles sit side by side.

Changing basic assumptions and approaches, along with dispelling outdated research, is challenging. There are several research needs in the Roadmap that relate to how to change policy and practice, and needs that will help add more research that challenges outdated research findings.

Crash Modification Factors

In developing the list of research needs and reviewing existing research, it became clear that more research is needed to develop crash modification factors (CMFs) for active transportation infrastructure that aligns with the design and operational decisions that are required to improve safety. While there has been progress and results, particularly for pedestrian midblock crossings, there is a gap in other key design areas, particularly for bicycle-related design options.

Walking and Bicycling Should Often be Considered Separately

The trend in the research shown in Figure 4 is partly the result of the field maturing and realizing the important differences between walking and bicycling. While the modes share some similarities, the factors influencing safety and use and the solutions are often not the same. Throughout the Roadmap process, the team resisted including both modes in a single research need, though that was not always practical. For research projects that include both modes, different methods may be necessary to adequately address the need, thus increasing the scope and budget and, potentially, the timeline.

What is Included: Highest-Priority Needs

The Roadmap includes six RPSs for the highest-priority needs identified:

A1. Applying and integrating active transportation data into planning and operations.

A2. Using minimum accommodations vs. alternative approaches to increase active transportation.

A3. Determining context-driven optimal spacing between marked crosswalks.

A4. Addressing barriers to integrating active transportation throughout planning and engineering practice.

A5. Racial and economic disparities in pedestrian and bicyclist safety.

A6. Speed management solutions and strategies to improve pedestrian and bicyclist safety on arterial roadways.

Each RPS follows the 2020 NCHRP problem statement format but does not include sections that identify the potential panel members and the persons submitting the statement. These RPSs should be considered as a starting point for the CAT. They can be revised based on further discussion of needs and related research projects that may be funded in the near term.

What is Included: High- and Medium-Priority Needs

For each of the high- and medium-priority needs, the team prepared a research need brief (RNB). The brief provides information to help guide the CAT in its next steps to advance the research need, organized by the headings described below.

Overview and Research Objectives

The Overview provides a short description of the need, highlighting key research gaps based on the Research Review document. The Research Objectives section provides specific suggestions for research projects. These were developed based on the Research Review, input from the workshops, the team's expertise, and considering on-going and anticipated research.

Research Type

The brief suggests one or more of the following types of research that could meet the objectives:

New empirical research. This type of project would require collecting new quantitative or qualitative data. It can also include developing new technology.

Research on best practices. This type of project is recommended when the objective focuses more on how agencies are implementing policies and programs and applying research. These projects may fit well with the NCHRP Synthesis program.

Technology transfer. This type of project is useful when solid empirical research exists but is not being widely adopted.

Systematic review. This type of project would be useful when there is empirical research from several different studies, but the findings are not consistent or compared in an objective way. A systematic review would consider how research methodologies may affect the relevance of the findings and try to standardize the findings using a common outcome measure.

Research Review

This section lists the relevant sections from the Research Review that contain information on existing research findings relevant to the need. These summaries would be a starting point for developing a RPS.

Potential Funding Pathways

For each need, we identify one or more possible funding pathways, described below.

NCHRP

State DOTs contribute each year to the National Cooperative Highway Research Program (NCHRP), administered by the Transportation Research Board (TRB) and governed by AASHTO. Approximately $40 million is available annually to fund the competitive research program with projects typically ranging from $200,000 to $600,000 over two to three years. The NCHRP annual process for these projects starts in the fall, with problem statements from state DOTs, AASHTO committee and council chairs, and FHWA due at the start of November. Statements are reviewed and ranked by relevant AASHTO committees and then sent to the AASHTO Research and Innovation Committee. Project selections are made in late spring. A TRB-selected technical panel then refines the scope of chosen projects and selects a contractor in a competitive process. Projects typically begin more than a full year after the original early November problem statement deadline.

In addition, there are several other NCHRP programs that support research relevant to the Roadmap:

- The **Synthesis Program** (NCHRP 20-05) documents the current state of knowledge and practice on specific topics. The program funds about 17 projects each year. Synthesis topics are due in mid-February and can be submitted by any interested party.
- The **Implementation Support Program** (NCHRP 20-44) provides funding to facilitate the use of NCHRP research by state DOTs and other transportation agencies.
- The **Legal Studies Program** (NCHRP 20-06) conducts research on legal issues associated with highway and transportation projects. Problem

statements are due in late-November (November 30 in 2021).

TCRP

The Transit Cooperative Research Program (TCRP) is sponsored by the Federal Transit Administration (FTA) to provide the transit industry with research and tools to solve problems and inform decision-making. Problem statements are usually due in mid-June each year. TCRP has conducted several projects on pedestrian safety and access to transit and has collaborated with NCHRP on active transportation research. Like NCHRP, TCRP also has a Synthesis Program.

BTSCRP

The Behavioral Traffic Safety Cooperative Research Program (BTSCRP) is the newest of the cooperative research programs managed by TRB. It is a partnership between the Governors Highway Safety Association (GHSA), the National Highway Traffic Safety Administration (NHTSA), and TRB. Problem statements can be submitted by a State Highway Safety Office, GHSA Executive Board members and Committees, and NHTSA.

UTCs

The University Transportation Center (UTC) program is funded by the FAST Act and managed by the USDOT Office of the Secretary – Research (OST-R). Each federally funded UTC involves multiple universities and has a theme related to one of the USDOT research priorities. Annual funding levels range from about $1.5 to $3.0 million in federal funding that must be matched with non-federal sources (1:1 or 1:0.5, depending upon the type of center). Research projects are carried out by faculty, researchers, and students at the universities. The process for selecting projects is developed by each UTC; many UTCs have a request for proposals (RFP) process. The research projects are largely driven by the interests and expertise of the researchers at the universities, along with the sources of the matching funds. State DOTs have often been match partners for UTC projects.

Transportaton Pooled Fund

The Transportation Pooled Fund (TPF) is an FHWA-administered program that allows any state (or the FHWA) to propose and sponsor a research idea. The program then solicits funding contributions from other states, federal agencies, local agencies, or other entities. The program funds projects ranging from $100,000 to $3,500,000, with anywhere from two to nearly 50 participants.

Research Timeline

This section suggests a possible timeline, in general terms, for pursuing this research need. The suggested timeline is based, in large part, on ongoing research projects. In some cases, the team is recommending that the CAT wait for results from a very relevant project which will make the remaining gaps clearer.

Research Partners

For each research need we identify possible partners that the CAT could collaborate with. For some needs, CAT might take the lead with support from partners. In other cases, the partner may be a more appropriate lead organization and the CAT would play a supportive role.

This section starts with identifying other AASHTO councils and committees that may be interested in the need, followed by TRB committees. FHWA and other USDOT agencies are often listed as partners, in many cases because these agencies are likely to fund a research project on the topic. For some topics, partners might include other transportation agencies (e.g., MPOs) and professional organizations.

Related Projects

This section lists the most relevant ongoing research projects. The description of the project here focuses on how the project may address the research need, providing some guidance to the CAT on what needs may still remain.

Related RPSs and RNSs

This section lists other RPSs developed within AASHTO (though not currently selected for funding) and RNSs included in the TRB database. These statements can be useful in developing a future RPS and in identifying possible research partners.

What is Included: Lower-Priority Needs

The lower-priority needs are included in a table with information about the relevant summary in the Research Review, the most relevant ongoing research projects, and relevant RNSs and RPSs prepared by other organizations.

Organization of the Needs

Each of the 110 needs is assigned to one of six primary topical categories:

- Data
- Design
- Equity and Accessibility
- Planning
- Policy and Practice
- Safety
- Technology and Micromobility

The needs are organized in this document by category. The needs are also divided into four priority levels:

A. Highest (six RPSs)

B. High (nine research need briefs)

C. Medium (31 research need briefs)

D. Lower (64)

Each need is identified with a letter representing the priority level and a number. The numbers ***do not*** represent a rank order within the priority level. The numbering is only for ease of reference.

Research Needs Matrix

The matrix table on the following pages has the complete list of needs, indicating the priority level. The matrix highlights some entities that the CAT could collaborate with on developing research problem statements and advancing the research needs. The matrix focuses on five AASHTO committees (Joint Non-Motorized Technical Committee, Design, Safety, Planning, and Environment & Sustainability) and two TRB committees (Bicycle and Pedestrian). These are the entities that are most relevant to a large number of the needs. The column of "Other Collaborators" includes other AASHTO committees and councils and TRB committees. Still, the list is not exhaustive. The RPSs and need briefs also identify potential collaborators, including entities outside of AASHTO and TRB.

Research Needs Matrix

Research Need		COLLABORATORS						
		AASHTO				TRB		
Research Problem Statement (RPS) - Highest Priority High Priority Medium Priority Lower Priority		JNMTC & Design	Safety	Planning	Evnt & Sust.	TRB Bicycle (ACH20)	TRB Ped (ACH10)	OTHER COLLABORATORS
NEED	DESCRIPTION							
DATA								
A1	Applying and integrating active transportation data into planning and operations			■	■	■	■	AASHTO Data Management and Analytics
B6	Improving data on pedestrian and bicyclist fatalities and injuries		■			■	■	AASHTO Data Management and Analytics
C2	Accuracy of new bicyclist and pedestrian counting technologies					■	■	AASHTO Data Management and Analytics
C16	Improving consistency of regional, statewide and national non-motorized data practices		■	■	■	■	■	
C17	Improving travel surveys to collect better active travel data			■				
C20	Methods to estimate pedestrian and bicycle travel from limited counts					■	■	AASHTO Data Management and Analytics
C22	New pedestrian and bicyclist traffic data sources					■	■	AASHTO Data Management and Analytics
C26	Refinement of pedestrian and bicyclist crash types		■			■	■	
D11	Developing site selection criteria for continuous and short-duration pedestrian and bike count locations			■		■	■	
D31	Improving data on pedestrian and bicyclist crashes not involving motor vehicles, including on trails		■			■	■	
D42	QA/QC standards for pedestrian and bicycle count data, including in different contexts, volumes, etc.					■	■	
DESIGN								
A2	Using minimum accommodations vs. alternative approaches to increase active transportation	■		■	■	■		
A3	Determining context-driven optimal spacing between marked crosswalks	■		■			■	
B4	Designs to improve safety at shared-use path intersections	■	■			■	■	
C12	Guidance on bicycle signal timing and design	■				■		AASHTO Traffic Engineering
C15	Improved pavement markings to make road users aware of bicycles and pedestrians	■				■	■	
C23	Pedestrian crossing treatments and transit: safety and design	■	■	■			■	
C25	Quantifying the active transportation facilities that would benefit from retrofits	■		■	■	■	■	
C31	Spacing and types of separated bike lane vertical elements: safety and operations	■	■			■		
D2	Bicycle signals: face design, bicyclist and driver comprehension and compliance	■				■		AASHTO Traffic Engineering
D3	Bicycle signals: user comprehension and safety of permissive phasing	■				■		AASHTO Traffic Engineering
D8	Deployment and effectiveness of emerging urban street and intersection design guides	■		■		■	■	TRB Geometric Design (AKD10)

Research Need		COLLABORATORS						
		AASHTO				TRB		
Research Problem Statement (RPS) - Highest Priority High Priority Medium Priority Lower Priority		JNMTC & Design	Safety	Planning	Evnt & Sust.	TRB Bicycle (ACH20)	TRB Ped (ACH10)	OTHER COLLABORATORS
NEED	DESCRIPTION							
D9	Design and operations strategies to promote social/ physical distancing of pedestrians during pandemics	■			■		■	
D10	Design of bicycle facilities to accommodate different bicycle types (e.g., cargo bikes, adult tricycles, etc.)	■				■		
D20	Guidance on adequate physical distancing for active transportation modes to reduce exposure to viruses	■			■	■	■	
D36	Optimal bicycle wayfinding signs and pavement markings	■				■		
D37	Optimal methods to communicate allowable, protected, or permissive movements to bicyclists at signalized intersections	■				■		AASHTO Traffic Engineering
D45	Rumble-strip design impacts on active transportation users	■				■	■	
D46	Safety and design considerations to accommodate the increasing use of e-bikes	■	■			■		
EQUITY & ACCESSIBILITY								
A5	Racial and economic disparities in pedestrian and bicyclist safety		■	■	■	■	■	AASHTO Civil Rights
B5	Equitable representation in active transportation			■		■	■	AASHTO Civil Rights
C1	Accessible shared street design for pedestrians with vision disabilities	■					■	AASHTO Traffic Engineering
C3	Barriers to bicycling for underserved populations relating to the built environment			■		■		AASHTO Civil Rights
C5	Crossing solutions at roundabouts and channelized turn lanes for pedestrians with vision disabilities	■	■				■	AASHTO Traffic EngineeringTRB Roundabouts (AKD80)
C7	Disparities in active transportation use and health outcomes			■	■	■	■	AASHTO Civil Rights
C13	Guidance on the use of tactile walking surface indicators (TWSIs) at decision points as decision-making surfaces	■					■	AASHTO Traffic Engineering
C14	Impact of harassment and violence in reducing active transportation use					■	■	AASHTO Civil Rights
C19	Increasing bicycling among women and girls: programs and policies			■		■		AASHTO Civil Rights TRB Women & Gender in Transportation (AME20)
C24	Programs and policies to overcome barriers to bicycling for underserved populations			■		■		AASHTO Civil Rights
D12	Disability and school active travel opportunities			■		■	■	AASHTO Civil Rights
D24	How infrastructural change might impact child bicycling	■				■		
D61	The potential of adaptive bikes for people with disabilities and older adults			■		■		AASHTO Civil Rights
PLANNING								
B2	Bicycle networks: measures and effects			■		■		
B3	Changes in bicycle ridership with innovative infrastructure	■		■		■		

Research Need		COLLABORATORS						
		AASHTO				TRB		
Research Problem Statement (RPS) - Highest Priority High Priority Medium Priority Lower Priority		JNMTC & Design	Safety	Planning	Evnt & Sust.	TRB Bicycle (ACH20)	TRB Ped (ACH10)	OTHER COLLABORATORS
NEED	DESCRIPTION							
B7	Incorporating active transportation into travel demand modeling			■	■	■	■	
C18	Incorporating active transportation modes into transportation impact studies			■	■	■	■	
C21	Methods to prioritize different modes across the network in planning processes			■		■	■	
D28	Impacts of bicycle facility design on air pollution exposure concentrations	■			■	■		
D33	Incorporating air pollution exposure of active transportation users in planning and forecasting			■	■	■	■	
D34	Incorporating physical activity and health outcomes of active transportation in transportation planning			■	■	■	■	
D35	Innovation in funding active transportation projects			■		■	■	AASHTO Funding and Finance
	POLICY & PRACTICE							
A4	Addressing barriers to integrating active transportation throughout planning and engineering practice			■		■	■	
C4	Best practices in systematic approaches and interagency collaboration to improve active transportation safety			■		■	■	
C8	Economic benefits active transportation infrastructure			■		■	■	
D7	Building political support for active transportation			■	■	■	■	
D13	Effectiveness and impacts of rail anti-trespass education						■	AASHTO Rail Council TRB Highway/Rail Grade Crossing (AHB60)
D14	Effectiveness of driver education and licensing requirements at improving active transportation safety, including for older drivers		■			■	■	
D15	Effectiveness of educational interventions for increasing bicycling among adults, including underserved populations			■		■		
D16	Effectiveness of educational interventions for increasing bicycling among children			■		■		
D17	Effectiveness of educational interventions for older pedestrians			■			■	
D19	Examination of the role of driving culture on active transportation safety and use					■	■	
D25	How to increase the adoption of innovative traffic control devices and infrastructure	■				■	■	AASHTO Traffic Engineering
D41	Public perceptions and communicating the benefits of active transportation			■	■	■	■	

Research Need		COLLABORATORS						
		AASHTO				TRB		
Research Problem Statement (RPS) - Highest Priority High Priority Medium Priority Lower Priority		JNMTC & Design	Safety	Planning	Evnt & Sust.	TRB Bicycle (ACH20)	TRB Ped (ACH10)	OTHER COLLABORATORS
NEED	DESCRIPTION							
SAFETY								
A6	Speed management solutions and strategies to improve pedestrian and bicyclist safety on arterial roadways	■	■			■	■	
B8	Safety and operations of separated bike lanes at intersections	■	■			■		TRB Geometric Design (AKD10)
B9	Using crash records and surrogate measures to identify safety hotspots and plan bicycle/pedestrian improvements		■			■	■	AASHTO Data Management and Analytics
C11	Factors uniquely affecting pedestrian and bicyclist safety in rural and small communities	■	■			■	■	
C27	Safety effects of bicycle/motor vehicle mixing zone treatments	■	■			■		
C28	Safety effects of curb extensions, curb radius reductions, and truck aprons	■	■			■	■	
C29	Safety effects of separated bike lane configurations	■	■			■		
C30	Safety impacts for pedestrians and bicyclists of motor vehicle access management strategies	■	■			■	■	
D4	Bicyclist safety impacts of driver and bicyclist distraction		■			■		
D23	Helmet use and impacts on cycling behavior (amount and risk compensation behavior)		■			■		
D26	Impact of functional declines on older adults' safety and mobility as pedestrians/bicyclists		■			■	■	
D27	Impact of vehicle design on pedestrian and bicycle safety, including impacts on crash severity and visibility		■			■	■	
D29	Impacts of new micromobility modes, including e-scooters, on pedestrian safety		■				■	
D30	Impaired pedestrians and safety		■				■	
D32	Improving data on pedestrian and bicyclist crashes not involving motor vehicles, including on trails		■			■	■	AASHTO Data Management and Analytics
D38	Pedestrian and bicycle safety at freeway ramp termini	■	■			■	■	
D40	Pedestrian safety impacts of distraction among drivers and pedestrians		■				■	
D43	Qualitative methodologies for understanding active transportation safety and the built environment		■			■	■	
D44	Risk analysis and guidance on the time frame for renewing safety performance function development		■	■		■	■	
D48	Safety and operation of shared streets/yield roadways	■	■			■	■	
D49	Safety and operation of shared bus and bike lanes	■	■			■		
D50	Safety effects and design of bicycle contraflow lanes	■	■			■		
D51	Safety effects of bicycle lane extensions through intersections	■	■			■		

Research Need		COLLABORATORS						
		AASHTO				TRB		
Research Problem Statement (RPS) - Highest Priority High Priority Medium Priority Lower Priority		JNMTC & Design	Safety	Planning	Evnt & Sust.	TRB Bicycle (ACH20)	TRB Ped (ACH10)	OTHER COLLABORATORS
NEED	DESCRIPTION							
D52	Safety effects of bicycle signals		■			■		AASHTO Traffic Engineering
D53	Safety effects of bike boulevards	■	■			■		
D54	Safety effects of bike boxes	■	■			■		
D55	Safety effects of crossing barriers	■	■			■		
D56	Safety effects of edge lanes/advisory bike lanes	■	■			■		TRB Geometric Design (AKD10)
D57	Safety effects of gateway treatments and in-street pedestrian crossing signs	■	■				■	
D58	Safety effects of leading bicycle intervals		■			■		AASHTO Traffic Engineering
D59	Safety effects of roundabouts for pedestrians and bicyclists	■	■			■	■	TRB Roundabouts (AKD80)
D60	Safety effects of two-stage bicycle turn queue boxes	■	■			■		TRB Geometric Design (AKD10)
D62	Understanding local control of speed limit-setting process			■		■	■	
D63	Use of surrogate measures for bicyclist and pedestrian safety analysis and monitoring		■			■	■	AASHTO Data Management and Analytics
D64	Using GPS direction-finding and routing to reduce conflicts in high-risk locations, especially in rural areas		■	■		■	■	
TECHNOLOGY & MICROMOBILITY								
B1	Connected and autonomous vehicles and active transportation users		■			■	■	TRB Human Factors of Vehicles (ACH30)
C6	Curb space access, AVs, and shared mobility: Impacts on active transportation	■					■	
C9	Effectiveness of programs and policies to increase bike share use among underrepresented populations					■		AASHTO Civil Rights TRB City Transportation Issues (A0030C)
C10	Effects of bike sharing systems on mode shift					■		
D1	Appropriateness of bicycle infrastructure for e-scooters and other new micromobility modes	■				■		
D5	Bike share data: assessment, use, data sharing					■		
D6	Bike share fleet rebalancing					■		
D18	Effects of e-bikes in bicycling behavior/demand, including among different demographic groups					■		
D21	Health impacts of bike sharing systems				■	■		
D22	Health impacts of e-scooters and other micromobility				■	■		
D39	Pedestrian safety effects of e-scooters and other new micromobility modes		■				■	
D47	Safety and design considerations to accommodate the increasing use of e-bikes	■	■			■		

Research Needs: Data

Highest Priority: Research Problem Statements

A1 Applying and integrating active transportation data into planning and operations.

High Priority: Research Need Briefs

B6 Improving data on pedestrian and bicyclist fatalities and injuries.

Medium Priority: Research Need Briefs

C2 Accuracy of new bicyclist and pedestrian counting technologies.

C16 Improving consistency of regional, statewide and national active transportation data practices.

C17 Improving travel surveys to collect better active travel data.

C20 Methods to estimate pedestrian and bicycle travel from limited counts.

C22 New pedestrian and bicyclist traffic data sources.

C26 Refinement of pedestrian and bicyclist crash types.

Lower Priority

D11 Developing site selection criteria for continuous and short-duration pedestrian and bike count locations.

D31 Improving data on pedestrian and bicyclist crashes not involving motor vehicles, including on trails.

D42 QA/QC standards for pedestrian and bicycle count data, including in different contexts, volumes, etc.

Problem Title	*A1: Applying and integrating active transportation data into planning and operations*
Background	Active transportation data, including bicycle and pedestrian volume and crash data, infrastructure data, and related information like travel behavior factors and safety outcomes, could all potentially help guide transportation decision-making at various agency levels. Gaps exist in identifying what type of information is most useful for guiding such decision-making, how to package and present such information to convey its meaning and limitations, how to integrate data from different sources and develop data flow systems to get information where it needs to go, and how to incorporate equity and environmental justice concerns. Further, as data sources and systems have become more abundant, they have also demanded more specialized skills to interpret and apply them. Active transportation data has proliferated in recent years, including an increasing deployment of automated counters, efforts to improve data quality and factoring, the emergence of smartphone trip data to document walking and bicycling trips across networks, bike share trip data, online facility inventories and resources such as OpenStreetMap, and more. There is an emerging industry of companies seeking to help agencies manage their transportation data, including active transportation data, and an expanding hope for data to inform smart city planning. This research will identify the needs and gaps for transportation agencies and practitioners to fully incorporating active transportation data in planning and operations, including decision-making around active transportation investments, and provide solutions to ensure that they have the systems, skills and supports to do so successfully.
Literature Search Summary	The need for this research follows a push in recent years to understand the potential of new connected technologies, from the expanding use of automated counters, smartphone and app-based activity data, increased processing capabilities, and more. NCHRP Report 797 (“Guidebook on Pedestrian and Bicycle Volume Data Collection”) focused on the broad range of pedestrian and bicycle counters, and noted that active transportation count data can be used to monitor facility usage, inform before-and-after assessments to determine facility impacts, monitor travel patterns, inform safety analyses to quantify exposure for interpreting crash data, project prioritization, and multimodal model development. However, agencies need to understand why they are collecting the data, plan collection locations, know how to place and maintain counters, and know how to store and adjust the count data. Research efforts have pushed forward our understanding of best practices for bicycling and pedestrian counting programs, including when and where to count (e.g., Nordback et al., 2016), through to estimating average daily traffic, developing factor groups and adjusting for data gaps (e.g., Nordback et al., 2019; Sanders et al., 2017). Emerging data sources can dramatically increase the scale of data collection, helping overcome small sample sizes and infrequent updates (Lee & Sener, 2020). However, these emerging sources may not always accurately detect the travel mode, and may

	not be a representative or unbiased sample. Further, such data often comes with privacy concerns, costs, and other issues that agencies must be aware of and plan for if they are going to make effective use of the data (Lee & Sener, 2020). Efforts to understand the benefits and limitations of emerging data sources are ongoing. However, a recent meta-analysis of literature related to mobile phone GPS data for transportation planning found "little mention to date within an applied transportation planning and policy context", with a need and opportunity for "policy-makers, transportation modelers, researchers and a wide range of stakeholders to collaborate in developing new analytic approaches, revise existing models and build the skills and related capacity needed to lever greatest value from the data" (Harrison et al., 2020). The upcoming NCHRP 07-31 ("*State DOT Usage of Bicycle and Pedestrian Data: Practices, Sources, Needs, and Gaps*") is closely related to this research project, and should be closely coordinated with. However, 07-31 is more focused on data sources and needs, and less on the application of data and integration into planning and practice. 07-31 should help provide important information on data availability, storage, maintenance and gaps, and what data agencies need. This project should build off of that by exploring in further depth how practitioners and agencies can incorporate data into planning and practice, including what agency steps, skills and processes are needed to apply data effectively. TCRP Synthesis 153 ("*The Transit Analyst Toolbox: Analysis and Approaches for Reporting, Communicating, and Examining Transit Data*") offers a model for what a portion of the project output may resemble. That report was undertaken "to describe how transit agencies manage, store, analyze, and, most importantly, govern their transit service data." The impetus for the project was, in part, the growing availability and potential of transit data, and the increasing need to plan and coordinate data usage in order to put it to use effectively. In the active transportation world, data is more dispersed, and requires more quality checking and interpretation. This research would also go beyond TCRP Synthesis 153 to provide more step-by-step details on incorporating data into planning and practice. NCHRP Web-Only Document 226: "Data Visualization Methods for Transportation Agencies" offers another model for a data application tool. Although not specific to active transportation, and focused on the end product of data presentation, the report demonstrates the importance of specialized data skills and effective data presentation. The proposed research would assess more specialized active transportation data needs and other data applications beyond visualization.
Research Objective	This research will assess the practitioner and agency gaps and needs in terms of managing, interpreting and applying data to active transportation planning and operations. To address these gaps, the project will document best practices and develop a set of tools and instructions to leverage active transportation data to improve facility selection, prioritization, safety, planning, network development, and policy- and decision-making. The research will seek to answer these key questions: • Do professionals have the right skills to use, analyze, access, and interpret data? Are they able to accurately and effectively convey data meaning, implications, and uncertainty?

- Are agencies technically equipped to handle, assess, and deploy data? Are agencies able to train and support employees on data management and analysis skills?
- How are agencies currently deploying active transportation data to improve planning and operations?
- How can best practices be documented and packaged, such as through a toolbox or step-by-step instructions, to facilitate data usage?

Outputs would include:

- Toolkit/guidance document
- Final report

Tasks include:

- Task 1. Literature review on data-informed project management relevant to active transportation, with the goal of documenting how data could and should inform active transportation planning and safety and effective workforce training approaches.
- Task 2. Develop initial data needs and applications matrices (one for practitioners and one for agencies) outlining which data can be used for which applications, along with the needed skills, programs and supports needed.
- Task 3. Scope the Task 4 scan, using the literature review and initial data needs and applications matrices, to identify the most useful best practices, understand gaps, and plan for the development of tools. Submit to panel for review and comment.
- Task 4. Conduct scan of best practices, gaps, and needs, according to the plan developed in Task 3. Scan may include case studies, interviews, etc. The scan should seek to understand the potential for applying data to improve active transportation planning and operations; what practitioners and agencies are doing well and need to do better; what skills, training and supports are needed; and how to implement these. The task should seek to interview policymakers, project managers, planners and analysts, and data specialists.
- Task 5. Conduct a survey of active transportation practitioners to assess how they use data and what data skills they have.
- Task 6. Prepare toolkit, with sections for practitioners and for agencies, with guidance to successfully integrate data in planning and operations for active transportation. The toolkit will include updated matrices (of those developed in Task 2), and may include skills and workforce development approaches, data management, analysis, and application and presentation best practices. The toolbox may include suggestions for integrating data management and application into planning processes, including step-by-step procedures for select key applications. The toolbox may also include suggested curricula for workforce development and strategies for skilled workforce retainment.
- Task 7. Prepare final report covering findings from the literature review, scan, and survey.

	Research will be presented in a toolkit and final report.
Urgency and Potential Benefits	Data-informed policy- and decision-making has the potential to help transportation departments and other agencies deliver safer and more comfortable walking and bicycling networks; to improve active transportation modeling; to identify and act on safety hazards and hotspots; focus spending and prioritize resources; and improve project planning processes. Better active transportation data could also help inform emissions reductions strategies. However, the vast amount of new data sources and technologies will leave agencies struggling to process the data, both literally and figuratively, and to apply the data into planning and operations. This project provides a resource to help agencies to understand active transportation data applications, skills and tools needs to utilize the data, and what steps to take to incorporate data into their processes. The outputs from this research should help practitioners to understand active transportation data potential uses and shortcomings, how they should interpret the data, and how the data can inform planning and evaluation efforts. For agencies, the outputs will help them to develop policies and systems to integrate data into various planning and operations steps, and to ensure staff have the skills and tools needed to utilize the data. More specifically, the project outputs should help agencies and practitioners to better interpret crash and safety trends, in conjunction with exposure data, to identify and act on usage and safety issues or needs earlier and more effectively, as well as to convey data meaning to partner agencies and the public. Agencies should be able to better incorporate data into planning processes, and to plan for data needs.
Implementation Considerations and Supporters	The results of the research will be used by agency administrators and managers to assess where and how to better integrate data into their active transportation planning and operations, and how to better support agency staff to make use of data. Agency staff will use the toolbox materials to better integrate data into their planning activities. Based on the project recommendations, agencies may decide to implement trainings or develop curriculum to assist staff in working with data. Further research should: 1) Evaluate the tools and steps developed in this research project to assess their utility and efficacy. 2) Monitor emerging data sources and methods, and assess when updates are needed to the materials developed in this project. The CAT could collaborate with the following AASHTO committees on the statement: Planning.
Recommended Research Funding and Research Period	$300,000-$400,000 24 months

Problem Statement Author(s)	Nathan McNeil, Portland State University Jessica Schoner, Toole Design Group
References:	Harrison, G., Grant-Muller, S. M., & Hodgson, F. C. (2020). New and emerging data forms in transportation planning and policy: Opportunities and challenges for "Track and Trace" data. *Transportation Research Part C: Emerging Technologies*, *117*, 102672. https://doi.org/10.1016/j.trc.2020.102672 Lee, K., & Sener, I. N. (2020). Emerging data for pedestrian and bicycle monitoring: Sources and applications. *Transportation Research Interdisciplinary Perspectives*, *4*. https://doi.org/10.1016/j.trip.2020.100095 National Academies of Sciences, Engineering, and Medicine 2017. *Data Visualization Methods for Transportation Agencies*. Washington, DC: The National Academies Press. https://doi.org/10.17226/24755 National Academies of Sciences, Engineering, and Medicine 2021. *The Transit Analyst Toolbox: Analysis and Approaches for Reporting, Communicating, and Examining Transit Data*. Washington, DC: The National Academies Press. https://doi.org/10.17226/26138 Nordback, K., Kothuri, S., Petritsch, T, McLeod, P., Rose, E., & Twaddell, Hannah. (2016). *Exploring Pedestrian Counting Procedures: A Review and Compilation of Existing Procedures, Good Practices, and Recommendations (No. FHWA-HPL-16-026)*. Federal Highway Administration. Nordback, K., Kothuri, S., Johnstone, D., Lindsey, G., Ryan, S., & Raw, J. (2019). Minimizing Annual Average Daily Nonmotorized Traffic Estimation Errors: How Many Counters Are Needed per Factor Group? *Transportation Research Record*, *2673*(10), pp 295-310. https://doi.org/10.1177/0361198119848699 Ryus, P., Ferguson, E., Laustsen, K. M., Schneider, R. J., Proulx, F. R., Hull, T., & Miranda-Moreno, L. (2014). *Guidebook on Pedestrian and Bicycle Volume Data Collection* (01551881; Issue 797). Transportation Research Board. http://www.trb.org/Publications/Blurbs/171973.aspx Sanders, R., Frackelton, A., Gardner, S., Schneider, R., & Hintze, M. (2017). Ballpark Method for Estimating Pedestrian and Bicyclist Exposure in Seattle, Washington: Potential Option for Resource-Constrained Cities in an Age of Big Data. *Transportation Research Record, 2605*, pp 32–44. https://doi.org/10.3141/2605-03

Research Topic	***B6: Improving data on pedestrian and bicyclist fatalities and injuries***
Overview	Although crash data are the primary source for safety analysis, they suffer from many limitations including inconsistencies in reporting, inaccurate or incomplete coding of crashes, and underreporting. Improving pedestrian and bicyclist injury and fatality data (crash severity, time, location); improving data storage, sharing and accessibility; and integrating police and hospital crash data would help practitioners understand risk factors and potential interventions. Further, it is important to understand the potential bias or skew in underreporting, and what the implications would be if present. Gaps and needs include understanding current data inconsistencies, developing better methods to match safety data sources, overcoming logistical and ethical barriers to accessing and matching medical records, and understanding how to store and make data accessible to practitioners and researchers. Research is also needed to better understand the potential benefits of integrating police and medical records, including the potential for tracking crash victims' mid- to long-range outcomes.
Research Objectives	Research on this topic needs to address the following objectives. • Document current shortcomings of crash data. • Identify best practices to improve the timeliness, accuracy, completeness, uniformity, integration and accessibility of crash data. • Improve the consistency of crash reporting including specific location of crashes, time of crash, contributing factors and crash severity. • Improve the data quality for non-fatal crashes. • Identify methods to improve and standardize crash typing for bicycle and pedestrian crashes. • Develop methods to link crash data to other pre- and post-crash data sources to improve decision-making. Pre-crash data-sets include citation histories, meteorological data, naturalistic data or crowdsourced data. Post-crash data include emergency response, hospital records, and medical insurance claims. Identify barriers to linkage of data-sets. • Identify or develop methods to incorporate race, ethnicity, and other equity aspects not captured in crash data. • Identify best practices to track long-term safety outcomes.
Research Type	 
Research Review	Bicycle and pedestrian data: Safety

Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process **Other:** NHTSA; NIH		
Research Timeline	***2021 – 2022***	***2023 – 2026***	***2027 and later***
	Monitor and coordinate with FHWA research and NCHRP 07-31	Scope and initiate research	Complete and implement research
Research Partners	**AASHTO Committees**: Safety; Data Management and Analytics **TRB Committees**: Pedestrians; Bicycle Transportation; Safety Performance and Analysis **US DOT**: FHWA; NHTSA **Other organizations**: CDC National Center for Health Statistics		
Related Projects	***Description/Connection***		***Status***
	NCHRP 07-31: State DOT Usage of Bicycle and Pedestrian Data: Practices, Sources, Needs, and Gap		
	A research project in this area would need to coordinate with or await the conclusion of NCHRP 07-31 ("State DOT Usage of Bicycle and Pedestrian Data: Practices, Sources, Needs, and Gap), which will catalog active transportation datasets, including police reports and hospital reports, and develop recommendations for next steps.		Anticipated start, 2021
	FHWA, Guide to Using Alternative Data Sources to Enhance Police Crash Reporting		
	Research on this topic should coordinate with this project described in FHWA's *Pedestrian and Bicycle Safety Program Strategic Plan.*		Anticipated, 2021-2022
Other Ongoing Research	TX DOT: Identify Risk Factors that Lead to Increase in Fatal Pedestrian Crashes and Develop Countermeasures to Reverse Trend (Start 2019, End 2021).		
Related RNSs	Better Reporting of Bicycle Movements Prior to Crash (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=42356 RNS: Creating and Integrating Relevant Nonmotorized Datasets (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=42354		

Research Topic	*C2: Accuracy of new bicyclist and pedestrian counting technologies*
Overview	Bicycle and pedestrian counts are critical for planning new facilities, monitoring trends, in safety analyses and for evaluating health and economic outcomes. While technology to count bicycles and pedestrians has improved tremendously over the last decade, it is still continuously evolving and, therefore, evaluation of technologies needs to be ongoing. NCHRP 797 provided a great overview of the existing technologies for counting bicyclists and pedestrians; however, many advancements in technology have occurred since the publication of that report in 2014. Artificial intelligence, machine learning and computer vision approaches are making it increasingly possible to automatically monitor, track and count pedestrians and bicyclists through video recordings or feeds; however, these need to be evaluated. Technologies to count bicycles and pedestrians in mixed traffic conditions, and at high-volume locations, are limited and need further research.
Research Objectives	This research should address the following objectives: • Review the existing technologies for counting bicyclists and pedestrians, including the strengths and weaknesses of each technology. • Conduct tests in a variety of conditions to evaluate technologies such as video, infrared, thermal cameras, LiDAR and others. • Develop adjustment factors for the tested technologies to account for errors. • Provide guidance on choosing an appropriate technology for counting based on a variety of conditions. • Review and recommend methods to perform QA/QC on count data. • Provide best practices for the management and storage of count data, including how to incorporate bicycle and pedestrian count data into a vehicle count database.
Research Type	 Empirical Data  Best Practices
Research Review	Bicycle and pedestrian data: Location-based counts
Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process **Other:** FHWA; Transportation Pooled Fund

<table>
<tr><td>Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td></td><td>Scope and initiate research</td><td>Complete and implement research</td><td>Monitor application of research and new counting technologies</td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Data Management and Analytics
TRB Committees: Pedestrians; Bicycle Transportation
US DOT: FHWA
Other organizations: UTCs</td></tr>
<tr><td>Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td></td><td colspan="3">NCHRP 07-31: State DOT Usage of Bicycle and Pedestrian Data: Practices, Sources, Needs, and Gaps</td></tr>
<tr><td></td><td colspan="2">NCHRP 07-31 will include cataloguing and emerging active transportation datasets and applications, and identifying gaps between data availability and state DOT needs. It is not clear whether it will assess the accuracy of new technologies.</td><td>Anticipated start, 2021</td></tr>
<tr><td></td><td colspan="3">FHWA, Crash Exposure Estimation for Nonmotorized Trips for Systemic Safety Applications</td></tr>
<tr><td></td><td colspan="2">Research on this topic should coordinate with this project described in FHWA's Pedestrian and Bicycle Safety Program Strategic Plan.</td><td>Anticipated, 2021-2022</td></tr>
<tr><td>Other Ongoing Research</td><td colspan="3">NC DOT: Bicycle Volume: Counting Machine Validation & Correction, Estimating & Forecasting, and Analysis of Injury Risk (Start 2019, End 2020).
SC DOT: Automatic Extraction of Vehicle, Motorcycle, Bicycle, and Pedestrian Traffic from Video Data+G63 (Start 2019, End 2021).
NC DOT: State of the Art Approaches to Bicycle and Pedestrian Counters (Start 2019, End 2021).
NCHRP 17-102: Safety Performance for Active Transportation Modes using Exposure Models (Start 2021-22).</td></tr>
<tr><td>Related RNSs</td><td colspan="3">None Identified</td></tr>
</table>

Research Topic	***C16: Improving consistency of regional, statewide and national active transportation data practices***
Overview	In addition to the need for more data on active transportation activity and infrastructure, there is also a need for data to be collected and managed in a consistent and reliable way so that it can be interpreted, compared and applied across jurisdictions. Currently, there are a wide range of data collection and management practices followed by agencies at the local, regional, state and national levels, with limited coordination. Standardization of data formats, collection procedures, quality metrics and other data management procedures is necessary to allow for comparisons, including enabling data to be used in analyses and to ground/adjust active transportation data from app-based sources.
Research Objectives	A project on this topic would seek to identify data best practices, including definitions, collection strategies, processing, storage and sharing. Best practices could then be synthesized and refined, in partnership with relevant stakeholders, to develop standards. Volume, safety and infrastructure data may be separated into distinct projects, but should be cognizant and interactive with one another. This project should consider data collection and handling practices and guidelines for cities, MPOs and state data warehouses such as the National Bicycle and Pedestrian Documentation Project (NBPDP) and FHWA's Travel Monitoring Analysis System (TMAS); private app-based datasets such as Strava and Streetlight; and data management practices in related areas, including around transit data (GTFS) and bike share (GBFS). A more consistent data collection framework could reduce data collection costs by providing consistent and reliable collection, storage and analysis methods, as well as making interjurisdictional comparisons easier and more useful. A move toward more real-time public data could also better inform planning and decision-making around active transportation and inform emissions reductions strategies.
Research Type	 Tech Transfer  Best Practices
Research Review	Bicycle and pedestrian data: Emerging user-based data Bicycle and pedestrian data: Location-based counts Bicycle and pedestrian data: Safety Bicycle and pedestrian data: Surveys
Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process **Other:** FHWA, Transportation Pooled Fund

<table>
<tr><td>Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td></td><td>Monitor NCHRP 07-31 scope and progress
Initiate best practices scan</td><td>Collaborative standards development and refinement</td><td>Implementation</td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Safety; Planning; Environment and Sustainability
TRB Committees: Pedestrians; Bicycle Transportation
US DOT: FHWA; NHTSA
Other organizations: Cities; MPOs; State DOTs</td></tr>
<tr><td>Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td></td><td colspan="3">NCHRP 07-31: State DOT Usage of Bicycle and Pedestrian Data: Practices, Sources, Needs, and Gaps</td></tr>
<tr><td></td><td colspan="2">NCHRP 07-31 should provide important input into active transportation data practices, gaps, and needs. Monitor 07-31 and develop/adapt this project in coordination with that research.</td><td>Anticipated start, 2021</td></tr>
<tr><td>Related RNSs</td><td colspan="3">Creating and Integrating Relevant Nonmotorized Datasets (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=42354</td></tr>
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Research Topic	*C17: Improving travel surveys to collect better active travel data*
Overview	Walk and bicycle trips are often undercounted in traditional travel diary surveys because respondents forget to report them. Part-time walkers or bikers may also be missed or undercounted if their active travel trips don't align with survey days. In addition, because bicycling is a rarely used mode in most U.S. cities, one-day travel diary surveys often do not have enough bicycle trips reported to use the data for modeling and forecasting or to understand demographic differences in behavior. Large-scale travel and other surveys usually do not collect data on personal factors that may influence active travel, such as attitudes and barriers. Such data can be useful in developing active transportation plans. Existing travel surveys also may not accurately represent some populations, particularly Black, Indigenous and people of color (BIPOC) households.
Research Objectives	Research is necessary on methods to ensure the accurate representation of BIPOC and other underrepresented populations in travel and special purpose surveys. This includes both sampling and the types of questions asked regarding active travel. Such research could review best practices from all types of surveys (not only travel surveys) and test new methods. The objective would be recommendations for best practices. Research to develop survey questions that accurately and reliably measure attitudes, perceptions, and preferences could be useful in helping standardize survey instruments. This would allow more comparisons across geographies and time. Results of such research may also help in incorporating such factors into demand models. Research on recall accuracy, including recommendations for the appropriate time period for recall, would be useful. Because active travel is not common, asking people to recall their behavior for a longer period of time (e.g., the past week or month) is a common approach to a single-day diary. Hybrid approaches of surveys combined with GPS-assisted methods may help to alleviate some challenges related to missing active travel trips through travel diaries, but further research is needed to understand if such a hybrid approach overcomes the relative weaknesses in each approach (e.g., GPS-assisted methods may suffer from participation bias, technical difficulties, mode imputation error, etc.).Best practices research on different sampling techniques and the use of GPS-assisted travel surveys could result in more and better active travel data.
Research Type	 Empirical Data  Best Practices
Research Review	Bicycle and pedestrian data: Surveys

<table>
<tr><td>Potential Funding Pathways</td><td colspan="3">TRB Cooperative Programs: NCHRP regular process
Other: Transportation Pooled Fund</td></tr>
<tr><td>Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td></td><td>Monitor NCHRP 07-31 and the NextGen NHTS (FHWA)</td><td>Scope and initiate research</td><td>Complete and implement research
Monitor application of research</td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Planning
TRB Committees: Travel Survey Methods
US DOT: FHWA National Household Travel Survey (NHTS).
Other organizations: State DOTs; MPOs</td></tr>
<tr><td>Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td></td><td colspan="3">NCHRP 07-31: State DOT Usage of Bicycle and Pedestrian Data: Practices, Sources, Needs, and Gap</td></tr>
<tr><td></td><td colspan="2">This project will likely focus on safety and volume data, not survey data. However, at the time of this writing, the exact focus is not clear.</td><td>Anticipated start, 2021</td></tr>
<tr><td></td><td colspan="3">FHWA, Methods to Predict Future Pedestrian and Bicyclist Demands to Support Safety Investments</td></tr>
<tr><td></td><td colspan="2">Research on this topic should coordinate with this project described in FHWA’s Pedestrian and Bicycle Safety Program Strategic Plan.</td><td>Anticipated, 2021-2022</td></tr>
<tr><td></td><td colspan="3">FHWA, NextGen National Household Travel Survey (NHTS) 2020</td></tr>
<tr><td></td><td colspan="2">The NextGen NHTS is a two-part effort collecting data on personal travel through surveys and on origin-destination data for nationwide travel through passive techniques.</td><td>Ongoing</td></tr>
<tr><td>Related RNSs</td><td colspan="3">Sampling Low-Incidence Travel Groups in Household Travel Studies (AEP25, Travel Survey Methods) https://rns.trb.org/details/dproject.aspx?n=41928</td></tr>
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Research Topic	***C20: Methods to estimate pedestrian and bicycle travel from limited counts***
Overview	Bicycle and pedestrian counts are used for planning and designing new facilities, in safety analyses and for quantifying economic impacts. Counting programs generally include both continuous and short-duration sites. Most of the research to date has focused on bicycle counting. Methods for factoring approaches to convert short-term bicycle counts into annual estimates have been well researched; however, pedestrian factoring approaches need more research. This research could be combined with topic C22 (*New pedestrian and bicyclist traffic data sources*) to assess broader count program future needs.
Research Objectives	The following objectives should be met through this research: • Review existing approaches to convert short-term counts into annual estimates. • Determine methods to optimize the number and type of counts to conduct to develop an accurate estimate of travel patterns. • Provide guidance on where to locate continuous and short-duration count sites and strategically place counters. • Identify pedestrian-specific pattern groups and develop methods for calculating and applying factors. • Identify best practices for assigning short-duration count locations to factor groups. • Provide guidance on estimating expansion factors to adjust short-duration counts.
Research Type	 Empirical Data
Research Review	Bicycle and pedestrian data: Location-based counts
Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process **Other:** UTCs

<table>
<tr><td>Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td></td><td>Monitor and coordinate with NCHRP 07-31, 17-102, and FHWA research
Scope research needs based on above</td><td>Initiate research
Complete and implement research</td><td>Monitor application of research</td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Data Management and Analytics
TRB Committees: Pedestrians; Bicycle Transportation
US DOT: FHWA
Other organizations: MPOs</td></tr>
<tr><td>Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td></td><td colspan="3">NCHRP 07-31: State DOT Usage of Bicycle and Pedestrian Data: Practices, Sources, Needs, and Gaps</td></tr>
<tr><td></td><td colspan="2">NCHRP 07-31 will include cataloguing and emerging active transportation datasets and applications, and identifying gaps between data availability and state DOT needs.</td><td>Anticipated start, 2021</td></tr>
<tr><td></td><td colspan="3">NCHRP 17-102: Safety Performance for Active Transportation Modes using Exposure Models</td></tr>
<tr><td></td><td colspan="2">Monitor this anticipated research into improved exposure models for active transportation, which will consider how to develop models from limited datasets.</td><td>Anticipated start, 2021-22</td></tr>
<tr><td></td><td colspan="3">FHWA, Crash Exposure Estimation for Nonmotorized Trips for Systemic Safety Applications</td></tr>
<tr><td></td><td colspan="2">Research on this topic should coordinate with this project described in FHWA's Pedestrian and Bicycle Safety Program Strategic Plan.</td><td>Anticipated, 2021-2022</td></tr>
<tr><td>Other Ongoing Research</td><td colspan="3">NC DOT: Bicycle Volume: Counting Machine Validation & Correction, Estimating & Forecasting, and Analysis of Injury Risk (Start 2019, End 2020).</td></tr>
<tr><td>Related RNSs</td><td colspan="3">None identified</td></tr>
</table>

Research Topic	*C22: New pedestrian and bicyclist traffic data sources*
Overview	With increasing bicycle and pedestrian activity, efforts to better measure these activities are developing. Observed counts at limited sets of locations continue to provide most of our information on bicycling and pedestrian activity at the facility level. With the advent of big data, there are many emerging data sources (third-party apps, bike share) but research is needed to establish the accuracy and consistency of new data sources, including comparing new sources to existing data sources. Research is also needed to assess potential sources of bias. Limited research has focused mainly on bicycle volumes, and a gap exists in pedestrian data acquisition from these datasets. There are several ongoing research projects in this area. This research could be combined with topic C20 (*Methods to estimate pedestrian and bicycle travel from limited counts*) to assess broader count program future needs.
Research Objectives	Research in this area should address the following objectives: • Review and document the existing non-count data sources (e.g., cellular/device data, crowdsourced, bike share) and summarize the existing research findings. • Evaluate the emerging data sources for accuracy, coverage, completeness, and representativeness consistency under various conditions (e.g., weather, usage levels/volumes, etc.). • Investigate to what extent the new data source sample demographics overlap with overall bicyclist and pedestrian demographics. • Determine sampling rates of user data and examine the stability of these rates over time. • Investigate the correlation between the derived counts or volume estimates and observed counts. Determine the factors that affect the correlation. • Determine the overlap that exists between different data sources and the marginal value each of these data sources may add in predicting bicycle and pedestrian volumes.
Research Type	 
Research Review	Bicycle and pedestrian data: Emerging user-based data Bicycle and pedestrian data: Location-based counts
Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process **Other:** FHWA; UTCs; Transportation Pooled Fund

Research Timeline	***2021 – 2022***	***2023 – 2026***	***2027 and later***
	Scope and initiate research Monitor and coordinate with NCHRP 07-31	Complete and implement research	Evaluate new and updated data sources; assess if tool revisions are necessary
Research Partners	**AASHTO Committees**: Data Management and Analytics **TRB Committees**: Pedestrians; Bicycle Transportation **US DOT**: FHWA **Other organizations**: MPOs		
Related Projects	***Description/Connection***		***Status***
	NCHRP 07-31: State DOT Usage of Bicycle and Pedestrian Data: Practices, Sources, Needs, and Gaps		
	NCHRP 07-31 will include cataloguing and emerging AT datasets and applications, and identifying gaps between data availability and state DOT needs.		Anticipated start, 2021
	NCHRP 17-102: Safety Performance for Active Transportation Modes using Exposure Models		
	Monitor this anticipated research into improved exposure models for active transportation, which is likely to consider new and emerging data sources as model inputs.		Anticipated start, 2021-22
	FHWA, Guide to Using Alternative Data Sources to Enhance Police Crash Reporting; Crash Exposure Estimation for Nonmotorized Trips for Systemic Safety Applications		
	Research on this topic should coordinate with these projects described in FHWA's *Pedestrian and Bicycle Safety Program Strategic Plan*.		Anticipated, 2021-2022
Other Ongoing Research	NC DOT: Bicycle Volume: Counting Machine Validation & Correction, Estimating & Forecasting, and Analysis of Injury Risk (Start 2019, End 2020). NITC (UTC): Exploring Data Fusion Techniques to Derive Bicycle Volumes on a Network (Start 2019, End 2020).		
Related RNSs	None identified		

Research Topic	*C26: Refinement of pedestrian and bicyclist crash types*		
Overview	Crash typing is used to describe events and movements prior to a crash. These are typically available to characterize motor vehicle crashes but for pedestrian- and bicycle-involved crashes, these details are not available or must be constructed using multiple variables. Crash typing is necessary for improved crash analysis and planning for safer networks. Some recent work has been done on bicycle crash typing, but more research is needed for adoption of consistent typing methods at the national and local levels.		
Research Objectives	This research should address the following objectives: • Review the existing methods to categorize the types of motorist-bicyclist and motorist-pedestrian collisions. • Summarize the top crash types for motorist-bicyclist and motorist-pedestrian collisions. • Outline a consistent method for crash typing that states can adopt. • Improve the consistency of regional, statewide and national active transportation data practices.		
Research Type			
Research Review	Bicycle and pedestrian data: Safety		
Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process **Other:** FHWA		
Research Timeline	***2021 – 2022***	***2023 – 2026***	***2027 and later***
	Scope and initiate research	Complete and implement research	Monitor application of research
Research Partners	**AASHTO Committees:** Safety **TRB Committees:** Pedestrians; Bicycle Transportation; Safety Performance and Analysis **US DOT:** FHWA		

Related Projects	*Description/Connection*	*Status*
	NCHRP 07-31: State DOT Usage of Bicycle and Pedestrian Data: Practices, Sources, Needs, and Gaps	
	While not focused on crash types, this research should cover data collection and storage practices, including crash data.	Anticipated start, 2021
Related RNSs	RNS: Better Reporting of Bicycle Movements Prior to Crash (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=42356	

Other data research needs

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D11: Developing site selection criteria for continuous and short-duration pedestrian and bike count locations	Bicycle and pedestrian data: Location-based counts	State of the Practice for Funding, Accessing, and Using Traditional and Emerging Active Transportation Data (ACH10, Pedestrians)	NCHRP 07-31: State DOT Usage of Bicycle and Pedestrian Data: Practices, Sources, Needs, and Gaps (Start 2021)
D31: Improving data on pedestrian and bicyclist crashes not involving motor vehicles, including on trails	Bicycle and pedestrian data: Safety	Better Reporting of Bicycle Movements Prior to Crash (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=42356 Creating and Integrating Relevant Nonmotorized Datasets (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=42354 State of the Practice for Funding, Accessing, and Using Traditional and Emerging Active Transportation Data (ACH10, Pedestrians)	NCHRP 07-31: State DOT Usage of Bicycle and Pedestrian Data: Practices, Sources, Needs, and Gaps (Start 2021)
D42: QA/QC standards for pedestrian and bicycle count data, including in different contexts, volumes, etc.	Bicycle and pedestrian data: Location-based counts	State of the Practice for Funding, Accessing, and Using Traditional and Emerging Active Transportation Data (ACH10, Pedestrians)	NC DOT: Bicycle Volume: Counting Machine Validation & Correction, Estimating & Forecasting, and Analysis of Injury Risk (Start 2019, End 2020) NCHRP 07-31: State DOT Usage of Bicycle and Pedestrian Data: Practices, Sources, Needs, and Gaps (Start 2021)

Research Needs: Design

Highest Priority: Research Problem Statements

A2 Using minimum accommodations vs. alternative approaches to increase active transportation.

A3 Determining context-driven optimal spacing between marked crosswalks.

High Priority: Research Need Briefs

B4 Designs to improve safety at shared-use path intersections.

Medium Priority: Research Need Briefs

C12 Guidance on bicycle signal timing and design.

C15 Improved pavement markings to make road users aware of bicycles and pedestrians.

C23 Pedestrian crossing treatments and transit: safety and design.

C25 Quantifying the active transportation facilities that would benefit from retrofits.

C31 Spacing and types of separated bike lane vertical elements: safety and operations.

Lower Priority

D2 Bicycle signals: face design, bicyclist and driver comprehension and compliance.

D3 Bicycle signals: user comprehension and safety of permissive phasing.

D8 Deployment and effectiveness of emerging urban street and intersection design guides.

D9 Design and operations strategies to promote social/physical distancing of pedestrians during pandemics.

D10 Design of bicycle facilities to accommodate different bicycle types (e.g., cargo bikes, adult tricycles, etc.).

D20 Guidance on adequate physical distancing for active transportation modes to reduce exposure to viruses.

D36 Optimal bicycle wayfinding signs and pavement markings.

D37 Optimal methods to communicate allowable, protected, or permissive movements to bicyclists at signalized intersections.

D45 Rumble-strip design impacts on active transportation users.

D46 Safety and design considerations to accommodate the increasing use of e-bikes.

Problem Title	*A2: Using minimum accommodations vs. alternative approaches to increase active transportation*
Background	A common approach used in transportation engineering and design is to set minimum accommodations or guidelines, such as a minimum width for a sidewalk or bike lane or a minimum number of bike parking spaces. Such guidelines provide for a basic level of infrastructure quality in cases where they are applied. The concept is also used at the planning level, such as some Complete Streets policies that specify minimum accommodations for pedestrians and bicycles. This approach is attractive to some practitioners because it is clear and simple. However, the minimum accommodations are frequently used by designers as the default or preferred width, despite the fact that these widths are unlikely to provide a level and quality that will increase the use of walking, bicycling, and rolling significantly, particularly among all types of users and in areas where greater walking, bicycling, and rolling activity is possible. Going above such guidelines may require knowledge or expertise that designers and decision-makers lack. In addition, the existence of such minimums may give decision-makers greater ability to reject higher-quality designs, even if designers propose them.
Literature Search Summary	There is very limited research on the effects of minimum accommodations and standards on the provision of active transportation infrastructure. Schultheiss, Sanders, and Toole (2018) documented the changes in standards in the AASHTO Bike Guide and how that guidance was not always based on strong empirical evidence. A review of the Oregon Department of Transportation's (ODOT) implementation of the state's requirement to devote a minimum of 1% of project expenditures on bicycle and pedestrian projects found that the requirement acted more like a ceiling rather than a floor, with spending averaging just 1.1% over 30 years (Hagedorn, 2020). Lessons from experience in using Performance-based Practical Design (PBPD) may also be useful. PBPD uses a "design up" approach that relies more on engineering judgment to identify improvements to meet project and system objectives. Decisions are based on performance analysis (FHWA, 2017; Mooney, 2015). Existing research on different decision-making methods may inform this research. For example, multicriteria decision-making techniques consider multiple criteria using both quantitative and qualitative data. A recent research review found applications across the transportation sector, though it was used more for project selection than project design (Yannis et al., 2020). A current project, NCHRP 15-78 Guidebook for Urban and Suburban Roadway Cross-Sectional Reallocation, may provide some research related to this topic, including alternative approaches. The project's objective "is to develop a guidebook and decision-making framework for roadway designers, planners, and others for identifying, comparing, evaluating, and justifying context-based cross-sectional reallocations of existing urban and suburban roadway space for multimodal safety, access, and mobility." The project began in June 2020.
Research Objective	The objective of this research is to understand (1) how and why the use of such minimum accommodations limits active transportation, and (2) what alternative

approaches would better serve all users. The research aims to understand this in different contexts, with a focus on the design and engineering of roadways and intersections.

Reasons for relying solely on minimum approaches may include a lack of staff knowledge, higher-level support, or policy. Funding sources or levels also likely play a role, though may also be evidence of a lack of higher-level support and policy decisions. A project's purpose and need statements may also be a factor if it does not include active travel.

Possible components of alternative approaches include:

- Basing decisions on desired performance. In such an approach, an agency would set an objective for what they want to achieve with respect to active travel (e.g., specific pedestrian and bicycle mode shares) and use guidance and research to design a solution to accommodate that performance goal. That objective could also be based on certain "design users" or, for example, on having most people of younger and older ages feel comfortable using the facility (e.g., "all ages all abilities" or "eight to eighty").
- Analyses that clearly indicate who would be accommodated with the minimum guidelines (e.g., what percentage of the population would feel comfortable using the facility walking, bicycling, or rolling) and how that would change with different designs.
- A safe-systems approach that includes expectations for safety outcomes. This would explicitly acknowledge that some users are at higher risk.
- Changing the language and framing. Under this approach, agencies would set preferred levels of accommodation and lower values that would only be used in constrained conditions.

Research tasks would include the following:

1. A review of existing research on minimum accommodations, design guidelines, and alternative decision-making techniques.
2. Empirical research to assess how the use of such minimum accommodations has affected the provision of infrastructure for active transportation in the U.S. and why agencies do not exceed minimums. This research could involve case studies, surveys of practitioners, or other data collection approaches. The research should identify the reasons for not exceeding minimums, including the extent to which this is due to a lack of research versus a lack of *awareness* of research that would justify better accommodations.
3. Identification and evaluation of alternative approaches, or ways of presenting guidelines, that would better serve all active transportation users in the design of roadways and intersections. The approaches should be context-specific and include consideration of factors such as stormwater and green infrastructure design. The research should draw on examples in the U.S. as well as other countries.
4. Produce a report with the findings of the empirical research, including options for addressing the reasons agencies do not often exceed the minimums. These may include, but are not limited to, technology transfer efforts to

	expand the use of existing research and guidance, developing new research to address gaps, changing agency culture, increased funding, and policy change. Develop a guidebook that explains the advantages and disadvantages of minimum accommodations and provides guidance on alternative approaches. This would include case studies. The final report and guidebook would be key tools for implementation. In addition, the results of the project could be a good candidate for the NCHRP Implementation Support Program (Project 20-44) to develop training or pilot projects to implement alternative approaches.
Urgency and Potential Benefits	The results of the research would provide agencies with evidence on the effects of relying on minimum accommodations and alternatives to that approach. If a move away from minimum-width facilities would likely lead to improved safety and comfort for people on foot and bicycles and higher levels of active travel.
Implementation Considerations and Supporters	The research could be used to change agency-wide policies and guidelines, which would be used by state DOT staff who are planning and designing new roadways and roadways undergoing reconstruction. Pilot testing, training and workshops would help further implementation. The CAT could collaborate with the following AASHTO committees on the statement: JNMTC/Design, Planning, Environment & Sustainability.
Recommended Research Funding and Research Period	$500,000 24 months
Problem Statement Author(s)	Jennifer Dill, Portland State University Christopher Monsere, Portland State University Jeremy Chrzan, Toole Design Group
References	Federal Highway Administration (2017). *Start-up Guide: Performance-Based Practical Design*, FHWA-HIF-17-026, March 1, 2017. https://www.fhwa.dot.gov/design/pbpd/ Hagedorn, Hau (2020), *Policy Implications of ORS 366.514 – The Oregon Bike Bill*, eMPA Capstone project, Portland State University. Mooney, Robert (2015). Performance-Based Practical Design: Maximizing System Performance by Rethinking Design Decisions. *ITE Journal*, 85 (12): 38-42. Schultheiss, W., Sanders, R. L., & Toole, J. (2018). A historical perspective on the AASHTO guide for the development of bicycle facilities and the impact of the vehicular cycling movement. *Transportation Research Record*, 2672(13), 38-49. Yannis, G., Kopsacheili, A., Dragomanovits, A., & Petraki, V. (2020). State-of-the-art review on multi-criteria decision-making in the transport sector. *Journal of Traffic and Transportation Engineering (English edition)*, 7(4): 413-431.

Problem Title	*A3: Determining context-driven optimal spacing between marked crosswalks*
Background	There were 6,205 pedestrian fatalities in the U.S. in 2019, down slightly from 2018, but still up 51% from 2009 (NHTSA, 2020). Pedestrian fatalities are projected to account for 17% of all traffic fatalities in 2019. Most pedestrian fatalities take place on local roads and away from intersections, highlighting a critical need for safe crossings. A key question, informed by the desire for persons walking or rolling to take the shortest path from their origin to their destination, is how often to provide safe crossings. Absent a suitable crossing opportunity, pedestrians may cross at locations where they are more at risk of injury. Increasing crossing opportunities for pedestrians can help improve pedestrian safety by attracting pedestrians to crossings that have been appropriately designed. Different contexts also give rise to varying levels of walking trips, crossing needs and risk. Prior research found that 25% of the pedestrians stated that they will travel 550 feet and 50% stated that they will travel 200 feet out of their way to access a marked crosswalk (NPTS, 1995). The quality of the crossing (unmarked vs. marked vs. enhanced), type and number of destinations, number of lanes, and traffic speed all likely play role in the expected diversion distance. Research is needed to fulfil this fundamental knowledge gap.
Literature Search Summary	Pedestrians interact with the environment at a ground level and have frequent demand for accessing destinations (NACTO). According to the Manual on Uniform Traffic Control Devices (MUTCD), crosswalk markings provide guidance for pedestrians who are crossing roadways by clearly defining and delineating paths for them to cross at controlled intersections. They are also used to alert road users of potential crossing pedestrians at uncontrolled locations. The MUTCD, however, does not provide guidance on the spacing between crosswalks except to suggest that an engineering study be conducted before a marked crosswalk is installed at an uncontrolled location (Section 3B.18). An important consideration to note is that providing marked crosswalks alone may not be sufficient to improve pedestrian safety, especially on multilane roadways with high traffic volumes, and enhancements are necessary at these locations (Zegeer et al., 2002). According to NACTO guidance, pedestrian crossings should be located based on current or projected pedestrian desire lines, the pedestrian network, and the built environment. NACTO recommends providing pedestrian crossings every 80-100 meters (262-328 feet) in urban environments and states that if it takes a person more than three minutes (630 feet assuming pedestrian speed of 3.5 feet/second) to walk to a pedestrian crossing, then they may cross along a more direct and unprotected route. Other agencies have adopted a minimum spacing distance which ranges from 200-600 feet between crosswalks. The City of Portland, New York State DOT, and Oregon DOT are the few agencies that provide guidance on spacing based on land use context. The City of Portland's guidelines suggest a desired spacing of 530 feet inside pedestrian districts, 800 feet outside of pedestrian districts, and within 100 feet of all transit stops (Ped PDX Plan). NYSDOT recommends a spacing of 100-150 meters (328-492 feet) in central business districts based on density, and not to exceed 0.4 kilometers (1,312 feet) in urban or

	suburban residential/retail areas based on density or land use, and as needed in low-density rural centers and seasonal use areas (NYSDOT Highway Design Manual, 2017). The Oregon DOT recommends placing crossings between 250-550 ft within CBD's and urban mix contexts, between 500-1000 ft along residential and commercial corridors, between 750-1,500 ft in suburban areas and between 250-750 ft in rural areas (ODOT, 2020). There is a wide variation in recommendations and, moreover, these figures are not grounded in research. In addition to spacing, the quality of the crosswalk and the crossing experience is also critical to pedestrians' perception of safety and comfort, and is likely associated with diversion distance. There is a critical need to conduct research to develop pedestrian crossing spacing guidance based on factors such as land use, pedestrian and vehicle volumes, density, facility type, speed limit, and road geometry.
Research Objective	The objective of this research is to take a holistic look at pedestrians' crossing experience to provide guidance for agencies on appropriate pedestrian crossing spacing under a variety of contexts. The goal is to determine how far pedestrians are willing to divert to a higher-quality crossing to improve their crossing experience under various contexts in order to develop spacing guidance between crosswalks, while considering various factors such as land use, transit stops, facility type, speed limit, geometry, and vehicle and pedestrian volumes. The research should consider the effectiveness and the quality of the crossing under different contexts. This research should include the following tasks: 1. Review of the literature and agency manuals to understand the current pedestrian crosswalk provision guidance, including current minimum and maximum spacing guidance for marked crosswalks. The review should also include factors affecting crosswalk compliance and safety. 2. Conduct a state-of-practice survey or targeted interviews to explore the factors agencies use to determine the type of crossing and spacing between marked crosswalks. The objective of this task is to determine how the existing guidance was developed, decision variables (e.g., type of crosswalk, spacing, location, land use, sight distance and visibility of nearby crosswalks, lighting, geometry, vehicle speeds, volumes, number of travel lanes, gaps in traffic, vehicle mix) and if any research was conducted to develop the guidelines. 3. Collect data on the maximum distance pedestrians are willing to deviate from their path to access a higher-quality crosswalk and explore how the distance varies by context. This data may be observational or simulated, or a combination. 4. Develop a guidebook to reflect guidance on the provision of pedestrian crossings, including type and minimum and maximum spacing based on context, safety, and compliance.
Urgency and Potential Benefits	This research has the potential to improve pedestrian safety and comfort by providing guidance on the quality of crossing and spacing between crossings across a variety of contexts (urban vs. rural, different facility types). Additional benefits include improved transit access and permeability of arterials or similar roads, which can support walking

	and bicycling on neighborhood streats. Agencies can use this guidance to provide additional crossing opportunities for pedestrians, thus improving pedestrian infrastructure.
Implementation Considerations and Supporters	The results of this research will be used by agency designers to design new crossings, which will increase legal crossing opportunities for pedestrians, thereby potentially reducing their risky behaviors. The CAT could collaborate with the following AASHTO committees on the statement: JNMTC/Design.
Recommended Research Funding and Research Period	$600,000 36 months
Problem Statement Author(s)	Sirisha Kothuri, Portland State University Chris Monsere, Portland State University Jeremy Chrzan, Toole Design Group
References	FHWA (2009). *Manual of Uniform Traffic Control Devices* (MUTCD). NACTO (2013). *Urban Street Design Guide*. https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/crosswalks-and-crossings/ FHWA (1995). *Nationwide Personal Transportation Survey*. New York State DOT (2017). *Highway Design Manual*, Pedestrian Facility Design. https://www.dot.ny.gov/divisions/engineering/design/dqab/hdm/hdm-repository/chapt_18.pdf NHTSA (2020). *Traffic Safety Facts 2019*. Research Note https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813060 Oregon Department of Transportation (2020). Blueprint for Urban Design. https://www.oregon.gov/ODOT/Engineering/Documents_RoadwayEng/Blueprint-for-Urban-Design_v1.pdf Portland Bureau of Transportation (2019). *PedPDX*. https://www.portlandoregon.gov/transportation/78224 Zegeer, C., Stewart, R., Huang, H., Lagerway, P., Feaganes, J., and Campbell, B.J. (2002). *Safety Effects of Marked versus Unmarked Crosswalks at Uncontrolled Locations*. FHWA-HRT-04-100 https://www.fhwa.dot.gov/publications/research/safety/04100/04100.pdf

Research Topic	*B4: Designs to improve safety at shared-use path intersections*
Overview	Shared or multiuse paths invite a wide range of users, including pedestrians, bicyclists, and other wheeled users, with a range of transportation purposes such as commuting, exercise, and recreation. For rail-adjacent paths, the crossings may also include traversing railroad tracks. Absent adequate accommodations, shared-use path crossings can present users with complex tasks including gap selection, scanning for turning vehicles, and interacting with other path users. Ensuring safe crossings for all users at these locations is essential. There is a large body of research on the effectiveness of enhanced crossing features for pedestrian-only crossings. Pedestrian-activated yellow flashing beacons, usually in combination with high-visibility crossings or advance yield markings, refuge median islands, rapid rectangular flashing beacons (RRFBs), and pedestrian hybrid beacons (PHBs) have all been shown to increase driver yielding rates and pedestrian safety. Additional enhancements and design elements such as signing, markings, and geometry can also be used at these crossings. While some or all of these tools translate to shared-use path crossings, it is not clear how to integrate treatments for different types of path users, road classifications, land-use contexts, and crossing geometries. Overall, there is limited guidance for treatment selection, particularly for paths next to railroads. Research is needed to identify contextually appropriate designs, and which design elements and tools practitioners should use in the shared-use path environment.
Research Objectives	Research in this area would likely include best practice scans, particularly to better document and understand how to safely implement shared-use path crossings in a wide variety of different state, land use, and roadway and path contexts. New empirical research may also be needed to confirm or validate typical designs and treatments. The research should seek to address the following: • Develop a design toolbox, including retrofit improvements, that is context sensitive and distinguishes how to assess and apply treatments at intersections of paths on all roads, including midblock crossings, and for different path user types. This toolbox would benefit from detailed case studies, including urban, suburban and rural, and guidance on appropriate performance measures for evaluating improvements (e.g., driver yielding, conflicts, crashes). • How best to design and accommodate people of all ages and abilities - ages, socioeconomic groups, mobility devices, types of bikes, visual acuity, and preferred speeds. • How to design intersections now to plan for changes in technology that can help mitigate conflicts with trail users.
Research Type	 Empirical Data  Best Practices

<table>
<tr><td>Research Review</td><td colspan="3">Bicycles at intersections: Design and safety</td></tr>
<tr><td>Potential Funding Pathways</td><td colspan="3">TRB Cooperative Programs: NCHRP regular process
Other: FHWA</td></tr>
<tr><td>Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td></td><td>Scope and initiate research
Monitor and coordinate with NCHRP 03-141</td><td>Complete and implement research</td><td>Monitor application of research</td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Design/JTCNMT; Safety
TRB Committees: Pedestrians; Bicycle Transportation
US DOT: FHWA
Other organizations: Rails-to-Trails Conservancy</td></tr>
<tr><td>Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td></td><td colspan="3">NCHRP 03-141: Midblock Pedestrian Signal Warrants and Operation</td></tr>
<tr><td></td><td colspan="2">This research will focus on when signals are suitable for midblock crossings.</td><td>Start 2021</td></tr>
<tr><td></td><td colspan="3">NCHRP 17-97: Strategies to Improve Pedestrian Safety at Night</td></tr>
<tr><td></td><td colspan="2">This research may touch on lighting for shared-use path intersections.</td><td>Anticipated 2021</td></tr>
<tr><td></td><td colspan="3">FHWA, Outreach and Awareness Program on Strategies to Enhance Pedestrian and Bicyclist Safety at Intersections</td></tr>
<tr><td></td><td colspan="2">Research on this topic should coordinate with this project described in FHWA's Pedestrian and Bicycle Safety Program Strategic Plan.</td><td>Anticipated, 2021-2022</td></tr>
<tr><td>Related RNSs</td><td colspan="3">Traffic Control at Shared-Use Path Road Crossings (ACH20, Bicycle Transportation)
https://rns.trb.org/dproject.asp?n=38925
Intersection Sight Distance for Bicyclists (ACH20, Bicycle Transportation)
https://rns.trb.org/details/dproject.aspx?n=43238
Evaluation of Pedestrian Crossing Design Practices Based on User Behavior and Psychology (ACH10, Pedestrians).</td></tr>
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Research Topic	*C12: Guidance on bicycle signal timing and design*
Overview	It is expected that the appropriate design and operation of traffic signals can improve safety for people on bicycles by separating or managing conflicts between people driving motor vehicles and riding bicycles at intersections. Left- and right-turning motor vehicles are one of the key factors in bicycle crashes at intersections. There is a need to understand the safety and operational impacts of permissive motor vehicle turns across the bicycle facility, especially left turns. While bicycle signals draw many parallels with signals for motorists, there are unique design aspects due to the human scale and performance issues involved. Some basic questions about the most appropriate size, placement, and visibility distance of bicycle signals and arrangement of signal heads could aide designers in designing safer intersections. More broadly, additional guidance is needed to inform signal timing parameters and phase selection. At urban intersections with more users, higher volumes, and more opportunity for conflict, designs require appropriate selections of fully protected, concurrent, leading, or split bicycle signal phases. Timing of clearance intervals needs additional data on the wide range of bicycle performance and other mobility devices. Appropriate and timely detection of bicycles s may also be important at some intersections, both on the approach and in the stopped condition. Strategies that limit the available green time and impose excessive delay for people on bicycles typically result in compliance issues.
Research Objectives	Research in this area would be designed to improve understanding of the safety effects of signal timing strategies for persons on bicycles. The research should focus on crash or conflict outcomes, and to a lesser extent compliance (which is often used as a proxy for safety at intersections but the safety relationship is likely weak). In addition, the research should seek to inform optimal design, placement, phase selection, and timing parameters of bicycle signals. The research would consider the influence of the number of bicycle signal heads per approach; near- and far-side installations; size of indication (4-, 8-, or 12-inch); horizontal and vertical distance of bicycle signals to motorist signals; presence of louvers and backplates; and the distance from bicycle stop line to bicycle signal. As part of this research, some consideration would be given to the comprehension of people driving and using electric mobility devices (e.g., scooters, hoverboards, etc.)
Research Type	  
Research Review	Bicycles at intersections: Design and safety
Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process **Other:** FHWA process

Research Timeline	*2021 – 2022*	*2023 – 2026*	*2027 and later*
	Scope and initiate research Monitor NCHRP 03-133	Complete and implement research	Monitor application of research
Research Partners	**AASHTO Committees**: Design/JTCNMT; Traffic Engineering **TRB Committees**: Bicycle Transportation; Traffic Signal Systems **US DOT**: FHWA		
Related Projects	***Description/Connection***		***Status***
	NCHRP 03-133: Traffic Signal Design and Operations Strategies for Non-Motorized Users		
	Monitor report to identify which gaps are filled and which remain.		Publication pending
	NCHRP 15-73: Design Options to Reduce Turning Motor Vehicle – Bicycle Conflicts at Controlled Intersections		
	This project will not focus on bicycle signals, but may have some findings relevant to treatment selection.		Start 2020, End 2023
Other Ongoing Research	DC DOT: Pedestrian and Cyclist Intersection Safety Sandbox (Start 2020, End 2022).		
Related RNSs	None identified		

Research Topic	***C15: Improved pavement markings to make road users aware of bicycles and pedestrians***
Overview	Research has found that intersection pavement markings of bike lanes and green-colored lane markings have generally positive effects on bicycle intersection safety performance. The majority of research has focused on the areas at the intersection where bike lane traffic may conflict with motor vehicles. Research in the U.S. context has consistently found the use of green-colored pavement markings increases motorist awareness of bicycle facilities, with some evidence showing increased driver yielding. Bike lane extensions, which are intended to increase motorist awareness of bicycle presence at the intersection and predictability of bicyclist location, have the potential to improve safety. Bike boxes encourage bicyclists to wait in positions that are more visible to motorists at intersections and out of the path of turning vehicles, and evidence suggests that their use reduces conflicts. Studies of shared lane markings, or sharrows, indicate that they may influence cyclists' position on the road, but there is no evidence of a reduction in crashes or injuries. Use of sharrows for route wayfinding is also used in practice but has not been studied. New research on edge lane roads in low-volume conditions suggests a safety improvement for all road users. There are knowledge gaps for pavement marking strategies at minor intersections, driveways, midblock segments, and low-volume shared roadways. Pavement markings to improve bicyclist awareness of pedestrians is also a research need. Few of the studies we reviewed examined how different intersection designs work for particular subgroups that might warrant special consideration, such as children, older adults, or pedestrians with vision disabilities.
Research Objectives	Research would need to include best practice scans to more fully define the context and questions that are faced in selecting the most appropriate marking strategies. Maintenance requirements (especially for winter-weather locations), costs, and placement strategies and the relationship to other signs and warning devices, should be included in the review. New empirical research is needed to establish quantitative crash modification and volume thresholds for selecting various treatments. Research designs could also include how human factors work to confirm or validate conceptions about driver and bicyclist detection and response to a variety of designs. The research should seek to improve consistency in application and identify volume thresholds for selecting various treatments as key issues.
Research Type	 Empirical Data  Best Practices
Research Review	Bicycles at intersections: Design and safety Bikeways: Safety and design Pedestrian crossings: Design and safety

Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process **Other:** FHWA		
Research Timeline	***2021 – 2022***	***2023 – 2026***	***2027 and later***
	Scope and initiate research Monitor and coordinate with NCHRP 15-73 and 15-74	Complete and implement research	Monitor application of research
Research Partners	**AASHTO Committees**: Design/JTCNMT **TRB Committees**: Pedestrians; Bicycle Transportation; Traffic Control Devices **US DOT**: FHWA		
Related Projects	***Description/Connection***		***Status***
	NCHRP 15-73: Design Options to Reduce Turning Motor Vehicle – Bicycle Conflicts at Controlled Intersections		
	NCHRP 15-73 should be monitored and may touch on markings related to bicycles at intersections.		Start 2020, End 2023
	NCHRP 15-74: Safety Evaluation of On-Street Bicycle Facility Design Features		
	NCHRP 15-74 should be monitored and may touch on markings related to bicycles.		Start 2020, End 2023
Other Ongoing Research	MNDOT: Pavement Marking Patterns and Widths – Human Factors Study (Start 2019, End 2021).		
Related RNSs	None identified		

Research Topic	*C23: Pedestrian crossing treatments and transit: safety and design*
Overview	Pedestrian crossings near transit stops are associated with a higher pedestrian crash risk. Prior research has found lower driver yielding rates near transit stops. In some jurisdictions, the provision of safe crossings is required near transit stops. While TCRP 175 "Guidebook on Pedestrian Crossings of Public Transit Rail Services" could be a helpful resource for this research, it is focused solely on pedestrian crossings near rail stations. Research gaps exist around bus stops specifically, and around facility prioritization, such as type of bus stop, and design elements such as floating bus stops and use of bus bulbs. Research should also examine the impact of high-visibility enforcement and education on safety.
Research Objectives	Research objectives include the following: • Explore driver yielding behavior near transit stops and identify factors that affect yielding. • Compare driver yielding behavior and pedestrian crash risk by bus stop location (e.g., near side, far side, and midblock) • Determine what design mitigations are available to improve safety for crossing pedestrians near transit stops and explore how these impact safety across various land use contexts (urban, suburban, rural). • Consider effectiveness of bus bulbs and floating bus stops in reducing risk to pedestrians crossing. • Explore the impact of micromobility station placement in relation to transit stops and conflicts between different types of users. • Develop best practices for pedestrian crossing safety treatments around transit stops. • Explore inter- and intra-agency barriers for designing and maintaining crossing treatments near transit stops. • Develop best practices to integrate ADA accommodations at stops, approaches to stops, and at crossings.
Research Review	Pedestrian crossings: Design and safety
Research Type	 
Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process; TCRP

Research Timeline	***2021 – 2022***	***2023 – 2026***	***2027 and later***
	Scope and initiate research	Complete and implement research	Monitor application of research
Research Partners	**AASHTO Committees**: Design/JTCNMT; Safety; Planning **TRB Committees**: Pedestrians **US DOT**: FHWA, FTA		
Related Projects	***Description/Connection***		***Status***
	TCRP Project J-07, Topic SD-06 Synthesis of Information Related to Transit Practices. Transit Agency Relationships and Initiatives to Improve Bus Stops		
	The objective of this synthesis report is to assess the relationships and vision between transit agencies and governmental agencies to improve bus stops and their pedestrian access.		In Progress
	NCHRP 03-143: Warrants for a Pedestrian Traffic Control Signal and for Other Pedestrian Traffic Control Devices		
	Focused more on class of treatment generally, this project should provide some insight into crossing treatment selection at transit crossings.		Start 2021-22
	FHWA, Enhancing Highway Safety Manual Guidance on Pedestrian and Bicyclist Countermeasures (CMF/SPF Development); Guidebook on Treated Crosswalk Spacing and Treatment Selection		
	Research on this topic should coordinate with these projects described in FHWA's *Pedestrian and Bicycle Safety Program Strategic Plan*.		Anticipated, 2021-2022
Related RNSs	Pedestrian Crossing Spacing Guidance (ACH10, Pedestrians) https://rns.trb.org/details/dproject.aspx?n=43172 Safety Effectiveness Assessment of Advanced Rail/Highway Grade Crossing Improvements (AR030, Railroad Operating Technologies) https://rns.trb.org/details/dproject.aspx?n=42552 Evaluation of Pedestrian Crossing Design Practices Based on User Behavior and Psychology (ACH10, Pedestrians).		

Research Topic	***C25: Quantifying the active transportation facilities that would benefit from retrofits***
Overview	Even when a roadway or intersection has active transportation facilities or accommodations, they may still be inadequate to provide a safe and comfortable experience for pedestrians and bicyclists. Facilities may not have been built to guidelines at the time of construction, may have deteriorated, rendered outdated by current engineering guidance and best practices, or may no longer support the current or expected traffic on a facility. Examples include facilities that are too narrow for volumes of pedestrians or bicyclists, or do not provide enough separation from traffic to provide the desired level of comfort. Retrofits may also allow for the integration of multimodal transportation accommodation and green infrastructure design. Agencies need guidance on prioritizing investments and facility upgrades, including understanding which facilities may have a detrimental impact on user safety or comfort and which investments may offer the best value.
Research Objectives	Research could provide guidance on prioritizing improvements and retrofits to existing facilities, including potential safety and comfort benefits, and provide a methodology for weighing these benefits against project costs and alternative projects/investments. The project may include a systematic research review to identify: • Which facilities or applications have detrimental safety impacts? • Which updates are likely to represent the greatest benefits in terms of improved safety or the potential to contribute to a more comfortable experience (including closing network gaps) and lead to increased walking, biking, or rolling activity? The latest research on safety and ridership impacts of active transportation facilities would be important to consult. • Are there updates that should be completed in a specific order, such as ensuring that there are safe crossings before (or coincident with) installing segment-level improvements? • What existing guidance is most applicable to these types of prioritization activities? • What temporary facilities have positive safety and comfort benefits? This research scan could be coupled with a survey of best practices on facility improvements and prioritization. A research product would include guidance on investments in active transportation facilities upgrades, and a proposed methodology to prioritize investments.
Research Type	 

<table>
<tr><td>Research Review</td><td colspan="3">Bicycles at intersections: Design and safety
Bikeways: Ridership and demand
Pedestrian crossings: Design and safety
Policy, planning and decision-making</td></tr>
<tr><td>Potential Funding Pathways</td><td colspan="3">TRB Cooperative Programs: NCHRP regular process
Other: FHWA</td></tr>
<tr><td rowspan="2">Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td>Scope; Initiate research review and best practice scan</td><td>Finalize review/scan and develop guidance/methods materials</td><td>Monitor application of research; update with new research</td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Design/JTCNMT; Planning; Environment and Sustainability
TRB Committees: Pedestrians; Bicycle Transportation
US DOT: FHWA
Other organizations: Local DOTs</td></tr>
<tr><td rowspan="3">Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td colspan="3">NCHRP 08-149: Impacts of Active Transportation Network Gaps,</td></tr>
<tr><td colspan="2">Upcoming NCHRP 08-149 Impacts of Active Transportation Network Gaps could provide relevant findings into identifying gaps or areas where improvements could help.</td><td>Pending, FY 2021</td></tr>
<tr><td>Related RNSs</td><td colspan="3">None identified</td></tr>
</table>

Research Topic	***C31: Spacing and types of separated bike lane vertical elements: safety and operations***
Overview	Vertical elements, including concrete curbs, plastic flex-posts, temporary barriers created by parked cars, and other types, are used to separate general traffic lanes from separated bike lanes. Early research suggests that separated bike lanes are associated with a reduction in bicycle crash risk, particularly for car-overtaking-bike and dooring crashes, when compared to roads with standard bike lanes or no bike facility. They are also viewed as being safer and more comfortable by most people riding bicycles. However, there is little guidance on the selection of vertical element materials, sizes and spacing, safety impacts of different vertical elements, and impacts of vertical element selection on ridership decisions.
Research Objectives	A research project in this area would study factors related to the selection of the vertical element type, size, and spacing of vertical elements for safety and comfort of people on bicycles, as well as motorist comprehension and compliance. Other considerations would include: • Placement/location of vertical elements within the buffer width; • Adjustments based on roadway speeds, volume, lanes and width; • Proximity to driveways and intersections; • Use in or near lane transition areas, such as merging areas or mixing zones; • Bike lane type (one- or two-way), bike volume and access/egress activity; • Presence and turnover of on-street parking; • Maintenance and visibility of different materials and design approaches; • Impacts on transit and curb access, emergency access or event removal capability; and • Implications for accessibility for pedestrians with visual or mobility disabilities. Research should aim to develop CMFs for different vertical separation elements and configurations based on context. Research could also consider impact of various barrier types and implementations on ridership decisions. Study findings could be combined with a summary of existing knowledge to produce design guidance.
Research Type	 Empirical Data  Tech Transfer
Research Review	Bikeways: Safety and Design Bikeways: Ridership and demand
Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process **Other:** FHWA; Transportation Pooled Fund

<table>
<tr><td>Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td></td><td>Explore funding and RNS development; state of practice research</td><td>Conduct research and CMF development</td><td>Research distribution and application</td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Design/JTCNMT; Safety
TRB Committees: Bicycle Transportation
US DOT: FHWA
Other organizations: NACTO</td></tr>
<tr><td>Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td></td><td colspan="3">NCHRP 15-74: Safety Evaluation of On-Street Bicycle Facility Design Features</td></tr>
<tr><td></td><td colspan="2">NCHRP 15-74 should be monitored and will likely fill in some of the gaps on this topic. Gaps around specific barrier types and applications are likely to remain.</td><td>Start 2020, End 2023</td></tr>
<tr><td></td><td colspan="3">NCHRP 22-37: Development of a MASH Barrier to Shield Pedestrians, Bicyclists, and Other Vulnerable Users from Motor Vehicle</td></tr>
<tr><td></td><td colspan="2">This project may provide insight for barrier selection in select circumstances, including on highway and major arterial locations.</td><td>Anticipated completion 2022</td></tr>
<tr><td></td><td colspan="3">FHWA, Enhancing Highway Safety Manual Guidance on Pedestrian and Bicyclist Countermeasures (CMF/SPF Development)</td></tr>
<tr><td></td><td colspan="2">Research on this topic should coordinate with this project described in FHWA’s Pedestrian and Bicycle Safety Program Strategic Plan.</td><td>Anticipated, 2021-2022</td></tr>
<tr><td>Other Ongoing Research</td><td colspan="3">NC DOT: Assessment of Separated Bike Lane (SBL) Applications in North Carolina (Start 2019, End 2021).</td></tr>
<tr><td>Related RNSs</td><td colspan="3">Safety Effectiveness Evaluation of Innovative On-Street Bikeway Designs (OR) Development of Crash Modification Factors and Design Guidelines for Innovative On-Street Bikeway Designs (AFB10, Geometric Design) https://rns.trb.org/dproject.asp?n=42538
Crashworthiness of Barrier Attachments (AFB20, Roadside Safety Design) https://rns.trb.org/details/dproject.aspx?n=42738
Safety Evaluation of Innovative On-Street Bikeway Designs (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=42636</td></tr>
</table>

Other design needs

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D2: Bicycle signals: face design, bicyclist and driver comprehension and compliance	Bicycles at intersections: Design and safety	Optimal Methods to Communicate Allowable Protected, or Permissive Movements to Bicyclists at Signalized Intersections (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=43256 Intuitively Understood Pedestrian Signal Indications (AND40, Visibility) https://rns.trb.org/details/dproject.aspx?n=38905	FHWA: Mainstreaming Best Practices for Nonmotorized Signal Timing Practice to Enhance Multimodal Safety (Anticipated, PBSP Strategic Plan)
D3: Bicycle signals: user comprehension and safety of permissive phasing	Bicycles at intersections: Design and safety	Optimal Methods to Communicate Allowable Protected, or Permissive Movements to Bicyclists at Signalized Intersections (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=43256 Intuitively Understood Pedestrian Signal Indications (AND40, Visibility) https://rns.trb.org/details/dproject.aspx?n=389055	FHWA: Mainstreaming Best Practices for Nonmotorized Signal Timing Practice to Enhance Multimodal Safety (Anticipated, PBSP Strategic Plan)
D8: Deployment and effectiveness of emerging urban street and intersection design guides	Bicycles at intersections: Design and safety Bikeways: Safety and design Bikeways: Ridership and demand Pedestrian crossings: Design and safety	Comprehensive Review and Synthesis of Emerging Urban Street and Intersection Design Guides (AFB10, Geometric Design) https://rns.trb.org/dproject.asp?n=41201	None identified
D9: Design and operations strategies to promote social/physical distancing of pedestrians during pandemics	None	None identified	None identified

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D10: Design of bicycle facilities to accommodate different bicycle types (e.g., cargo bikes, adult tricycles, etc.)	Accessibility for pedestrians and cyclists with disabilities Bikeways: Safety and design Equity and bicycling	None identified	None identified
D20: Guidance on adequate physical distancing for active transportation modes to reduce exposure to viruses	None	None identified	None identified
D36: Optimal bicycle wayfinding signs and pavement markings	Bicycles at intersections: Design and safety Bikeways: Safety and design Bikeways: Ridership and demand	None identified	MNDOT: Pavement Marking Patterns and Widths – Human Factors Study (Start 2019, End 2021)
D37: Optimal methods to communicate allowable, protected, or permissive movements to bicyclists at signalized intersections	Bicycles at intersections: Design and safety	Optimal Methods to Communicate Allowable Protected, or Permissive Movements to Bicyclists at Signalized Intersections (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=43256 Intuitively Understood Pedestrian Signal Indications (AND40, Visibility) https://rns.trb.org/details/dproject.aspx?n=38905	FHWA: Mainstreaming Best Practices for Nonmotorized Signal Timing Practice to Enhance Multimodal Safety (Anticipated, PBSP Strategic Plan)

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D45: Rumble-strip design impacts on active transportation users	Access management and active transportation Bikeways: Safety and design Speed management and active transportation	None identified	NCHRP 17-106: Motorist behavior and safety impacts on bicyclists from centerline and shoulder rumble strips on high-speed two-lane highways (Start 2021-22)
D46: Safety and design considerations to accommodate the increasing use of e-bikes	Bicycles at intersections: Design and safety Bikeways: Safety and design Micromobility, including e-scooters	None identified	None identified

Research Needs: Equity and Accessibility

Highest Priority: Research Problem Statements

A5 Racial and economic disparities in pedestrian and bicyclist safety

High Priority: Research Need Briefs

B5 Equitable representation in active transportation

Medium Priority: Research Need Briefs

C1 Accessible shared street design for pedestrians with vision disabilities

C3 Barriers to bicycling for underserved populations relating to the built environment

C5 Crossing solutions at roundabouts and channelized turn lanes for pedestrians with vision disabilities

C7 Disparities in active transportation use and health outcomes

C13 Guidance on the use of tactile walking surface indicators (TWSIs) at decision points as decision making surfaces

C14 Impact of harassment and violence in reducing active transportation use

C19 Increasing bicycling among women and girls: programs and policies

C24 Programs and policies to overcome barriers to bicycling for underserved populations

Lower Priority

No equity and accessibility needs were in the lower-priority tier.

Problem Title	*A5. Racial and economic disparities in pedestrian and bicyclist safety*
Background	Lower-income people and Black, Indigenous and people of color (BIPOC) experience disproportionate levels of pedestrian crashes, injuries and fatalities. There is limited data on bicycle injury and fatality disparities, although initial research suggests there may be disparities in both safety outcomes and in access to safe and comfortable bicycling facilities. There is a need for further data and analysis on exposure to unsafe conditions, such as high-speed and high-volume arterials, and access to safe facilities, including the differences in access based on income versus race. On the pedestrian side, this would include access to safe and convenient crossings, sidewalks, street lighting, and safe access to transit. On the bike side, this includes comfortable, well-marked routes, crossings, separated facilities or other low-stress facilities. Disparate exposure does not end at traffic safety. Other environmental factors to consider include exposure to harmful air pollution. Are lower-income or BIPOC people walking, bicycling or rolling exposed to different levels of toxins when they walk or bike? Racial bias, whether explicit or implicit, could also play a role in pedestrian and bicycle safety. Does bias have an impact on decisions people make about whether to or where to walk or bike? For example, do people avoid certain streets or areas because they feel they could be subject to undue police attention? Alternatively, do people choose to avoid certain facilities or infrastructure if they don't believe it was built for people like them? Additionally, there is research to suggest that implicit racial bias may result in reduced yielding to BIPOC pedestrians (Goddard et al., 2015; Coughenour et al., 2020), which poses both a direct threat to pedestrians via the immediate non-yielding activity, as well as an indirect threat in that it may reduce safe crossing opportunities and promote unsafe crossing decisions. Finally, there is also a need to better understand the role of underreporting of pedestrians and bicycle exposure and crashes for certain groups, and how that might affect our understanding of pedestrian and bicycling safety disparities. Further analysis is needed to expand our understanding of the various ways that lower-income and BIPOC people walking, bicycling, and rolling face disproportionate safety threats. To be successful, that analysis requires a full understanding of strength, limitations, gaps, and biases of existing data sources, a pathway to improved data practices (including demographic data on safety outcomes), and improved methods of incorporating data on exposure, access to safe facilities, to the direct or indirect effects of bias into safety analyses.
Literature Search Summary	Numerous studies have found an inverse relationship between socioeconomic status and pedestrian injury and fatality risk (e.g., Stoker et al., 2015; Chakravarthy et al., 2010; Guerra et al., 2019; Jermprapai & Srinivasan, 2014; Maciag, 2014; Wier et al., 2009). Black or African American pedestrians and American Indian and Alaska Native pedestrians are more likely to be struck and killed while walking than the overall U.S. rate (GHSA, 2021; Zaccaro et al., 2019). A national study employing data from FHWA, NHTSA, EPA, and the Census Bureau to assess connections between the transportation system, the built environment, and pedestrian fatalities (Mansfield et al., 2018) found strong associations between fatalities and traffic levels on "non-access-

controlled principal arterials in urban areas as well as employment density in the retail sectors in urban and rural contexts." Further research is needed to understand the relationship between these types of areas and factors such as race and income. That study also noted that using different models for urban and rural areas was necessary.

A national study on equity and active transportation in U.S. cities found that non-white people and those with lower socio-economic status may actually have access to more "walkable" environments using a simple metric of density and connectivity, while having access to fewer bike lanes (Braun, 2018). In contrast, a 2012 national study based on walkability audits of over 10,000 street segments in a nationally representative sample of over 150 U.S. communities, found that "people living in low-income communities are less likely to encounter sidewalks, street/sidewalk lighting, marked crosswalks and traffic calming measures such as pedestrian-friendly medians, traffic islands, curb extensions and traffic circles" (Gibbs et al., 2012). However, the study does not take into account pedestrian injury risk factors, including exposure and road characteristics.

Mansfield et al. (2018) noted that better pedestrian activity/exposure data is needed, as pedestrian volumes are not tracked systematically on a wide scale (e.g., across states or nationally). Pedestrian environment characteristics, including sidewalks and crossings, are not available nationally, or even in many regions. Further non-fatal injury data is not tracked in a consistent way. Examples of crash types that are less likely to appear in police records include minor or property damage-only crashes, in which case police are never notified (Imprialou & Quddus, 2019); pedestrian crashes outside the roadway, which may include people walking next to the road (Tarko & Azam, 2011); and crashes not involving motor vehicles (Doggett et al., 2018; Medury et al., 2019).

There is some evidence of disproportionate underreporting of pedestrian crashes for certain groups, such as Black men (Sciortino et al., 2005). However, most studies that have found underreporting of pedestrian and bicycle crashes have not looked at whether such crashes were more likely to involve lower-income or BIPOC pedestrians or bicyclists. Further, there is limited analysis of the impact of such underreporting on our understanding of safety disparities.

While there is evidence of bias in yielding to pedestrians (Goddard et al., 2015; Coughenour et al., 2020), it is not clear what impact this bias has on route choice and exposure, risk-taking, or safety outcomes. Other gaps in the research include separating out the impact of race and income in terms of exposure to traffic and air pollution exposure, as well as safety outcomes.

This research should coordinate closely with:

- NCHRP 08-150 "Valuation of Transportation Equity in Active Transportation and Safety Investments," which is anticipated to begin in 2021-22. The project will likely "develop data driven tools and guidelines for use by practitioners in safety decision making and in supporting Safe System principles." Although 08-150 will focus more on developing tools for practitioners to use, and the proposed research focuses on evaluating and improving data sources and analysis methods to understand demographic disparities, there is an opportunity to coordinate closely on assessing and applying data.

	• FHWA is likely to fund a project on "Exploring Race, Ethnicity, and Socio-Economic factors for Pedestrian and Bicyclist Morbidity and Mortality." The project is likely to identify crash types that BIPOC pedestrians and bicyclists are overrepresented in, and propose countermeasures, guidance, and materials to address those disparities. The proposed research would be a valuable input, and coordination would benefit both projects. • In July 2021, BTSCRP announced an anticipated project on "Equity in Pedestrian and Bicyclist Mobility, Safety, and Health: The Impact of Racial Bias" (BTS-21). The objective focuses on racial disparities in policing. Other projects or potential projects to coordinate with include: • TRB Circular E-C270 includes Problem Statements C2: Identify the causes of racial disparities in traffic safety and C3: Understand bias in traffic and transit enforcement and implications for minority communities. • Understanding Pedestrian Crash Injury and Social Equity Disparities in Oregon (ODOT SPR 841), which is applying an ecological analysis approach to pedestrian crash disparities in Oregon, and findings and methods could inform the proposed research. • The TRB Pedestrians committee has developed a Research Needs Statement on "Documenting the Impact of Racial Bias in Policing and Evaluating Alternative Approaches to Advance Equity in Pedestrians' and Bicyclists' Mobility, Safety, and Health." The statement is likely to be submitted for a BTSCRP topic. If funded, this would be a valuable input into the proposed research. • The TRB Bicycle committee has developed a Research Needs Statement on "Social Equity in Pedestrian Collision Trends, Reporting and Decision Making." https://rns.trb.org/details/dproject.aspx?n=43252
Research Objective	This research would aim to clarify the strengths and gaps of existing data for understanding active transportation safety equity implications, propose improvements to data collection practices, and improve the application of available data and modeling. A better understanding of what available data can and cannot tell us about safety disparities is an important step before we can understand and act most effectively to reduce and eliminate disparities. The products of this project include a document proposing improvements to data collection practices, and a research report detailing improved methods of assessing and understanding disparities. This research should seek to disentangle disparities by both race and income, since it is likely that disparities would be different between distinct demographic groups. The research should also assess urban, suburban and rural areas separately, so as not to entangle the effects of urban context with race or income effects. All aspects of the research should also examine walking and bicycling separately, recognizing both the commonalities and differences between the modes. Phase 1 of the research would focus on documenting available data, current data applications, and proposing updates to data collection and application processes to be utilized in assessing pedestrian and bicycle safety disparities. 1) Document availability, strengths and weaknesses, of sociodemographic data in:

	a. Pedestrian and bicycle exposure data, including by location of activity (e.g., to assess exposure on high-speed, high-volume arterials, or on other facilities that may be unsafe). b. The availability of and access to safe countermeasures, including crosswalks, sidewalks, lighting, traffic calming, bicycle infrastructure, etc. c. Crash data, including fatal, injury and non-injury crashes. 2) Conduct a systematic assessment of potential/likely bias and/or underreporting of pedestrian and bicycle exposure, activity, and crashes. 3) Document current practices to deploy available data for active transportation safety equity assessments, including any efforts to overcome or correct for data gaps. Phase 2 of the research would focus on understanding the extent and causes of active transportation safety disparities. 4) Using data and outputs from Phase I, estimate the extent of racial and economic safety disparities in walking and in bicycling nationally and in different contexts (e.g., urban, suburban, rural). The assessment should seek to use the best available data and modeling methods; knowledge about the limits, potential bias, and underreporting; and illustrate proxy data, methodological adjustments, and limitations. The analysis would explicitly address uncertainties in estimates due to data limitations. These findings would help inform recommendations on improvements to data collection. 5) Conduct a literature review on the causes of racial disparities in active transportation safety and the impact that these causes (including racial biases) and disparities may have on decisions about whether and where to walk or bike. 6) Based on gaps in the existing research, conduct new research to better understand the causes of safety disparities in walking and bicycling. The causes would include, but not be limited to, differences in exposure, access to safe infrastructure, and driver and other racial biases. This research may rely on some existing data and may involve the collection of new data. The project will culminate in the development of two products: 7) Identification of best practices and policies to improve active transportation safety data to overcome safety data gaps identified in steps 1-3. 8) A research report documenting the following: a. Strengths, weaknesses, and application of current active transportation safety data sources for assessing disparities; b. Research and analysis methods used in the project; c. An estimate of the extent of racial and economic safety disparities in active transportation; and d. An assessment of the causes of disparities, including racial bias.
Urgency and Potential Benefits	While there is clear evidence of some key disparities in active transportation safety, existing data and data applications limit the ability to understand the extent of safety disparities, differences by specific sociodemographic groups, and causes of disparities.

	Better data and understanding of how to analyze active transportation safety disparities is a key step in acting to address causes and promote investment in targeted safety programs and infrastructure, and inform policies to improve bicycle and pedestrian data and safety in disadvantaged areas.
Implementation Considerations and Supporters	State DOT safety officials can utilize the report findings to work with DMVs, state and local police, and hospitals to improve active transportation crash and injury reporting. Research findings can be used by state and local planners to assess exposure to dangerous transportation/roadway environments, and access to safe facilities, by race and income, in urban, suburban and rural contexts. The research would be used to improve data collection practices, conduct safety analyses, target investments in walking and bicycling infrastructure, and to develop safety policies and plans. Analysis methods related to ecological assessment of risk for people walking and bicycling based on exposure, environment, and access to facilities, could be deployed at state, regional or local levels. Follow-up research could develop strategies to deploy countermeasures to reduce disparities in safety outcomes, access to safe facilities and activity levels, and then test the strategies. Inform future research to explore the causes or contributors to disparities revealed in this project, as well as evaluations of policies and investments seeking to address disparities. The CAT could collaborate with the following AASHTO committees on the statement: Safety, Civil Rights.
Recommended Research Funding and Research Period	$800,000 36 months
Problem Statement Author(s)	Nathan McNeil, Portland State University Jennifer Dill, Portland State University Stefanie Brodie, Toole Design Group
References:	Braun, L. M. (2018). *Geographies of (dis)advantage in walking and cycling: Perspectives on equity and social justice in planning for active transportation in U.S. cities* [Doctor of Philosophy in the Department of City and Regional Planning]. University of North Carolina. Chakravarthy, B., Anderson, C. L., Ludlow, J., Lotfipour, S., & Vaca, F. E. (2010). The Relationship of Pedestrian Injuries to Socioeconomic Characteristics in a Large Southern California County. *Traffic Injury Prevention*, 11(5), 508–513. https://doi.org/10.1080/15389588.2010.497546 Coughenour, C., Abelar, J., Pharr, J., Chien, L.-C., & Singh, A. (2020). Estimated car cost as a predictor of driver yielding behaviors for pedestrians. *Journal of Transport & Health*, 16, 100831. https://doi.org/10.1016/j.jth.2020.100831

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Research Topic	*B5: Equitable representation in active transportation*
Overview	Equity is often not adequately integrated into active transportation planning and programming. There is a growing amount of research on equity and active transportation, but the focus has been on evaluating infrastructure distribution and safety outcomes. There is almost no research identifying and evaluating the effectiveness of efforts to have more inclusive processes and representation in active transportation planning and project prioritization. There is also a limited understanding of whether and how equity is incorporated in active transportation plans and implementation of plans. Without adequate and effective representation in all levels of decision-making, active transportation infrastructure, programs and policies will likely continue to favor the privileged, including people who are male, white, higher-income, and able-bodied. Research is needed focusing on incorporating equity into planning and decision-making processes, including evaluating the effectiveness and outcomes of inclusive planning efforts. In addition to case studies within active transportation, there are likely lessons that can be applied from efforts in other policy realms.
Research Objectives	Research on this topic needs to address diversity in terms of race and ethnicity, gender identity, disability, language, age, and income. • Evaluate the outcomes of processes in active transportation planning and project prioritization based on level and type of representation. What levels and forms of representation lead to more equitable and just outcomes? This research would include representation within advisory committees, advocacy groups, consultants, public agency staff, and decision-making bodies. The research would evaluate if the intended and realized outcomes of the plans and project prioritization are more equitable and just. The research would examine processes with a range of representation, not just those that were thought to be diverse. One outcome would be the identification of best practices, including from other policy realms. • Identify best practices for engaging underrepresented groups in public outreach processes. This would include practices of compensating individuals and organizations, engaging diverse groups in data collection (e.g., walk and bike audits), virtual engagement, and other innovative approaches. This research would identify how well the practices increased trust among underrepresented voices and how that transferred to new insights and influenced decisions. • Identify best practices for diversifying the active transportation workforce. This research would first assess current representation and recent trends in the workforce, along with the pipeline of professionals. The research should examine whether the active transportation profession is different with respect to representation than the larger transportation profession and, if so, how and why. It would then identify and evaluate strategies for diversifying the workforce.
Research Type	 Empirical Data  Best Practices

Research Review	Policy, planning, and decision-making		
Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process **Other:** FHWA		
Research Timeline	***2021 – 2022***	***2023 – 2026***	***2027 and later***
	Monitor scope of upcoming NCHRP projects	Scope and initiate new research Complete and implement research	Monitor application of research
Research Partners	**AASHTO Committees**: Planning; Civil Rights **TRB Committees**: Pedestrians; Bicycle Transportation; Equity in Transportation **US DOT**: FHWA **Other organizations**: APBP; NACTO		
Related Projects	***Description/Connection***		***Status***
	NCHRP 08-152: Strategies for advancing equity in transportation planning by increasing diversity, equity, and inclusiveness in the transportation planning profession		
	This project would overlap in part with one of the research objectives above. The project does not address engineering or other professions and only addresses workforce issues, not public engagement and other processes.		Start 2021-22
	NCHRP 08-161: Identify emerging approaches for public engagement to meaningfully involve minorities, low-income, and other vulnerable populations. ***NCHRP 08-162: Identify practices and policies to advance social justice and equity into transportation decision-making***		
	Monitor these anticipated NCHRP projects to identify remaining gaps.		Start 2021-22
	NCHRP Synthesis 53-01: Practices to Promote Equity in Transportation Funding		
	Monitor this anticipated NCHRP project.		Start 2021-22
Other Ongoing Research	CTEDD (UTC): Transportation Equity Needs Assessment Toolkit (Start 2020, End 2021).		
Related RNSs	None identified		

Research Topic	*C1: Accessible shared street design for pedestrians with vision disabilities*
Overview	Shared street (and shared space) designs offer the potential to reinvigorate cities and towns, and bring more pedestrian activity and improved safety. However, they pose a challenge to people with vision disabilities, particularly if they do not employ best practices around detectable warning surfaces and other methods to promote safe user interactions and a comfortable experience for all users. To help with this need, FHWA released a 2017 guide on *Accessible Shared Streets*. With increased implementation, there is a growing opportunity to evaluate existing shared streets, assess use and efficacy, and provide updated guidance. There is a need to develop more specific and nuanced guidance on the use of tactile walking surface indicators (TWSIs) and tactile delineator strips in a shared street implementation, along with questions about how to provide directional indicators and other signage/markings to help users safely and comfortably navigate shared space. Flush streets (also referred to as "festival" or "curbless" streets) are more common in the United States than shared streets. These are streets that operate as conventional streets most of the time (i.e., spaces are clearly delineated by mode, conventional traffic controls, defined crossings) but lack curbs and can be closed to vehicular traffic for special events. There is also a need to better understand best practices for designing these streets so they are safe and accessible for people with vision disabilities and the differences and similarities with shared streets.
Research Objectives	Research in this area could evaluate a set of shared streets and flush streets to assess how well they work for users, including those with vision disabilities. This research may be able to be combined into a broader shared street design study, including tracking shared street implementations and usage of best practices. Key questions include: • Are people with vision disabilities involved in planning and design? • Are shared and flush streets being used by people with vision disabilities? • How comfortable/safe do people with vision disabilities feel using shared streets and flush streets, including specific features? • How do people with vision disabilities navigate different types of shared and flush streets? • How do motor vehicle speed and volume affect access, safety, and comfort for people with vision disabilities? • How effective are TWSIs, tactile delineator strips, and other guidance markings at helping people with vision disabilities navigate shared space and flush streets? Are they adequate for providing directional guidance and indicating the edge between pedestrian and vehicular space? Video collection and review, along with user surveys, may help in understanding usage of shared spaces and flush streets, but additional focused outreach to include and understand the experience of people with vision disabilities will likely be necessary. Findings should provide improved guidance on use of TWSIs, directional indicators

<table>
<tr><td></td><td colspan="3">(note that directional indicators are a TWSI), tactile delineator strips on shared streets and best practices in managing and maintaining shared spaces.</td></tr>
<tr><td>Research Type</td><td colspan="3"> 
</td></tr>
<tr><td>Research Review</td><td colspan="3">Accessibility for pedestrians and cyclists with disabilities</td></tr>
<tr><td>Potential Funding Pathways</td><td colspan="3">TRB Cooperative Programs: NCHRP regular process; NCHRP Synthesis; TCRP
Other: FHWA</td></tr>
<tr><td>Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td></td><td>Scope and initiate research
Scan best practices and MUTCD experiments</td><td>Complete and implement research</td><td></td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Design/JTCNMT; Civil Rights
TRB Committees: Pedestrians; Accessible Transportation and Mobility
US DOT: FHWA
Other organizations: U.S. Access Board</td></tr>
<tr><td>Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td></td><td colspan="3">MUTCD Official Rulings</td></tr>
<tr><td></td><td colspan="2">Monitor MUTCD official rulings for experiments related to signage for shared streets.</td><td>Ongoing</td></tr>
<tr><td></td><td colspan="3">TCRP B-46, Tactile Wayfinding in Transportation Settings for Travelers Who Are Blind or Visually Impaired</td></tr>
<tr><td></td><td colspan="2">This research may provide insight into tactile wayfinding in shared street settings, particularly related to transit facilities.</td><td>Start 2019, End 2021</td></tr>
<tr><td></td><td colspan="3">FHWA, Accessibility Guide for Safe Intersections and Multimodal Facilities</td></tr>
<tr><td></td><td colspan="2">Research on this topic should coordinate with this project described in FHWA's Pedestrian and Bicycle Safety Program Strategic Plan.</td><td>Anticipated, 2021-2022</td></tr>
<tr><td>Related RNSs</td><td colspan="3">None identified</td></tr>
</table>

Research Topic	***C3: Barriers to bicycling for underserved populations relating to the built environment***
Overview	Ensuring that safe and comfortable active transportation travel options are available to communities of color and low-income populations has the potential to help improve mobility and accessibility along with providing recreational and physical activity opportunities to populations that have been historically underserved and underrepresented. There is evidence that bicycle infrastructure is limited in areas with lower incomes, and that Black, Indigenous, and people of color (BIPOC) feel less safe when bicycling without adequate infrastructure. However, further research is needed to understand the potential for increases in bicycling amongst historically underserved populations *if* safe facilities are provided, including which facilities offer the most opportunity and how to build out complete and connected networks that serve BIPOC and low-income communities. Research on access to facilities should be aligned with research on programs and policies to overcome barriers to bicycling.
	This topic has gaps both in terms of a clear understanding of the extent of gaps in the bicycle network and of the expected impact of improving access to facilities. Tackling these gaps could be done as part of a single project or as discrete projects. Study elements could include the following: • An in-depth examination of access to various bicycle facility types associated with higher comfort levels (such as trails and separated bike lanes), as well as network completeness and connectivity to destinations and transit, by factors such as race and income. Research in this area would need to first identify available facility data sources and define access and connectivity approaches. This could include access to key destinations. • An assessment of expected impacts of implementing bicycle facilities in underserved communities, including safety improvements and expected uptake of bicycling when facilities are provided. Research in this area should also focus on understanding the underserved communities being considered, including the distinctions and intersection between factors such as race, ethnicity, gender, immigrant status, income, age, and disability. Within these groups, there may be differences in preferences for facility types, along with current and desired travel modes and patterns. Research outputs would include findings on differences in access to safe and comfortable bicycling facilities and networks, and an improved understanding of how to fill gaps in an effective way.
Research Type	 Empirical Data

Research Review	Equity and bicycling		
Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process **Other:** FHWA		
Research Timeline	***2021 – 2022***	***2023 – 2026***	***2027 and later***
	Scope and initiate research	Complete research and distribute findings	Monitor application of research
Research Partners	**AASHTO Committees**: Planning; Civil Rights **TRB Committees**: Bicycle Transportation; Equity in Transportation **US DOT**: FHWA **Other organizations**: NACTO		
Related Projects	***Description/Connection***		***Status***
	FHWA, Exploring Race, Ethnicity, and Socio-Economic factors for Pedestrian and Bicyclist Morbidity and Mortality		
	Although more focused on health and equity, this research project described in FHWA's *Pedestrian and Bicycle Safety Program Strategic Plan* overlaps in terms of access to and use of safe active transportation facilities. Monitor research for possible coordination and overlap.		Anticipated, 2021-2022
	NCHRP 08-159 Understand how access to employment, health care, education, and other vital needs varies for different population groups in different settings, and methods for effectively assessing mobility and accessibility needs		
	Monitor this project to see how active transportation is included. This project evolved from TRB Circular E-C270 Problem Statement A1, which included the following research questions: What is the relative importance of transit, autos, bicycle–pedestrian infrastructure in searching for and obtaining employment, subsequent earnings, and job tenure in urban, suburban, and rural areas? What do low-income and minority populations see as the relative importance of modes?		Anticipated, 2021-2022
Related RNSs	None identified		

Research Topic	***C5: Crossing solutions at roundabouts and channelized turn lanes for pedestrians with vision disabilities***
Overview	With the uptick in the U.S. in the application of roundabouts, which typically replace stoplights, there is an increasing need to consider how to incorporate the needs and safety of people with vision disabilities in their design. NCHRP Report 834 Crossing Solutions at Roundabouts and Channelized Turn Lanes provided guidance to transportation practitioners on this topic, and also identified ongoing research needs in the area. Research is needed to refine the safe application of the known toolset, including better understanding of how certain facility types, such as pedestrian hybrid beacons or rapid rectangular flashing beacons, function in the roundabout setting.
Research Objectives	Research in this area could involve a set of evaluations of various treatments and combinations of treatments and should involve people with vision disabilities in planning the research. There are a number of known tools that could be used, but better information is needed on: • The efficacy of various elements in combination with one another at the same roundabout/location or nearby locations. • The thresholds (volume, speeds, lanes, yielding, etc.) for more intense intervention (such as a HAWK), and what other factors, such as background noise levels, need to be considered. • Longer-term performance of applications, such as pedestrian hybrid beacons, at roundabouts • The impact of having a signal (including a hybrid beacon) near the entry of a roundabout, including the potential for confusion among motorists that the green at the signal applies to their entry into the roundabout. • Audible messages using speech – how to clarify messages on which lanes or portions of a roundabout are safe to cross. • The use of textured paving or “sound strips” in advance of crosswalks to give people with vision disabilities an audible cue that a motor vehicle is headed toward the crosswalk or has stopped. • The potential for state-of-the-art technologies to provide innovative solutions for pedestrians with vision disabilities
Research Type	 Empirical Data
Research Review	Accessibility for pedestrians and cyclists with disabilities

<table>
<tr><td>Potential Funding Pathways</td><td colspan="3">TRB Cooperative Programs: NCHRP regular process
Other: FHWA; NHTSA; Transportation Pooled Fund</td></tr>
<tr><td rowspan="2">Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td>Monitor TCRP B-46 and NCHRP 03-130
Scope and initiate research</td><td>Complete and implement research</td><td></td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Design/JTCNMT; Safety; Traffic Engineering
TRB Committees: Pedestrians; Accessible Transportation and Mobility; Roundabouts and other Intersection Design and Control Strategies
US DOT: FHWA
Other organizations: U.S. Access Board</td></tr>
<tr><td rowspan="5">Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td colspan="3">TCRP B-46: Tactile Wayfinding in Transportation Settings for Travelers Who Are Blind or Visually Impaired</td></tr>
<tr><td colspan="2">Monitor findings from TCRP B-46 for any findings related to roundabouts or channelized turn lanes.</td><td>Start 2019, End 2021</td></tr>
<tr><td colspan="3">NCHRP 03-130: Guide for Roundabouts</td></tr>
<tr><td colspan="2">This upcoming guide on roundabouts may fill some gaps in design solutions knowledge and best practices for pedestrians with vision disabilities.</td><td>Publication pending</td></tr>
<tr><td>Other Ongoing Research</td><td colspan="3">Mobility21 (UTC): Safe Intersection Crossing for Pedestrians with Disabilities (Start 2020, End 2021).</td></tr>
<tr><td>Related RNSs</td><td colspan="3">None identified</td></tr>
</table>

Research Topic	*C7: Disparities in active transportation use and health outcomes*
Overview	Active transportation is often touted as an important contributing factor to a healthy and active lifestyle. Further evidence shows that people of color and low-income populations suffer disproportionately from diseases such as obesity, hypertension, and diabetes. However, there is also some evidence that active transportation (particularly walking) among these communities is done more out of necessity than out of choice, and is more likely to occur in areas with higher traffic volumes, higher speeds, and more air pollution. Research is needed to explore the complex relationship between active transportation, the overall transportation system, and health and safety outcomes, including whether the benefits and burdens of active transportation are disproportionately distributed as a result of how and where participation occurs.
Research Objectives	Key questions for this topic include: • What are the disparities in physical activity (amount, intensity, etc.) derived from active transportation? • What are the disparities in exposure and outcomes to sources of air, sound or other pollution? • How do the neighborhoods, environments, or other activity characteristics (e.g., time of day) in which people walk, bike or roll influence these disparities? • Although covered in other topics, a related important question pertains to disparities in traffic safety exposure and outcomes. • What measures can help maximize the health benefits and safety of these activities? Research could examine differences (by race/ethnicity, income, comorbidities) in the combined impact of pollution exposure, traffic safety, physical activity and stress on health. Further research could explore the interaction of race and ethnicity, income, access and use of active transportation to understand disparate positive health outcomes. A project could include a systematic research review of health literature and an analysis of the distribution of transportation facility locations and walking, bicycling, and rollling activity.
Research Type	 Empirical Data  Systematic Review
Research Review	Accessibility for pedestrians and cyclists with disabilities Equity and bicycling Equity and pedestrian travel
Potential Funding Pathways	**TRB Cooperative Programs:** BTSCRP **Other:** FHWA; NIH

Research Timeline	***2021 – 2022***	***2023 – 2026***	***2027 and later***
	Scope and initiate research Monitor related FHWA projects	Data collection and interim reporting (if longitudinal research)	Complete and implement research
Research Partners	**AASHTO Committees**: Planning; Environment and Sustainability; Civil Rights **TRB Committees**: Pedestrians; Bicycle Transportation; Transportation and Public Health **US DOT**: FHWA **Other organizations**: NIH		
Related Projects	***Description/Connection***		***Status***
	FHWA, Exploring Race, Ethnicity, and Socio-Economic factors for Pedestrian and Bicyclist Morbidity and Mortality		
	Although more focused on health and equity, this project described in FHWA's *Pedestrian and Bicycle Safety Program Strategic Plan* overlaps in terms of access to and use of safe active transportation facilities. Monitor research for possible coordination and overlap.		Anticipated, 2021-2022
Other Ongoing Research	OR DOT: Understanding Pedestrian Crash Injury and Social Equity Disparities in Oregon (Start 2020, End 2022).		
Related RNSs	Documenting the Impact of Racial Bias in Policing and Evaluating Alternative Approaches to Advance Equity in Pedestrians' and Bicyclists' Mobility, Safety, and Health (ACH10, Pedestrians).		

<table>
<tr><td>Research Topic</td><td colspan="3">C13: Guidance on the use of tactile walking surface indicators at decision points as decision-making surfaces</td></tr>
<tr><td>Overview</td><td colspan="3">Tactile warning surfaces can be used in different patterns and shapes to convey information to vision-impaired pedestrians, including conveying walking routes and borders. However, research indicates that many vision-impaired pedestrians have difficulty using detectable warning surfaces to effectively find their course.

Detectable warning surfaces are more commonly used in other countries to signify to a person with a vision disability “stop, pay attention, there’s something here.” However, there is limited research in the U.S. context on the utilization of detectable warning surfaces at decision points to convey choice information to pedestrians about routes.</td></tr>
<tr><td>Research Objectives</td><td colspan="3">Research in this area should monitor the findings of TCRP B-46 and assess identified research gaps that emerge from that report.</td></tr>
<tr><td>Research Type</td><td colspan="3"> 
Empirical Data
 
Tech Transfer</td></tr>
<tr><td>Research Review</td><td colspan="3">Accessibility for pedestrians and cyclists with disabilities</td></tr>
<tr><td>Potential Funding Pathways</td><td colspan="3">TRB Cooperative Programs: NCHRP regular process

Other: FHWA</td></tr>
<tr><td rowspan="2">Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td>Monitor and coordinate with TCRP B-46</td><td>Scope and initiate research</td><td>Complete and implement research</td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Design/JTCNMT; Traffic Engineering

TRB Committees: Pedestrians; Accessible Transportation and Mobility

US DOT: FHWA

Other organizations: US Access Board</td></tr>
</table>

Related Projects	***Description/Connection***	***Status***
	TCRP B-46, Tactile Wayfinding in Transportation Settings for Travelers Who Are Blind or Visually Impaired	
	Research on this topic should await findings TCRP B-46 to assess remaining gaps.	Active, anticipated completion 2021
	FHWA, Accessibility Guide for Safe Intersections and Multimodal Facilities	
	Research on this topic should coordinate with this project described in FHWA's *Pedestrian and Bicycle Safety Program Strategic Plan*.	Anticipated, 2021-2022
Other Ongoing Research	Mobility21 (UTC): Safe Intersection Crossing for Pedestrians with Disabilities (Start 2020, End 2021).	
Related RNSs	None identified	

Research Topic	*C14: Impact of harassment and violence in reducing active transportation use*
Overview	There is growing evidence of certain population groups experiencing higher levels of harassment and violence while walking and bicycling, namely Black, Indigenous, and people of color (BIPOC), people with disabilities, women, gender nonconforming and LGTBQ people. Fear of such harassment or violence can affect behavior by reducing the overall use of active transportation, as well as changing routes and times of travel. This can also impact the use of transit, as walking and bicycling are common modes of access and egress transit. High-profile examples, such as the murder of Ahmaud Arbery while running in a public street, have highlighted the problem. Studies have also documented that people of color, particularly Black people, are more concerned about the possibility of being stopped by police while walking or cycling. These fears are well-grounded, as there is evidence from some cities that Black people are more likely to be stopped and/or ticketed by police while walking or cycling. Moreover, there are well-documented cases of police stops of Black pedestrians and cyclists escalating to violence and even death, such as the case of Dijon Kizzee in Los Angeles in 2020. Despite growing evidence of the problem, this is a relatively under-researched topic. There are gaps in knowledge regarding the extent of the problem as well as solutions.
Research Objectives	This research should address three primary objectives. First, additional research is needed to understand the magnitude of the problem of harassment and violence affecting active transportation users: • What are the shared experiences with street harassment and violence while walking and cycling for different population groups? • How much do personal safety fears affect travel behavior and reduce levels of walking and cycling among certain populations, particularly BIPOC people and people who identify as women? • How does this vary by different geographies (e.g., denser urban areas, suburbs, and rural areas)? • How does the presence of law enforcement impact active transportation use among different population groups? How does it affect the perception of walking or bicycling for different communities? Second, comprehensive research is needed on racial biases in traffic enforcement affecting pedestrians and cyclists, including the extent, causes, and effects of the problem and effectiveness of solutions. Third, research is needed on actions transportation agencies can take to reduce harassment, violence and fear. While there is research on design solutions addressing some fears (e.g., better street lighting), there is little or no research that evaluates solutions to other problems such as gender- or race-based street harassment. All three of these objectives would benefit from social science approaches and methods and needs to consider the intersectionality of different demographics, such as race and gender identity, race and disability, etc.

<table>
<tr><td>Research Type</td><td colspan="3"> 
Empirical Data
 
Best Practices</td></tr>
<tr><td>Research Review</td><td colspan="3">Equity and personal safety</td></tr>
<tr><td>Potential Funding Pathways</td><td colspan="3">TRB Cooperative Programs: NCHRP
Other: UTCs; Health agencies, including NIH and CDC; U.S. Department of Justice, National Institute of Justice</td></tr>
<tr><td rowspan="2">Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td>Initiate collaborations to scope research
Initiate research</td><td>Complete and implement research</td><td>Monitor application of research</td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Civil Rights
TRB Committees: Pedestrians; Bicycle Transportation; Equity in Transportation
US DOT: FHWA
Other organizations: NIH and CDC; U.S. DOJ, National Institute of Justice</td></tr>
<tr><td rowspan="5">Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td colspan="3">FHWA, Exploring Race, Ethnicity, and Socio-Economic factors for Pedestrian and Bicyclist Morbidity and Mortality (FHWA Strategic Plan)</td></tr>
<tr><td colspan="2">Research on this topic should coordinate with this project described in FHWA’s Pedestrian and Bicycle Safety Program Strategic Plan.</td><td>Anticipated, 2021-2022</td></tr>
<tr><td colspan="3">BTSCRP, Equity in Pedestrian and Bicyclist Mobility, Safety, and Health: The Impact of Racial Bias (BTS-21)</td></tr>
<tr><td colspan="2">Research on this topic should coordinate with this anticipated project that will focus on racial disparities in policing.</td><td>Anticipated, 2021-2022</td></tr>
<tr><td>Other Ongoing Research</td><td colspan="3">CTEDD (UTC): Transportation Equity Needs Assessment Toolkit (Start 2020, End 2021).</td></tr>
<tr><td>Related RNSs</td><td colspan="3">TRB Circular E-C270 includes Problem Statements C2: Identify the causes of racial disparities in traffic safety and C3: Understand bias in traffic and transit enforcement and implications for minority communities.</td></tr>
</table>

Research Topic	***C19: Increasing bicycling among women and girls: programs and policies***
Overview	It is well-documented in the U.S. that girls and women bicycle less than boys and men, which is in contrast to many countries with higher rates of overall cycling. There is ample evidence that concerns about traffic and personal safety disproportionately negatively affect women's likelihood of bicycling. There is also strong evidence that infrastructure that provides higher levels of separation from motor vehicles will likely increase cycling among women. There are additional factors that likely affect women's rates of cycling that we do not understand as well, including the role of larger societal issues and policies (e.g., family leave, economic equality, child care, etc.), fear of harassment, the effect of childhood cycling experience, the relationship between children's cycling and independence and mother's cycling. In addition, most research does not look at the intersection of other demographic characteristics and gender, such as race or age. There is also limited research focused on factors influencing cycling by girls, both younger and teenagers. Finally, few or no studies have evaluated the effectiveness of non-infrastructure solutions for increasing bicycling among girls or women.
Research Objectives	Research would: • Identify the relative importance of factors that influence rates of cycling among girls and women, including non-infrastructure factors. The research would incorporate additional demographics, such as race, income, and age. • Evaluate the effectiveness of programs and policies aimed at increasing cycling among girls and women. These could include targeted education and marketing efforts; programs to increase use and availability of different bicycle technologies (e-bikes, cargo bikes, etc.); policies and programs that reduce the need for women to transport family members; and policies that affect traditional gender norms and income inequality. This research could draw on international examples.
Research Type	 Empirical Data
Research Review	Equity and bicycling
Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process **Other:** FHWA; UTCs; NIH

Research Timeline	*2021 – 2022*	*2023 – 2026*	*2027 and later*
	Scope and initiate research	Complete research	Implement research.
Research Partners	**AASHTO Committees:** Planning **TRB Committees:** Bicycle Transportation; Women and Gender in Transportation **US DOT:** FHWA **Other organizations:** League of American Bicyclists		
Related Projects	***Description/Connection***		***Status***
	No relevant ongoing projects identified		
Related RNSs	Sociocultural Factors Impacting Bicycle Use (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=38926		

Research Topic	***C24: Programs and policies to overcome barriers to bicycling for underserved populations***
Overview	In addition to needing access to safe and comfortable bicycle facilities, programs and policies may be able to help make bicycling an appealing and easy mobility and recreation option for underserved and underrepresented populations, including BIPOC people, households with lower incomes, women, people with disabilities, and LGBTQ people. Barriers such as needing a working bike that fits an individual's needs, fear of traffic violence, crime and harassment, and feeling unwelcomed in bicycling spaces likely all contribute to limiting participation in bicycling. Programs and policies can be designed to provide additional supports to underserved populations, such as opportunities to acquire a safe and well-fitting bicycle, bicycle education and community building activities, and more. Other programs or policies may seek to reduce personal security barriers, such as harassment and crime.
Research Objectives	Research in this area could explore the contribution of various barriers to decisions about bicycling for underserved populations, along with the impact of various programming approaches to breaking down those barriers, including approaches that make bicycling affordable, comfortable, safe, and fun. Research in this area could include: • Survey- or focus group-based research to better understand barriers and motivators to bicycling for different people and groups. • Longitudinal or retrospective research to assess changes in bicycling behavior associated with particular programs or policies. • Interviews with community organizations and non-profits that run programs to increase bicycling among underserved populations. Outputs of the research should explore the impacts of combinations of program, policy and infrastructure on bicycling behavior for different groups. A scan of best practices could provide a helpful toolkit of programming and policy ideas as well.
Research Type	 Empirical Data  Best Practices
Research Review	Accessibility for pedestrians and cyclists with disabilities Equity and bicycling Equity and personal safety
Potential Funding Pathways	**TRB Cooperative Programs:** BTSCRP **Other:** FHWA

Research Timeline	***2021 – 2022***	***2023 – 2026***	***2027 and later***
	Scope and initiate research	Complete short-term research; implement tools	Longitudinal research may continue
Research Partners	**AASHTO Committees**: Planning; Civil Rights **TRB Committees**: Bicycle Transportation; Equity in Transportation **US DOT**: FHWA		
Related Projects	***Description/Connection***		***Status***
	FHWA, Exploring Race, Ethnicity, and Socio-Economic factors for Pedestrian and Bicyclist Morbidity and Mortality		
	Although more focused on health and equity, this project described in FHWA's *Pedestrian and Bicycle Safety Program Strategic Plan* overlaps in terms of access to and use of safe active transportation facilities. Monitor research for possible coordination and overlap.		Anticipated, 2021-2022
Related RNSs	Sociocultural Factors Impacting Bicycle Use (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=38926 Documenting the Impact of Racial Bias in Policing and Evaluating Alternative Approaches to Advance Equity in Pedestrians' and Bicyclists' Mobility, Safety, and Health (ACH10, Pedestrians).		

Other equity and accessibility needs

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D12: Disability and school active travel opportunities	Accessibility for pedestrians and cyclists with disabilities Equity and bicycling Equity and pedestrian travel	None identified	None identified
D24: How infrastructural change might impact child bicycling	Bicycle and pedestrian data: Safety Bicycles at intersections: Design and safety Bikeways: Ridership and demand	Active Transportation Design for All Ages and Abilities (ACH10, Pedestrians)	None identified
D61: The potential of adaptive bikes for people with disabilities and older adults	Accessibility for pedestrians and cyclists with disabilities Bike share Equity and bicycling	None identified	None identified

Research Needs: Planning

Highest Priority: Research Problem Statements

No planning needs were in the highest-priority tier.

High Priority: Research Need Briefs

B2 Bicycle networks: measures and effects

B3 Changes in bicycle ridership with innovative infrastructure

B7 Incorporating active transportation into travel demand modeling

Medium Priority: Research Need Briefs

C18 Incorporating active transportation modes into transportation impact studies

C21 Methods to prioritize different modes across the network in planning processes

Lower Priority

D28 Impacts of bicycle facility design on air pollution exposure concentrations

D33 Incorporating air pollution exposure of active transportation users in planning and forecasting

D34 Incorporating physical activity and health outcomes of active transportation in transportation planning

D35 Innovation in funding active transportation projects

Research Topic	*B2: Bicycle networks: measures and effects*
Overview	The evidence is fairly clear that cycling infrastructure is associated with more cycling, and that people prefer infrastructure with more separation from motor vehicles. However, much of this evidence is not based on longitudinal, empirical studies of increasing bicycle networks over time. Research on the effect of networks of infrastructure (rather than just a single facility) would help inform planning decisions. Most of the existing research uses cross-sectional data (one point in time), making conclusions about cause and effect difficult. Longitudinal studies, ideally with controls (also known as natural experiments), can better examine causal relationships. There is also no agreed-upon "best" measure for bicycle infrastructure networks, particularly a measure that best predicts bicycling behavior for different types of users. Related to this, there are no clear standards for bike network data. Problems include inconsistent facility types, lack of dates on when facilities are changed, and outdated facility data. These problems make longitudinal data analysis difficult.
Research Objectives	Research is needed on what are the best measures of a bicycle network, using the criteria of (1) what correlates best with behavior and (2) what can be implemented relatively easily in practice? This research should also address network data gaps. Longitudinal studies of network improvements in different contexts (urban, suburban, and rural) and that include a variety of infrastructure types are necessary to provide better estimates for planning, programming, and modeling. A primary objective of the research would be to develop estimates of the marginal effects in bicycling and motorized VMT as a result of different networks. The outputs of such models could be used to estimate safety exposure, emissions, physical activity, health, and other outcomes. The research should provide evidence and tools for practice to determine which investments will yield the greatest benefits. The studied networks should vary in density (i.e., quantity) and types of infrastructure (i.e., quality) for both links and intersections. This research should also incorporate the possible synergistic effects of supportive infrastructure (e.g., transit integration, bike parking, speed management, bike share, etc.) and other factors (e.g., land use, parking pricing, e-bikes). An approach that focuses on access to destinations is likely most appropriate. The research should also consider different users, particularly different ages (children and teens, as well as older adults) and genders. The results of the research should help better integrate bicycling into travel demand models. Research is also necessary on how to best incorporate equity into bicycle network planning. This includes racial equity as well as ADA considerations. An additional and separate research question relates to tourism: What size or scale of a bicycle trail network is necessary to attract significant tourism? What trail attributes make individual facilities and networks attractive to riders?
Research Type	 Empirical Data  Systematic Review

Research Review	Bikeways: Ridership and demand		
Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process **Other:** FHWA; Transportation Pooled Fund		
Research Timeline	***2021 – 2022***	***2023 – 2026***	***2027 and later***
	Monitor ongoing research (NCHRP 08-149)	Develop new research based on results of NCHRP 08-149	Complete and implement research Monitor application of research
Research Partners	AASHTO Committees: Planning TRB Committees: Bicycle Transportation US DOT: FHWA Other organizations: MPOs		
Related Projects	***Description/Connection***		***Status***
	NCHRP 08-149: Impacts of Active Transportation Network Gaps		
	This project focuses on understanding the causes of gaps in networks, how to complete the gaps, and the impacts of completion using a variety of performance measures. As of early April 2021, the RFP has not been released.		Project will begin in 2021
	FHWA, Effect of Bicycle Network Expansion on Safety; Methods to Predict Future Pedestrian and Bicyclist Demands to Support Safety Investments; Guide to Using Alternative Data Sources to Enhance Police Crash Reporting;		
	Research on this topic should coordinate with these projects described in FHWA's *Pedestrian and Bicycle Safety Program Strategic Plan.*		Anticipated, 2021-2022
Related RNSs	Bicycle Network Planning: Validating and Extending Bicycle Level of Traffic Stress Analysis (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=43244 Evaluating and Refining the Bicycle Level of Traffic Stress (BLTS) Methodology for Geometric Design of Intersections (AFB10, Geometric Design) https://rns.trb.org/dproject.asp?n=41195 Sociocultural Factors Impacting Bicycle Use (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=38926		

Research Topic	*B3: Changes in bicycle ridership with innovative infrastructure*
Overview	There is clear evidence that bicycle facilities are associated with increased ridership, and indications that people generally prefer more separation from motor vehicles. However, most of the research in the U.S. is based on a narrow range of facilities, primarily striped bike lanes and separate paths, along with signed or marked streets. There is some research on separated or protected bike lanes and bicycle boulevards, and no or very limited research on more innovative facilities such as advisory bike lanes, contraflow lanes, and intersection treatments. In addition, what evidence there is for these newer types of bicycle infrastructure often suffers from some methodological limitations, including lack of control sites, short time frames, and limited contexts (e.g., only a few urban areas). In addition, research on new designs often relies on stated preference methods, rather than observations of actual behavior or "revealed preferences." All of these limitations mean that it is difficult to provide methods to estimate how different types of facilities will increase bicycle ridership and use those estimates for planning and programming decisions.
Research Objectives	Develop standard methods to conduct longitudinal studies of new infrastructure. Providing a simple and low-cost method for collecting data could encourage more agencies to collect and analyze such data. Moreover, these data could more easily be pooled across several locations to develop more accurate estimates of ridership change that could be used in forecasting tools. The project would need to provide guidance on the selection of control sites, count methodology, and timing. A standard set of questions and methodology for optional intercept surveys would also be useful in understanding behavior change. Once such guidance is developed, an effort would be necessary to encourage its use in a variety of contexts (urban, suburban, small town, and rural) and types of infrastructure. The infrastructure designs that need more evidence include separated bike lanes of different designs (one-way, two-way, at sidewalk grade vs. street, barrier types), bicycle boulevards, shared streets, advisory bike lanes, contraflow lanes, protected intersections, bike boxes, and bike signals. Identify how long after construction it takes for demand to increase. Many existing studies include before-and-after counts or intercept surveys. The post-construction data collection periods are often soon after construction (e.g., one year or less). However, there is some research indicating that it takes longer than one year for significant numbers of people to shift modes. Early data collection may largely be capturing people who already cycle and are shifting routes to use the new facility. This research would provide guidance on how long it may take to see people shift from driving or other modes to bicycling as a result of new infrastructure. The results would be useful in designing performance measurement efforts. Examine whether newer, innovative bicycle infrastructure designs are more effective at increasing ridership among demographic groups that currently do not ride at all or regularly (e.g., women, older adults, children). This research could be done through stated preference surveys and intercept surveys of users on new infrastructure. Estimate changes in ridership based on people's stated level of comfort. For many new facility designs, it is not possible to measure ridership change with observed data. Stated preference methods, including those using video, can provide data on people's

<table>
<tr><td></td><td colspan="3">stated levels of comfort and stated intentions for changing behavior. However, there are no agreed upon methods of converting such findings to estimates of demand.</td></tr>
<tr><td>Research Type</td><td colspan="3"> 
Empirical Data
 
Tech Transfer</td></tr>
<tr><td>Research Review</td><td colspan="3">Bikeways: Ridership and demand</td></tr>
<tr><td>Potential Funding Pathways</td><td colspan="3">TRB Cooperative Programs: NCHRP regular process
Other: FHWA; UTCs for individual project evaluations</td></tr>
<tr><td>Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td></td><td>Scope and initiate research</td><td>Complete and implement research</td><td>Monitor application of research</td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Design/JTCNMT; Planning
TRB Committees: Bicycle Transportation
US DOT: FHWA
Other organizations: APBP; NACTO</td></tr>
<tr><td>Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td></td><td colspan="3">FHWA, Methods to Predict Future Pedestrian and Bicyclist Demands to Support Safety Investments</td></tr>
<tr><td></td><td colspan="2">Research on this topic should coordinate with this project described in FHWA’s Pedestrian and Bicycle Safety Program Strategic Plan.</td><td>Anticipated, 2021-2022</td></tr>
<tr><td></td><td colspan="3">NCHRP 08-149: Impacts of Active Transportation Network Gaps</td></tr>
<tr><td></td><td colspan="2">This project focuses on understanding the causes of gaps in networks, how to complete the gaps, and the impacts of completion using a variety of performance measures.</td><td>Project will begin in 2021</td></tr>
<tr><td>Other Ongoing Research</td><td colspan="3">NHTSA: Understanding and Using New Pedestrian and Bicycle Facilities (Start 2019, End 2022).</td></tr>
<tr><td>Related RNSs</td><td colspan="3">None identified</td></tr>
</table>

Research Topic	***B7: Incorporating active transportation into travel demand modeling***
Overview	Incorporating walking and bicycling into travel demand modeling can help agencies to anticipate facility needs, prioritize improvements, and promote safe active transportation. However, agencies have struggled to incorporate these modes into planning, either not including them at all or lumping them together when finer analysis would be more useful for informing decision-making. Many agencies and regions also lack the refined data (e.g., on a finer level than a traffic analysis zone, or "TAZ") that would enable adequate pedestrian and bicycle modeling, and/or rely on an auto network for pedestrian and bicycle modeling. Further, there are gaps for many agencies in being able to apply the latest modeling techniques (e.g., they do not have the skills or time to carry out the techniques). Other key research needs include better incorporating the built environment as a utility consideration for active transportation, expanding the application of activity or tour-based modeling, which can provide more context than trip-based modeling, and overcoming household travel surveys which may not capture adequate active transportation trip data (see need *B17: Improving travel surveys to collect better data on active transportation*).
Research Objectives	Research would seek to improve travel demand modeling and extend the utility of active transportation count data by: • Identifying appropriate zone sizes and characteristics for pedestrian and bicycle travel modeling. Research could involve a scan to identify environmental characteristics associated with pedestrian and bicycle decision-making, data availability, aggregation and analysis methods, as well as testing zone sizes and methods to draw borders. A product would be a detailed description of feasible pedestrian analysis zones or bicycle analysis zones, and utilizing application techniques such as a network buffer, following the route of the trip, rather than a circular buffer around origin or destination points. • Exploring best practices for collecting, storing, accessing, and utilizing appropriately scaled data for walking and bicycling, as well as best practices in fully integrating walking and biking into travel forecasting models, and various types of off-model adjustments. • Developing tools to ensure agency-based modelers and non-modelers can apply the refined zonal analysis and apply methods such as activity or tour-based modeling for walking and biking trips. • Advancing methods to evaluate return on investment for active transportation, going beyond mode shift and reduction of VMT and related costs, to impacts related to health and utility benefits to existing and potential cyclists and pedestrians. • Exploring ways to design or improve count programs to support modeling. In general, research should presume that pedestrian and bicycle models would be developed separately based on each mode's unique characteristics. Research could be

<table>
<tr><td></td><td colspan="3">combined or coordinated with research incorporating active transportation modes into impact studies.</td></tr>
<tr><td>Research Type</td><td colspan="3"> 
Best Practices
 
Tech Transfer</td></tr>
<tr><td>Research Review</td><td colspan="3">Modeling and traffic impact analysis</td></tr>
<tr><td>Potential Funding Pathways</td><td colspan="3">TRB Cooperative Programs: NCHRP regular process
Other: FHWA; UTCs</td></tr>
<tr><td rowspan="2">Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td>Scope and initiate research</td><td>Complete and implement research</td><td>Monitor application of research</td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Planning
TRB Committees: Pedestrians; Bicycle Transportation; Transportation Demand Forecasting
US DOT: FHWA
Other organizations: MPOs</td></tr>
<tr><td rowspan="5">Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td colspan="3">NCHRP 20-102(29): Incorporating New Mobility Options into Transportation Demand Modeling</td></tr>
<tr><td colspan="2">This project should push non-standard transportation demand modeling forward, including methods that could be useful for pedestrian and bicycling modeling, but will likely leave significant needs for modeling walking and bicycling.</td><td>Anticipated; FY 2020</td></tr>
<tr><td colspan="3">FHWA, Methods to Predict Future Pedestrian and Bicyclist Demands to Support Safety Investments</td></tr>
<tr><td colspan="2">Research on this topic should coordinate with this project described in FHWA's Pedestrian and Bicycle Safety Program Strategic Plan.</td><td>Anticipated, 2021-2022</td></tr>
<tr><td>Related RNSs</td><td colspan="3">None identified</td></tr>
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Research Topic	***C18: Incorporating active transportation modes into transportation impact studies***
Overview	In planning for the transportation needs of new development, transportation impact studies have traditionally had a singular focus on motor vehicle trips. The implications for congestion, safety, public infrastructure and other harms of this automobile-orientation have been well documented. Further, local jurisdictions lack the methods and data to appropriately assess potential impacts on active transportation modes and plan and fund necessary improvements. Only about a third of trip generation studies have included expected trips from modes such as walking and bicycling, along with transit, all of which could alleviate motor vehicle congestion and other harms. Limited data on active transportation impacts have been incorporated into the Institute of Transportation Engineers' Trip Generation Manual, but considerably more is needed to reflect areas of various urban, suburban, and rural settings, along with assessment of the consistency of multimodel trip generation data collection. Research in this area could help jurisdictions meet active transportation user needs and justify allocating impact fees to active transportation infrastructure, and promote a more balanced understanding of the transportation needs that come with development.
Research Objectives	Research in this area should first explore standardization of walk and bike trip data collection techniques to facilitate cross-jurisdiction comparison and extrapolation of findings. To capture walking and bicycling trips, the research may need to incorporate intercept or household/work/school travel surveys, and consider how to use technology or other data to capture active transportation demand. Research should consider ways to focus on person trips and how they are distributed across modes, along with conflicts between modes, and whether assessments should focus on comprehensive planning goals for a corridor or neighborhood rather than only focusing on current conditions and piecemeal development. In addition to improving trip generation study methods and consistency, research could include a scan of potential legislative limitations on if, how and when traffic impact mitigations can be used for active transportation, and how funds can be used (e.g., can they be used for transportation demand management projects, or only for capital improvements?). Research could also include a review of known factors influencing walking and bicycling trip generation.
Research Type	 Best Practices  Tech Transfer
Research Review	Modeling and traffic impact analysis

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<tr><td>Potential Funding Pathways</td><td colspan="3">TRB Cooperative Programs: NCHRP regular process; TCRP
Other: ITE</td></tr>
<tr><td rowspan="2">Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td>Scope and initiate research</td><td>Complete and implement research</td><td>Monitor application of research</td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Planning; Environment and Sustainability
TRB Committees: Pedestrians; Bicycle Transportation; Transportation Demand Forecasting
US DOT: FHWA
Other organizations: ITE</td></tr>
<tr><td rowspan="5">Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td colspan="3">ITE, Recommended Practice on Multimodal Transportation Impact Analysis for Site Development</td></tr>
<tr><td colspan="2">This project would develop a recommended approach to transition from traditional traffic impact analysis to a multimodal transportation impact analysis, and should be monitored for this research, including any traffic studies that inform the effort.</td><td>Initiated 2017</td></tr>
<tr><td colspan="3">FHWA, Methods to Predict Future Pedestrian and Bicyclist Demands to Support Safety Investments</td></tr>
<tr><td colspan="2">Research on this topic should coordinate with this project described in FHWA’s Pedestrian and Bicycle Safety Program Strategic Plan.</td><td>Anticipated, 2021-2022</td></tr>
<tr><td>Related RNSs</td><td colspan="3">None Identified</td></tr>
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Research Topic	***C21: Methods to prioritize different modes across the network in planning processes***
Overview	High-quality infrastructure for active transportation is often not prioritized in transportation planning and programming. One factor is the lack of adequate tools. For example, regional travel demand models may offer limited insight into active travel modes (see research need *B7: Incorporating active transportation into travel demand modeling*). These models, along with standards and analysis procedure manuals, are often more robust, precise, and valid at analyzing motor vehicle travel. Other factors relate to transportation agency standards and methods that prioritize vehicle mobility about other modes (see Research Problem Statement *A4*: *Addressing barriers to integrating active transportation throughout planning and engineering practice*). In addition, planners may be unsure how to effectively introduce prioritization frameworks into a public process and how to gain consensus for prioritizing active travel modes above other priorities.
Research Objectives	Research on this topic could examine more innovative approaches that would lead to decisions that prioritize active transportation in planning processes at the regional, county, city, and subarea scale, as well as project programming at the city, regional, and state levels (e.g., TIPs). Possible approaches include: • Scenario planning, which may demonstrate trade-offs between different modal priorities given different objectives (e.g., GHG reduction, safety, equity, congestion, etc.). • Performance-based practical design, which uses a "design up" approach and performance analysis to identify improvements to meet project and system objectives. • Multicriteria decision-making, which considers multiple criteria using both quantitative and qualitative data. The research could identify the technical and data needs and gaps for using these methods, and what outputs and processes would be most useful for decision-making and public engagement.
Research Type	 
Research Review	Policy, planning, and decision-making
Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process; Synthesis **Other:** FHWA

Research Timeline	*2021 – 2022*	*2023 – 2026*	*2027 and later*
	Monitor and coordinate with related research needs in this Roadmap	Scope and initiate research	Complete and implement research
Research Partners	**AASHTO Committees**: Planning **TRB Committees**: City Transportation Issues Coordinating Council US DOT: Other organizations:		
Related Projects	***Description/Connection***		***Status***
	NCHRP 15-78: Guidebook for Urban and Suburban Roadway Cross-Sectional Reallocation		
	This NCHRP project will "develop a guidebook and decision-making framework for roadway designers, planners, and others for identifying, comparing, evaluating, and justifying context-based cross-sectional reallocations of existing urban and suburban roadway space for multimodal safety, access, and mobility." The project will not address larger-scale planning, such as for a subarea, city, county, or region.		Underway, starting June 2020
	NCHRP 08-149: Impacts of Active Transportation Network Gaps		
	Monitor this project focused on the causes and impacts of gaps in the active transportation network.		Start 2021
	FHWA, Safe System Approach to Link Design Decisions to the Safety of Nonmotorized Road Users; Outreach and Implementation Assistance to Increase the Use and Selection of Bicycle Facilities in the United States		
	Research on this topic should coordinate with these projects described in FHWA's *Pedestrian and Bicycle Safety Program Strategic Plan*.		Anticipated, 2021-2022
Related RNSs	None identified		

Other planning needs

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D28: Impacts of bicycle facility design on air pollution exposure concentrations	Modeling and traffic impact analysis Policy, planning and decision-making	None identified	None identified
D33: Incorporating air pollution exposure of active transportation users in planning and forecasting	Modeling and traffic impact analysis Policy, planning and decision-making	None identified	None identified
D34: Incorporating physical activity and health outcomes of active transportation in transportation planning	Policy, planning and decision-making	None identified	None identified
D35: Innovation in funding active transportation projects	Economic benefits of walking and bicycling Policy, planning and decision-making	Impacts of Bicycle Infrastructure Investments on Economic Vitality (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=38923	None identified

Research Needs: Policy and Practice

Highest Priority: Research Problem Statements

A4 Addressing barriers to integrating active transportation throughout planning and engineering practice

High Priority: Research Need Briefs

No policy and practice needs were in the high-priority tier.

Medium Priority: Research Need Briefs

C4 Best practices in systematic approaches and interagency collaboration to improve active transportation safety

C8 Economic benefits of active transportation infrastructure

Lower Priority

D7 Building political support for active transportation

D13 Effectiveness and impacts of rail anti-trespass education

D14 Effectiveness of driver education and licensing requirements at improving active transportation safety, including for older drivers

D15 Effectiveness of educational interventions for increasing bicycling among adults, including underserved populations

D16 Effectiveness of educational interventions for increasing bicycling among children

D17 Effectiveness of educational interventions for older pedestrians

D19 Examination of the role of driving culture on active transportation safety and use

D25 How to increase the adoption of innovative traffic control devices and infrastructure

D41 Public perceptions and communicating the benefits of active transportation

Problem Title	***A4: Addressing barriers to integrating active transportation throughout planning and engineering practice***
Background	Walking, bicycling, and rolling needs should be considered in nearly all transportation agency projects. There are several informative national guidance documents to aid practitioners working in active transportation: • *Bike Network Mapping Idea Book* (FHWA, 2016). • *Case Studies in Delivering Safe, Comfortable, and Connected Pedestrian and Bicycle Networks* (FHWA, 2015). • *Guidebook for Developing Pedestrian and Bicycle Performance Measures* (Semler et al., 2016). • *Guidebook for Measuring Multimodal Network Connectivity* (Twaddell et al., 2018). • *Incorporating On-Road Bicycle Networks into Resurfacing Projects* (FHWA, 2015). • *Noteworthy Local Policies That Support Safe and Complete Pedestrian and Bicycle Networks* (Louch et al., 2016). • *Separated Bike Lane Planning and Design Guide* (FHWA et al., 2015). • *Small Town and Rural Multimodal Networks,* (Dickman et al., 2016). • *Strategies for Accelerating Multimodal Project Delivery* (Raulerson et al., 2018). However, despite such guidance and tools, walking, bicycling, and rolling are often neglected or considered only as an afterthought. This points to the need for deeper institutional change to ensure that adequate policies are adopted and implemented effectively.
Literature Search Summary	There is some limited research that helps explain why active transportation infrastructure and policies are (or are not) widely adopted. That research identified factors such as: political leadership and local advocacy; certain motivations and political arguments; taking advantage of timely opportunities and experiments; and increased learning and training, including exposure to places with high levels of bicycling and walking (Dill et al., 2017; Wilson & Mitra, 2020; McLeod et al., 2020). However, there are few studies that examine policy transfer in transportation, particularly active transportation. Carefully documented case studies of successes and failures in policy adoption and planning for active transportation can help inform current efforts, but these are rare. There are applicable theories from other disciplines that help explain the processes of policy learning, policy transfer, and learning transfer – theories that examine how knowledge gets transferred and implemented between and within agencies (Glaser et al., 2019; Marsden & Reardon, 2017; Marsden & Stead, 2011). Theories of organizational culture and change among public agencies are also relevant (Fernandez & Rainey, 2006). One review compared “top-down” and “bottom-up” approaches to understand how transportation policy gets implemented. Both provide insights, though bottom-up approaches recognize the dispersed nature of who controls implementation, including lower-level personnel who have discretion and knowledge of the system (Marsden & Reardon, 2017). The “bottom-up” approach highlights the role of professional staff

	who can influence implementation. The 2010 survey of state DOT staff involved in active transportation revealed that lack of support from mid-level management was tied for the second-highest ranked barrier to implementation (after funding and tied with technical expertise among staff) (Dill et al., 2017). There is little research on how to effectively change the actions of professionals who can help or hinder implementation of active transportation policies at all levels of an agency. The NCHRP has sponsored several projects that focus on how state DOTs operate. In 2001, NCHRP published a series of documents on *Managing Change in State Departments of Transportation* that touch on some of the topics in this research need. One of the scans for that project identified several keys to strategic leadership: widespread participation of internal and external stakeholders; a customer orientation; top management commitment; a deliberate pace and frequent reinforcement in implementation; ongoing communication; and aligning customer concerns and agency goals (Poister & Van Slyke, 2001). More recently, NCHRP Report 750 *Strategic Issues Facing Transportation* looked at "Sustainability as an Organizing Principle for Transportation Agencies." That research found that about 60% of state DOTs had sustainability performance measures or indicators, though only about 20% used them for project prioritization. The report found that "[s]ustainability will require substantial culture change, both within agencies and among public and state leaders" (National Academies of Science, 2014, p. 9). Some of the findings from that work could inform this research. There may also be lessons from agencies that have shifted to a data-driven approach to safety, including the use of performance measures.
Research Objective	This research will (1) identify and assess the barriers to embedding active transportation throughout planning and engineering practice within public agencies and (2) identify strategies to overcome those barriers. The research should focus on internal barriers that can be influenced and changed directly by public agencies. The research would involve comparative case studies of transportation agencies in the U.S. Additional data collection could involve a survey of practitioners, focus groups, or other appropriate methods. The research would use relevant theory from transportation and other disciplines. The findings would both assess the barriers to embedding active transportation throughout planning and engineering practice within agencies, and identify successes in overcoming those barriers. The barriers and factors considered in the research would focus on internal factors and include, but not be limited to, the following: • organizational structure and scale (including the position of the state bicycle and pedestrian coordinator); • political and administrative leadership (including the influence on leadership by outside organizations); • staff knowledge, experience, and attitudes; • research or information gaps and the application of outdated or inaccurate information and data; • reliance on inflexible, outdated, or inappropriate manuals and other guidance; • use and influence of agency performance measures; • funding levels and structures; • rationales used to support active transportation efforts;

	• project and plan timing, including windows of opportunity and use of experiments and tactical approaches; • training and professional development; • professional and learning networks, including peer exchanges; • workforce characteristics; and • equity and systemic biases. The strategies for overcoming the barriers would cover all levels of an agency – from top leadership through all levels of staff, advisory and public outreach activities, and contracting practices. Project tasks would include the following: 1. Review of existing research. The review would cover relevant theories from other disciplines, such as policy transfer, policy learning, and organizational change and culture, as well as existing case studies from transportation. 2. Develop a research plan. That plan will include case studies. It may also include other data collection methods, such as a survey or focus groups. 3. Identify and select case studies based on selection criteria. The case studies would likely include examples of both success and failure and represent a range of agency, geographic (urban, rural and suburban) and social contexts. 4. Conduct case studies that cover different phases of planning and engineering and any additional data collection efforts. 5. Prepare a report that: (a) reviews the existing research; (b) describes this research effort; (c) identifies the barriers and their relative importance; (d) identifies strategies used to overcome these barriers; and (e) provides clear recommendations of specific actions agencies can undertake to embed active transportation throughout their planning and engineering practices. The report should identify any particular information gaps or the application of inaccurate information that may impede progress in active transportation planning and engineering. Prepare an implementation plan that includes materials for agency leaders that can be used to help them implement the research findings. The plan should also include ideas for future implementation activities that could be undertaken by AASHTO, TRB, FHWA, and other collaborating partners. This would include efforts to fill research gaps, improve the transfer of existing research to practice, and to “mythbust” any inaccurate information found to be a barrier.
Urgency and Potential Benefits	This research would identify barriers and strategies for overcoming those barriers, which public agencies could use to change practice. The benefit would be greater consideration of active transportation throughout planning and engineering processes, leading to greater use of active transportation modes and improved safety and health and reduced emission. The research would help shift the culture of transportation agencies, including a recognition that walking and bicycling are transportation, though the needs of these modes are often different than those of motor vehicles. This shift should lead to agencies including active transportation in all of their efforts by default. Active transportation would also be formalized in procedures.

Implementation Considerations and Supporters	The project report and materials would inform agency leaders, providing them clear guidance on how to affect change in their organization. The implementation plan would also have ideas for what additional steps could further implementation. The CAT could collaborate with the following AASHTO committees on the statement: Planning.
Recommended Research Funding and Research Period	$600,000 24 months
Problem Statement Author(s)	Jennifer Dill, Portland State University Talia Jacobson, Toole Design Group
References	Dickman, D., Falbo, N., Durrant, S., Gilpin, J., Gastaldi, G., Chesston, C., Morrill, P., Ward, C., Walker, W., Jones, B., Cheng, C., Portelance, J., Kack, D., Gleason, R., Lonsdale, T., Nothstine, K., Morgan, J., & Pressly, R. (2016). *Small Town and Rural Multimodal Networks*. Federal Highway Administration. http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/small_towns/fhwahep17024_lg.pdf Dill, J., Smith, O., & Howe, D. (2017). Promotion of Active Transportation among State Departments of Transportation in the U.S. *Journal of Transport & Health*, *5*, pp 163-171. https://doi.org/10.1016/j.jth.2016.10.003 Federal Highway Administration, University of North Carolina, C. H., Sam Schwartz Engineering, & Kittelson & Associates. (2015). *Separated Bike Lane Planning and Design Guide*. http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/separated_bikelane_pdg/separatedbikelane_pdg.pdf Federal Highway Administration. (2015). *Case Studies in Delivering Safe, Comfortable, and Connected Pedestrian and Bicycle Networks*. http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/network_report/network_report.pdf Federal Highway Administration. (2016). *Bike Network Mapping Idea Book* (01605748). http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/bikemap_book/bikemap_book.pdf Federal Highway Administration. (2016). *Incorporating On-Road Bicycle Networks into Resurfacing Projects*. http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/resurfacing/resurfacing_workbook.pdf Fernandez, S., & Rainey, H. G. (2006). Managing successful organizational change in the public sector. *Public administration review*, *66*(2), 168-176. Glaser, M., te Brömmelstroet, M., & Bertolini, L. (2019). Learning to build strategic capacity for transportation policy change: An interdisciplinary exploration.

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Research Topic	*C4: Best practices in systematic approaches and interagency collaboration to improve active transportation safety*
Overview	Recent national trends indicate that safety for people walking and bicycling is not improving in most places. While more agencies have adopted Vision Zero policies and plans, they face challenges at interagency collaboration in implementing those efforts, particularly with respect to active transportation. These interagency challenges range from crash data reporting for bicycle and pedestrian crashes to jurisdictional control of roadways in urban areas (e.g., state highways functioning as urban arterials). There are some tools that provide guidance to help overcome these challenges (see https://safety.fhwa.dot.gov/ped_bike/tools_solve/ for examples), though they may focus more on defining and understanding safety problems (e.g., road safety audits) rather than developing systematic and collaborative solutions that involve multiple agencies. What is often missing is a systematic approach that addresses multiple levels of planning and operations, and works across agencies and organizations in a deliberate way.
Research Objectives	Best practices research, including case studies, focusing on interagency collaboration around active transportation safety that involves multiple levels of government and types of agencies (e.g., law enforcement, public health, etc.). The research should include an evaluation of effectiveness, including examples of what does not work. The case studies could focus on MPOs and cities, if case studies of state DOTs are adequately addressed in current, ongoing research (see below). The case studies should address both efforts to improve safety data (e.g., crash reporting) and safety planning and engineering, in addition to increasing funding for active transportation safety. The research and case studies could also examine governance solutions, such as memoranda of understanding (MOUs), joint task forces, and other mechanisms used in interagency collaboration. Research on effectiveness of systematic Vision Zero planning on active travel safety. How different disciplines, as well as agencies, can contribute to better planning for active transportation safety. Research on how equity is or is not incorporated in planning for active transportation safety, including in the assessment of the problem, the planning process, and solutions. Research could include best practices, and should address all aspects of safety, including enforcement. Case studies of incorporating active transportation safety into regional transportation plans, as well as plans developed by non-transportation agencies, such as health, housing and land use, and police and fire departments.
Research Type	 Best Practices  Tech Transfer

<table>
<tr><td>Research Review</td><td colspan="3">Bicycle and pedestrian data: Safety
Policy, planning and decision-making
Speed management and active transportation</td></tr>
<tr><td>Potential Funding Pathways</td><td colspan="3">TRB Cooperative Programs: NCHRP regular process; Synthesis
Other: FHWA; Transportation Pooled Fund</td></tr>
<tr><td rowspan="2">Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td>Monitor NCHRP 07-31 and FHWA I2</td><td>Scope and initiate research/technology transfer project
Complete and implement research</td><td>Monitor application of research</td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Planning
TRB Committees: Pedestrians; Bicycle Transportation
US DOT: FHWA</td></tr>
<tr><td rowspan="5">Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td colspan="3">NCHRP 07-31: State DOT Usage of Bicycle and Pedestrian Data: Practices, Sources, Needs, and Gaps</td></tr>
<tr><td colspan="2">This project aims to determine how state DOTs are using data and to identify data sources, gaps, and recommendations for developing the data and tools state DOTS need. Safety data and applications are a focus of the project.</td><td>Expected to start in mid-2021</td></tr>
<tr><td colspan="3">FHWA, Implementing Systemic Safety for Pedestrians and Bicyclists; Outreach and Implementation Assistance to Increase the Use and Selection of Bicycle Facilities in the United States</td></tr>
<tr><td colspan="2">Research on this topic should coordinate with these projects described in FHWA's Pedestrian and Bicycle Safety Program Strategic Plan.</td><td>Anticipated, 2021-2022</td></tr>
<tr><td>Related RNSs</td><td colspan="3">None identified</td></tr>
</table>

Research Topic	*C8: Economic benefits of active transportation infrastructure*
Overview	Demonstrating the economic benefits of active transportation infrastructure can be an effective argument to increasing investments. These potential benefits include jobs, wages, sales, property values, and tourism revenue, as well as the economic benefits of improved health outcomes, increased accessibility to destinations, and reduced motor vehicle travel (e.g., lower emissions, congestion). Over the past decade, there has been a growing volume of research linking increased economic activity (e.g., sales, jobs) to active transportation infrastructure, particularly bicycle infrastructure. While economic benefits are rarely a driving factor in most pedestrian safety countermeasures, estimating such benefits may help make the case for more comprehensive pedestrian improvements in commercial areas. The research relating active transportation infrastructure to property values is mixed and focuses on trails and bicycle facilities. There is growing interest in, though less research on, the distribution of such benefits and the potential for infrastructure investments contributing to gentrification. Some research also exists documenting economic outcomes from tourism related to trails infrastructure. There is research estimating the new positive economic value of the health benefits of active transportation, in addition to a handful of tools to estimate those benefits. However, much of this research is from outside the U.S.
Research Objectives	New research on the direct economic impacts (e.g., jobs, sales, real estate prices) should address the following: • Impacts of pedestrian infrastructure in urban areas, complementing the existing research on bicycle infrastructure. • Research on the economic effects of parking removal. • Impacts of pedestrian and bicycle infrastructure in suburban and small towns. • Examining the distribution of benefits by race and income. This would include issues of gentrification, displacement, and employment. The research would also include tools for countering displacement and inequitable distribution of benefits. A meta-analysis or synthesis of existing research on the wide range of economic impacts would be useful to help explain the benefits to a wider audience, including policymakers and the public. A meta-analysis of existing research in North America could be used to help adapt existing tools, such as the Integrated Transport and Health Impact Modelling Tool for the U.S. The outcomes of such tools can be used to estimate the economic benefits related to health outcomes.
Research Type	 Empirical Data  Systematic Review

<table>
<tr><td>Research Review</td><td colspan="3">Economic benefits of walking and bicycling</td></tr>
<tr><td>Potential Funding Pathways</td><td colspan="3">TRB Cooperative Programs: NCHRP regular process
Other: UTCs</td></tr>
<tr><td rowspan="2">Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td>Scope and initiate research</td><td>Complete and implement research</td><td>Monitor application of research</td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Planning
TRB Committees: Pedestrians; Bicycle Transportation
Other organizations: Industry organizations (e.g., bicycle manufacturers) are potential partners for this research.</td></tr>
<tr><td rowspan="5">Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td colspan="3">NCHRP Synthesis 20-05/Topic 52-15: Measuring Investments and Benefits of Active Transportation Investments When Accomplished as Part of Other Roadway Projects</td></tr>
<tr><td colspan="2">Though limited to active transportation as a portion of other road projects, this synthesis should provide useful information for this project.</td><td>Start 2021</td></tr>
<tr><td colspan="3">NCHRP 08-160: Understand the role of transportation infrastructure investment in gentrification and displacement and identify effective policies and strategies to address these effects</td></tr>
<tr><td colspan="2">This project may address the effects of active transportation infrastructure on gentrification and displacement.</td><td>Anticipated 2021-22</td></tr>
<tr><td>Other Ongoing Research</td><td colspan="3">GA DOT: Economic Impact of Bicycling in Georgia (Start 2017, End 2021).
CAMMSE (UTC): Quantification of Societal Bicycle Impacts (Phase III) (Start 2019, End 2021).</td></tr>
<tr><td>Related RNSs</td><td colspan="3">Economic development impact of active transportation infrastructure in rural communities (ACH20, Bicycle Transportation) https://rns.trb.org/details/dproject.aspx?n=43242
Impacts of Bicycle Infrastructure Investments on Economic Vitality (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=38923</td></tr>
</table>

Other policy and practice needs

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D7: Building political support for active transportation	Policy, planning and decision-making	Impacts of Bicycle Infrastructure Investments on Economic Vitality (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=38923 Sociocultural Factors Impacting Bicycle Use (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=38926	None identified
D13: Effectiveness and impacts of rail anti-trespass education	Bicycles at intersections: Design and safety Policy, planning and decision-making	Pedestrian "Shortest Path" Considerations as An Approach to Reducing Railroad Trespassing (AHB60, Highway/Rail Grade Crossings) https://rns.trb.org/dproject.asp?n=42535 Evaluation of Rail Trespasser Warning Systems (AHB60, Highway/Rail Grade Crossings) https://rns.trb.org/details/dproject.aspx?n=42482 Railroad and Rail-Transit Trespasser and Suicide Incident and Casualty Data Synthesis (AHB60, Highway/Rail Grade Crossings) https://rns.trb.org/details/dproject.aspx?n=42532 Effectiveness and Impacts of Rail Anti-Trespass Education (AHB60, Highway/Rail Grade Crossings) https://rns.trb.org/details/dproject.aspx?n=42533 Rail Trespass Prevention Countermeasures: Empirical Evidence of Effective Behavior Modification (AHB60, Highway/Rail Grade Crossings) https://rns.trb.org/details/dproject.aspx?n=42534	None identified
D14: Effectiveness of driver education and licensing requirements at improving active transportation safety, including for older drivers	Policy, planning and decision-making	None identified	None identified

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D15: Effectiveness of educational interventions for increasing bicycling among adults, including underserved populations	Bikeways: Ridership and demand Equity and bicycling Policy, planning and decision-making	Sociocultural Factors Impacting Bicycle Use (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=38926	None identified
D16: Effectiveness of educational interventions for increasing bicycling among children	Bikeways: Ridership and demand Policy, planning and decision-making	Sociocultural Factors Impacting Bicycle Use (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=38926	None identified
D17: Effectiveness of educational interventions for older pedestrians	Policy, planning and decision-making	Sociocultural Factors Impacting Bicycle Use (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=38926	None identified
D19: Examination of the role of driving culture on active transportation safety and use	Access management and active transportation Distraction and impairment: Impacts on pedestrian and bicyclist safety Speed management and active transportation	Sociocultural Factors Impacting Bicycle Use (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=38926	None identified

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D25: How to increase the adoption of innovative traffic control devices and infrastructure	Bicycles at intersections: Design and safety Bikeways: Safety and design Policy, planning and decision-making	None identified	FHWA: Safe System Approach to Link Design Decisions to the Safety of Nonmotorized Road Users (Anticipated, PBSP Strategic Plan) NHTSA: Understanding and Using New Pedestrian and Bicycle Facilities (Start 2019, End 2022)
D41: Public perceptions and communicating the benefits of active transportation	Economic benefits of walking and bicycling Policy, planning and decision-making	Sociocultural Factors Impacting Bicycle Use (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=38926	None identified

Research Needs: Safety

Highest Priority: Research Problem Statements

A6 Speed management solutions and strategies to improve pedestrian and bicyclist safety on arterial roadways

High Priority: Research Need Briefs

B8 Safety and operations of separated bike lanes at intersections

B9 Using crash records and surrogate measures to identify safety hotspots and plan bicycle/pedestrian improvements

Medium Priority: Research Need Briefs

C11 Factors uniquely affecting pedestrian and bicyclist safety in rural and small communities

C27 Safety effects of bicycle/motor vehicle mixing zone treatments

C28 Safety effects of curb extensions, curb radius reductions, and truck aprons

C29 Safety effects of separated bike lane configurations

C30 Safety impacts for pedestrians and bicyclists of motor vehicle access management strategies

Lower Priority

D4 Bicyclist safety impacts of driver and bicyclist distraction
D23 Helmet use and impacts on cycling behavior (amount and risk compensation behavior)
D26 Impact of functional declines on older adults' safety and mobility as pedestrians/bicyclists
D27 Impact of vehicle design on pedestrian and bicycle safety, including impacts on crash severity and visibility
D29 Impacts of new micromobility modes, including e-scooters, on pedestrian safety
D30 Impaired pedestrians and safety
D32 Improving data on pedestrian and bicyclist crashes not involving motor vehicles, including on trails
D38 Pedestrian and bicycle safety at freeway ramp termini
D40 Pedestrian safety impacts of distraction among drivers and pedestrians
D43 Qualitative methodologies for understanding active transportation safety and the built environment
D44 Risk analysis and guidance on the time frame for renewing safety performance function development
D48 Safety and operation of shared streets/yield roadways
D49 Safety and operation of shared bus and bike lanes
D50 Safety effects and design of bicycle contraflow lanes
D51 Safety effects of bicycle lane extensions through intersections
D52 Safety effects of bicycle signals
D53 Safety effects of bike boulevards
D54 Safety effects of bike boxes
D55 Safety effects of crossing barriers
D56 Safety effects of edge lanes/advisory bike lanes
D57 Safety effects of gateway treatments and in-street pedestrian crossing signs
D58 Safety effects of leading bicycle intervals
D59 Safety effects of roundabouts for pedestrians and bicyclists
D60 Safety effects of two-stage bicycle turn queue boxes
D62 Understanding local control of speed limit-setting process
D63 Use of surrogate measures for bicyclist and pedestrian safety analysis and monitoring
D64 Using GPS direction-finding and routing to reduce conflicts in high-risk locations, especially in rural areas

Problem Title	*A6: Speed management solutions and strategies to improve pedestrian and bicyclist safety on arterial roadways*
Background	While the role of speed in traffic crashes is a complex topic, research has found unequivocally that higher speeds lead to higher injury severity for vulnerable road users (Sanders et al., 2019). Notably, the risk of serious injury or fatality for pedestrians increases dramatically as vehicle speed on impact increases, with a roughly 13% change of fatality or severe injury at 20 miles per hour (mph), 40% at 30 mph, and 73% at 40 mph (Tefft, 2013). It is also clear that drivers travelling at higher speeds have less time to react to unexpected situations, less recovery time if distracted, and longer braking distance, which contributes to crashes (Boodlal et al., 2015). A safe-systems approach to roadway safety requires a robust speed management effort. On lower-volume roadways, traffic calming strategies with vertical and horizontal deflections (raised speed humps, bumps, chicanes, center turning islands) have a been found to be effective at lowering speeds. Solutions for traffic-speed management along arterials and higher-speed roadways, however, are more limited and often much more challenging to implement. Research has found that higher-speed arterial roadways are associated with both increased frequency and severity of pedestrian and bicycle crashes (Guerra et al., 2019; Lin et al., 2019). There is some evidence that strategies such as road lane reductions, automated speed enforcement, lane width reductions, speed limit reductions, modifications to traffic signal timing, and well-placed landscaping can reduce vehicle speeds. In general, the relationship between lowering vehicle speeds and the magnitude of changes in outcomes for pedestrian and bicycle safety are less clear. Importantly, although the factors relating to the increased risk of speed to people walking will also apply to people bicycling, few studies specifically link bicyclist or pedestrian injury or fatality risk to speed management directly. In addition, research shows that more active travel lowers risk and while research generally suggests that slower motor vehicle speeds encourage more walking or cycling, there is limited research that quantifies this relationship directly. Research, identified as high-priority in the research roadmap for the AASHTO Council on Active Transportation, is needed to 1) demonstrate the impacts of speed management efforts on higher-speed roadways, specifically for people walking and bicycling and 2) provide clear guidance on successful implementation strategies that have balanced lower speeds for some users with safety improvements for others.
Literature Search Summary	There is a research gap quantifying the relationship between lowered vehicle speeds and pedestrian and bicycle safety. In recognition of this, there is a NHTSA project underway (Impact of Lowering Speed on Pedestrian and Bicyclist Safety) that has an objective of answering this question. The project is scheduled for completion in 2023. There is a still a need for a case study that demonstrates successful strategies on higher-speed roadways. Some of the existing research and documents include:

	• Sanders, R. L., Judelman, B., Schooley, S. (2019). *NCHRP Synthesis 535: Pedestrian Safety Relative to Traffic-Speed Management* (01721960; Issue 535). Transportation Research Board. http://www.trb.org/Publications/Blurbs/179827.aspx • Federal Highway Administration. (2014). *Engineering Speed Management Countermeasures: A Desktop Reference of Potential Effectiveness in Reducing Crashes*. U.S. Dept. of Transportation. https://safety.fhwa.dot.gov/speedmgt/ref_mats/eng_count/2014/reducing_crashes.cfm • Neuner, M., Atkinson, J., Chandler, B., Hallmark, S., Milstead, R., Retting, R., Leidos, & Federal Highway Administration. (2016). *Integrating Speed Management within Roadway Departure, Intersections, and Pedestrian and Bicyclist Safety Focus Areas* (01641642; p. 128p). https://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa16017/spd_mgt_rwdpdbik.pdf
Research Objective	The research objective is to produce a guidebook that can be used as a roadmap to speed management on the arterial and higher-speed roadways. The case studies would cover all aspects of speed management - roadway design, enforcement, speed limit setting, self-enforcing roadways, signs, and traffic calming that are appropriate for a range of speeds and road classifications. The final product would be a toolbox of specific recommendations and guidance to implement effective speed management efforts. It would include details on policies and strategies implemented, how much speeds were reduced, evidence of improved safety (both perceived and actual), and documentation of how travel volumes and delays have changed for all modes. Combined with results from the forthcoming NHTSA project, this research would be a powerful and useful tool for understanding how to make changes that improve active transportation safety. Realistically, on some roadways, effective solutions will require greater separation of the modes and this should also be addressed in the case studies. The successful completion of this project, at the minimum, will consist of the following tasks: • Task 1 – A review of the literature and state-of-the-practice inventory to further establish the range of needs and possible case studies. • Task 2 – Identify possible case studies covering the range of needs and roadway types. Develop case study protocol including the need for any new or additional data collection needed. • Task 3 – Prepare an interim report for review and approval by the project panel documenting the literature review, state of the practice, and proposed case study effort. • Task 4 – Execute the case study protocol. • Task 5 – Develop a draft of the case study guidebook documenting the results. • Task 6 – Conduct a small user focus group with the draft guidebook to refine the final product.

	• Task 7 – Prepare final deliverables and guidelines documenting the research.
Urgency and Potential Benefits	Over the past decade, pedestrian fatalities have been steadily increasing and are a significant share of the urban transportation safety problem. Bicycle crashes and fatalities are also a concern. Addressing the problem will require a multifaceted and strategic approach. Reducing speeds, in addition to improving safety, will make many routes more attractive for active transportation. More active travel improves public health and reduces climate impacts of motorized travel. Given the documented relationship between higher-speed roadways and active travel safety and the challenges of managing speed on these roadways, the product of this and other related research is critical to reversing this trend.
Implementation Considerations and Supporters	The guidebook will be of interest and useful to a wide range of traffic engineering, safety and active transportation professionals. The pilot user focus group in Task 6 will provide a template for outreach and additional workshops. The CAT could collaborate with the following AASHTO committees on the statement: JNMTC/Design, Safety, Traffic Engineering. Other organizations with interest in this research include the TRB Standing Committees on Highway Safety, Pedestrian, and Bicycles and NACTO.
Recommended Research Funding and Research Period	$550,000 2 years
Problem Statement Author(s)	Christopher Monsere, Professor, Portland State University Sirisha Kothuri, Portland State University Ryan Martinson, Toole Design Group
References	Agerholm, N., Knudsen, D., & Variyeswaran, K. (2017). Speed-calming measures and their effect on driving speed – Test of a new technique measuring speeds based on GNSS data. *Transportation Research Part F: Traffic Psychology and Behaviour*, 46, 263–270. https://doi.org/10.1016/j.trf.2016.06.022 Boodlal, L., Donnell, E. T., Porter, R. J., Garimella, D., Le, T., Croshaw, K., Himes, S., Kulis, P., & Wood, J. (2015). *Factors Influencing Operating Speeds and Safety on Rural and Suburban Roads*. https://trid.trb.org/view/1356043 Federal Highway Administration. (2014). *Engineering Speed Management Countermeasures: A Desktop Reference of Potential Effectiveness in Reducing Crashes*. U.S. Dept. of Transportation. https://safety.fhwa.dot.gov/speedmgt/ref_mats/eng_count/2014/reducing_crashes.cfm Fitzpatrick, K., Das, S., Texas A&M Transportation Institute, Safety through Disruption University Transportation Center, & Office of the Assistant Secretary for Research and

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Research Topic	***B8: Safety and operations of separated bike lanes at intersections***
Overview	A noted safety concern for separated bike lanes (SBLs) is how to safely manage interactions at intersections. Research suggests that designs that separate bicycle and motor vehicle movements in time (through signal phasing) and space (via maintaining physical separation up to an intersection) are perceived as safe and comfortable by people riding bicycles. However, practitioners need further research to understand the safety implications of treatment selection and design choices so that trade-offs of space, budget, and priority can be evaluated with a safety lens. In particular, crash modification factors (CMFs) are needed to help guide agency decision-making on design options. Needs include identifying turning volume and speed thresholds for varying design types, understanding key design elements such as clear zone and offset distances for visibility and yielding, and accommodating design principles in constrained circumstances. Other research needs include developing evaluation methods that can be easily implemented by jurisdictions to test local applications. This research could encourage engineers and agencies to deploy more SBLs.
Research Objectives	Research in this area would seek to focus on identifying practitioner decision points and constraints for treatment selection, and design approaches identified as likely to improve safety and encourage bicycling. Questions may include: • At what turn volumes and speeds should phase separation be considered? • How can protected intersection principles, including offset bike lane crossings, yielding zones and visibility clear zones be accommodated, including in constrained conditions? • When should other designs, such as bend-in approaches, mixing zones, pocket lanes, and raised crossings be considered, and what conditions dictate which to choose? • How do designs function for more vulnerable people on bicycles, including older adults and children? • How does actual safety relate to perceived safety? This research should coordinate or extend on ongoing research, such as NCHRP 15-73, "Design Options to Reduce Turning Motor Vehicle – Bicycle Conflicts at Controlled Intersections," which runs through 2023.
Research Type	 Empirical Data
Research Review	Bicycles at intersections
Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process **Other:** Transportation Pooled Fund

Research Timeline	***2021 – 2022***	***2023 – 2026***	***2027 and later***
	Monitor ongoing research; Identify elements/thresholds for further research or CMF development	Scope and launch research	Finalize research and guidance outputs
Research Partners	**AASHTO Committees**: Design/JTCNMT; Safety **TRB Committees**: Bicycle Transportation **US DOT**: FHWA **Other organizations**: NACTO		
Related Projects	***Description/Connection***		***Status***
	NCHRP 15-73: Design Options to Reduce Turning Motor Vehicle – Bicycle Conflicts at Controlled Intersections		
	Monitor/coordinate closely with NCHRP 15-73; however, there are many design, safety and selection research questions outstanding.		End 2023
	FHWA: Evaluations of Innovative Intersection Designs for Pedestrian and Bicyclists		
	Monitor this FHWA project investigating protected intersection designs.		*End 2022*
	FHWA: Outreach and Awareness Program on Strategies to Enhance Pedestrian and Bicyclist Safety at Intersections		
	Research on this topic should coordinate with this project described in FHWA's *Pedestrian and Bicycle Safety Program Strategic Plan.*		Anticipated, 2021-22
Other Ongoing Research	FHWA: Development of Crash Modification Factors for Different Separated Bike Lane (SBL) Configurations (End 2022). NCHRP 17-84: Pedestrian and Bicycle Safety Performance Functions for the Highway Safety Manual (Start 2017, End 2021). OR DOT: Impacts of Intersection Treatments and Traffic Characteristics on Bicyclist Safety (Start 2019, End 2021). DC DOT: Pedestrian and Cyclist Intersection Safety Sandbox (Start 2020, End 2022).		
Related RNS	Intersection Sight Distance for Bicyclists (ACH20, Bicycle Transportation) https://rns.trb.org/details/dproject.aspx?n=43238 Design Options to Reduce the Turning Vehicle and Bicycle Crashes at Intersections (AFB10, Geometric Design) https://rns.trb.org/dproject.asp?n=42772 Getting Smart on Protected Intersections (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=42355		

Research Topic	***B9: Using crash records and surrogate measures to identify safety hotspots and plan bicycle/pedestrian improvements***
Overview	Crash data are the primary source of safety analyses. However, crash data suffer from well-known limitations including low frequency, inaccurate or incomplete coding, and exclusion of bicycle and pedestrian crashes due to not meeting reporting requirements. Conflict studies are often used when crash data are not available. An important use of crash records and surrogate safety measures is the identification of locations where pedestrian and bicycle safety hazards exist and improvements should be made. It is critical to address the strengths and weaknesses of these data sources and particularly how these data sources can complement each other. In particular, there is a need to establish the linkage between crashes and surrogate safety measures, which can be particularly useful when there is not enough crash data to make meaningful inferences. If a better understanding can be established between crashes and surrogate safety measures and a correlation exists, a CMF equivalent from surrogates can be developed. Research on this area could also explore how to collect surrogate safety measures across different contexts to conduct comparative safety analyses.
Research Objectives	This research should address the following objectives: • Review the methods agencies are using to identify hotspots and strengths and weaknesses of the approaches. • Develop case studies to assess how crash data and surrogate measures can be used for hotspot identification. • Investigate the linkage between crash data and surrogate measures. Develop guidance on best practices for hotspot identification.
Research Type	 
Research Review	Bicycle and pedestrian data: Safety
Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process **Other:** FHWA

<table>
<tr><td>Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td></td><td>Scope and initiate research
Monitor and coordinate with NCHRP 17-86</td><td>Complete and implement research
Monitor application of research</td><td></td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Safety; Data Management and Analytics
TRB Committees: Pedestrians; Bicycle Transportation; Safety Performance and Analysis
US DOT: NHTSA</td></tr>
<tr><td>Related Projects</td><td colspan="2">Description / Connection</td><td>Status</td></tr>
<tr><td></td><td colspan="3">NCHRP 17-86: Estimating Effectiveness of Safety Treatments in the Absence of Crash Data</td></tr>
<tr><td></td><td colspan="2">A project on this topic would need to coordinate with NCHRP 17-86, which explores surrogate safety measures but is not exclusively focused on active transportation.</td><td>Anticipated completion, 2022</td></tr>
<tr><td></td><td colspan="3">FHWA, Guide to Using Alternative Data Sources to Enhance Police Crash Reporting</td></tr>
<tr><td></td><td colspan="2">Research on this topic should coordinate with this project described in FHWA’s Pedestrian and Bicycle Safety Program Strategic Plan.</td><td>Anticipated, 2021-2022</td></tr>
<tr><td>Related RNSs</td><td colspan="3">Improving Bicyclist and Pedestrian Safety Using Perceived Risk and Surrogate Safety Measures (NCHRP Balloting).</td></tr>
</table>

Research Topic	***C11: Factors uniquely affecting pedestrian and bicyclist safety in rural and small communities***
Overview	Pedestrian and bicycle crashes in rural areas tend to be on higher-speed, two-lane roads, and are much more likely to result in severe or fatal injury. However, pedestrian and bicycle activity and crashes in rural and small communities also tend to be more dispersed, both in time and location, than in urban and suburban communities. This dispersion makes it very challenging to identify bicycle and pedestrian activity patterns (particularly outside of town centers), including volumes and routes, as well as potential safety hotspots or hazards, combining to make cost-effective interventions a challenge. First, research is needed to better understand how to better target active transportation facility interventions in rural areas to make them cost effective. This research should pay particular attention to high-speed, two-lane highways. Further, research is needed to assess how to increase public and political awareness and support of walking and bicycling activity in rural and small communities, which is necessary to implement more improvements.
Research Objectives	Research into this area could evaluate efficacy of before-and-after countermeasures taken to reduce pedestrian and bicycle crashes on rural, high-speed highways. Research could include a scan of best practices in analyzing safety hazards for active transportation users in local rural communities to develop a strategy to: • deploy targeted, cost-effective interventions across a road system, including incorporating active transportation safety considerations into general road projects, along with retrofits. • build out active transportation networks between small/rural communities to provide connectivity, including transition zones into smaller communities. • meet active transportation user safety and comfort needs in small town settings where Main Street is also a highway. Further, research should explore the utility of deploying app-based data sources and other innovative counting technology to provide new insight into rural areas with previously unobserved pedestrian and bicycle activity. Key questions could include whether these sources provide new insight on targeting interventions, and if they provide more complete activity data to make the case for more attention to active transportation safety and facilities. Related to making the case for more investment in walking, bicycling, and rolling in rural and small communities, research is also needed on effective means of building public and political support, which could involve a best practices scan or an evaluation of the efficacy of conveying activity data derived from innovative data sources.
Research Type	 Empirical Data  Best Practices

<table>
<tr><td>Research Review</td><td colspan="3">Rural and small urban areas</td></tr>
<tr><td>Potential Funding Pathways</td><td colspan="3">TRB Cooperative Programs: NCHRP regular process
Other: FHWA; NHTSA</td></tr>
<tr><td rowspan="2">Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td>Scope and initiate research
Monitor MN DOT research</td><td>Complete and implement research</td><td>Monitor application of research</td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Design/JTCNMT; Safety
TRB Committees: Pedestrians; Bicycle Transportation
US DOT: FHWA; NHTSA
Other organizations: UTCs</td></tr>
<tr><td rowspan="3">Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td colspan="3">NCHRP 17-106: Motorist behavior and safety impacts on bicyclists from centerline and shoulder rumble strips on high-speed two-lane highways</td></tr>
<tr><td colspan="2">Findings from this project should be relevant to some rural and small communities.</td><td>Start 2021-22</td></tr>
<tr><td>Other Ongoing Research</td><td colspan="3">CSET (UTC): Barriers and Opportunities for Using Rail-Trails for Safe Travel in Rural, Isolated, and Tribal Communities (Start 2018, End 2020).
CSET (UTC): Assessing the Relative Risks of School Travel in Rural Communities (Start 2020, End 2021).
MN DOT: Understanding Pedestrian Travel Behavior and Safety in Rural Settings (Start 2019, End 2023).</td></tr>
<tr><td>Related RNSs</td><td colspan="3">Economic development impact of active transportation infrastructure in rural communities (ACH20, Bicycle Transportation) https://rns.trb.org/details/dproject.aspx?n=43242
Edge Lane Roads: Operations and Safety in Rural and Urban Areas (ACH20, Bicycle Transportation) https://rns.trb.org/details/dproject.aspx?n=43240
Advisory Bicycle Lanes – A New Facility for North America Needing Investigation (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=42163</td></tr>
</table>

Research Topic	***C27: Safety effects of bicycle/motor vehicle mixing zone treatments***
Overview	In a mixing zone treatment, bicyclists and turning motor vehicles enter a shared lane upstream of the intersection, such that the interaction or potential conflict occurs as they are entering the shared lane, rather than when the motorist is completing the turn. The design positions bicyclists directly in front of approaching motorists, which should increase visibility. Initial studies have found mixing zones to be associated with increased yielding and reductions of bicycle-motorist conflicts, although there are questions about how long they should be, and at what speeds and turning volumes they are appropriate. They are also associated with reduced perceived safety by people on bicycles, particularly for less experienced or less confident riders. As cities consider design options, they will need to better understand the preferred dimensions, configurations and signage for mixing zones, and to weigh the potential safety benefits of mixing zones in light of efforts to promote an appealing and comfortable bicycle network.
Research Objectives	Research should seek to provide clear findings on: • Thresholds for mixing zone versus fully separated phasing or other treatments. • Preferred mixing zone dimensions, including mixing zone storage distance and merging entry location and length; other features such as signage, yield or other markings; and usage of posts or other vertical markers to delineate entry area. • Studies have also found inconsistent use of mixing zones by bicyclists, particularly in terms of lateral positioning. Research could explore appropriate bicyclist positioning for maximum visibility, driver yielding and safety, as well as designs that promote such positioning. • Acceptability of mixing zone treatments by different users, including older adults or children. • CMFs based on right-turn volume, including congested versus free flow conditions.
Research Type	 Empirical Data
Research Review	Bicycles at intersections: Design and safety
Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process **Other:** FHWA; Transportation Pooled Fund

Research Timeline	***2021 – 2022***	***2023 – 2026***	***2027 and later***
	Scope and initiate research Monitor and coordinate with NCHRP 15-73	Complete and implement research	Monitor application of research
Research Partners	**AASHTO Committees**: Design/JTCNMT; Safety **TRB Committees**: Bicycle Transportation; Safety Performance and Analysis **US DOT**: FHWA **Other organizations**: NACTO; Local DOTs		
Related Projects	***Description/Connection***		***Status***
	NCHRP 15-73: Design Options to Reduce Turning Motor Vehicle – Bicycle Conflicts at Controlled Intersections		
	Monitor NCHRP 15-73 for findings related to SBL safety at intersections.		Expected completion, 10/2/23
	FHWA, Outreach and Awareness Program on Strategies to Enhance Pedestrian and Bicyclist Safety at Intersections; Enhancing Highway Safety Manual Guidance on Pedestrian and Bicyclist Countermeasures		
	Research on this topic should coordinate with these projects described in FHWA's *Pedestrian and Bicycle Safety Program Strategic Plan*.		Anticipated, 2021-2022
Other Ongoing Research	OR DOT: Impacts of Intersection Treatments and Traffic Characteristics on Bicyclist Safety (Start 2019, End 2021). D DOT: Pedestrian and Cyclist Intersection Safety Sandbox (Start 2020, End 2022).		
Related RNSs	Design Options to Reduce the Turning Vehicle and Bicycle Crashes at Intersections (AFB10, Geometric Design) https://rns.trb.org/dproject.asp?n=42772		

Research Topic	***C28: Safety effects of curb extensions, curb radius reductions, and truck aprons***
Overview	Higher vehicle-turning speeds and longer crossing distances are two important factors that affect the perceived and actual safety of people walking and bicycling at intersections. Curb radius reductions, including the use of truck aprons, and curb extensions are tools to slow turning speeds and reduce crossing distances. These elements have additional benefits of increasing visibility. These designs elements may be valuable tools for designing safer pedestrian and bicycle crossings, including use in innovative bicycle facilities such as protected intersections. Although initial research suggests that these facilities are associated with reduced turning speeds and reduced pedestrian crash severities, CMFs have not yet been developed for either. Raised crossings have demonstrated safety effects for pedestrians and are widely used in the international context to improve bicycle safety. More information is needed on the safety and contextual implementation, such as minimum radius by functional classification, turning volume, and other usage/access factors.
Research Objectives	This research should seek to organize and add to the existing (and in-progress) research in this area. Potential steps to do this include: • Scan of academic literature and agency reports for any evaluations looking at before-and-after conflicts, yielding, and turning speeds. • Scan for locations with crash data before and after implementations of curb extensions, curb radius reductions and truck aprons, including consideration of the combination of elements included at each location (e.g., Were they part of a protected intersection? Was there a crossing median island? Was it a signalized intersection?). • Document, along with best practices for maintaining essential local access for residents, businesses, and emergency vehicles (e.g., through measures such as truck aprons). • Assess need for additional CMFs based on facility type and context. Consider what gaps could potentially be filled through further analysis of the materials identified through the literature scan and scan of locations (e.g., using existing crash data). • If needed, conduct additional data collection to develop needed CMFs. • Gather scan and new analysis material into a guidance resource for contextual application of curb extensions, curb radius reductions and truck apron.
Research Type	
Research Review	Bicycles at intersections: Design and safety Pedestrian crossings: Design and safety

<table>
<tr><td>Potential Funding Pathways</td><td colspan="3">TRB Cooperative Programs: NCHRP regular process
Other: FHWA; Transportation Pooled Fund</td></tr>
<tr><td rowspan="2">Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td>Scope and initiate research (scans)
Monitor and coordinate with NCHRP 15-73</td><td>Conduct CMF analyses
Complete and implement research</td><td>Monitor research</td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Design/JTCNMT; Safety
TRB Committees: Safety Performance and Analysis; Pedestrians; Bicycle Transportation
US DOT: FHWA
Other organizations: NACTO; State or Local DOTs</td></tr>
<tr><td rowspan="6">Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td colspan="3">NCHRP 15-73: Design Options to Reduce Turning Motor Vehicle -Bicycle Conflicts at Controlled Intersections</td></tr>
<tr><td colspan="2">Monitor NCHRP 15-73 for findings related to SBL safety at intersections. Research results should provide some additional safety knowledge, particularly for curb radius reductions in bicycle intersection designs.</td><td>Expected completion, 10/2/23</td></tr>
<tr><td colspan="3">FHWA, Outreach and Awareness Program on Strategies to Enhance Pedestrian and Bicyclist Safety at Intersections
Enhancing Highway Safety Manual Guidance on Pedestrian and Bicyclist Countermeasures
Outreach and Awareness Program on Strategies to Effectively Manage the Curbside to Serve All Users</td></tr>
<tr><td colspan="2">Research on this topic should coordinate with these projects described in FHWA's Pedestrian and Bicycle Safety Program Strategic Plan.</td><td>Anticipated, 2021-2022</td></tr>
<tr><td>Related RNSs</td><td colspan="3">Intersection Sight Distance for Bicyclists (ACH20, Bicycle Transportation) https://rns.trb.org/details/dproject.aspx?n=43238
Evaluating the Effectiveness of Geometric Design Measures for Reducing Speeds (ACH10, Pedestrians) https://rns.trb.org/details/dproject.aspx?n=42722
Effectiveness of Intersection Turning Speed Reduction Strategies (ACH10, Pedestrians) https://rns.trb.org/details/dproject.aspx?n=43173</td></tr>
</table>

Research Topic	*C29: Safety effects of separated bike lane configurations*
Overview	As jurisdictions look to provide safe and comfortable bike facilities for current and potential bicyclists, separated bike lanes (SBLs) have emerged as a major tool. Better information about SBL safety effects, including for different SBL configurations and contexts, would provide practitioners with the information needed to implement more and safer facilities. There are several major research efforts ongoing that are looking at safety for on-street bicycle facilities and bicycle conflicts at intersections. However, due to the large variety of SBL configurations and contexts, along with challenges in acquiring or developing crash and exposure data, there will likely be remaining gaps. For example, much of the research on SBLs has focused on right-side, one-way lanes. Two-way SBLs and left-side SBLs offer potential for increased ridership or improved flow in some contexts, but remain understudied. Further, with limited crash modification factors existing for SBLs, there will likely be an ongoing need for further research on safety impacts related to bike lane configuration, widths to accommodate different volumes and user types, lane/curb height relative to roadways and sidewalks, buffer width and type, and more.
Research Objectives	Research in this area could include best practice scans, particularly to better document and understand how to safely implement various SBL configurations, and new empirical research to better document safety effects of various SBL factors. Best practice scans and case studies could be conducted related to: • Two-way SBL safety, including driveway locations, intersections, best practices for handling bicyclist and motorist turning movements, concurrent traffic signals, LPIs, and mitigation strategies for complications associated with two-way SBLs (e.g., motorist expectations); and, • Left-side SBLs, particularly on one-way streets – design considerations. Findings from the best practices scan findings and monitoring of ongoing research, particularly NCHRP 15-74, identify designs and context for SBLs that require further safety assessment, such as development of crash modification factors or safety performance functions. In particular, consider one-way vs two-way SBLs, compared to a bike lane or no bike facility, left-side vs right-side SBLs, compared to a bike lane or no bike facility, SBL width, and buffer type and width. Other factors could include driveway spacing and segment length.
Research Type	 
Research Review	Bicycles at intersections: Design and safety Bikeways: Ridership and demand Bikeways: Safety and design

<table>
<tr><td>Potential Funding Pathways</td><td colspan="3">TRB Cooperative Programs: NCHRP regular process
Other: FHWA; UTCs</td></tr>
<tr><td rowspan="2">Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td>Best practice scan
Monitor NCHRP 15-74; 15-73; and FHWA research</td><td>Scope and implement safety research</td><td>Monitor application of research</td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Design/JTCNMT; Safety
TRB Committees: Bicycle Transportation; Safety Performance and Analysis
US DOT: FHWA
Other organizations: NACTO</td></tr>
<tr><td rowspan="8">Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td colspan="3">NCHRP 15-74: Safety Evaluation of On-Street Bicycle Facility Design Features</td></tr>
<tr><td colspan="2">NCHRP 15-74 will assess safety impacts of on-street bicycle facilities, including SBLs. There will likely be gaps and further research needed to delineate different SBL configurations and contexts.</td><td>Expected completion, 8/31/2023</td></tr>
<tr><td colspan="3">NCHRP 15-73: Design Options to Reduce Turning Motor Vehicle - Bicycle Conflicts at Controlled Intersections</td></tr>
<tr><td colspan="2">Monitor NCHRP 15-73 for findings related to SBL safety at intersections.</td><td>Expected completion, 10/2/23</td></tr>
<tr><td colspan="3">FHWA: Development of Crash Modification Factors for Different Separated Bike Lane Configurations</td></tr>
<tr><td colspan="2">Monitor this project evaluating the safety of SBL facilities for remaining gaps and CMF needs.</td><td>Expected completion, 2022</td></tr>
<tr><td>Other Ongoing Research</td><td colspan="3">NC DOT: Assessment of Separated Bike Lane (SBL) Applications in North Carolina (Start 2019, End 2021).</td></tr>
<tr><td>Related RNSs</td><td colspan="3">None identified</td></tr>
</table>

Research Topic	***C30: Safety impacts for pedestrians and bicyclists of motor vehicle access management strategies***
Overview	Access management (AM) techniques for highways and arterials are designed to control flow and access by focusing on access and exit locations and methods. Some AM techniques offer the potential to reduce bicyclist and pedestrian conflict points and improve safety, such as those that space out driveway access, add medians, and add turning lanes. However, AM can also promote higher speeds, which is associated with higher safety risk. A better understanding is needed of the safety impacts for active transportation road users of access management techniques.
Research Objectives	Research in this area could include a holistic assessment of pedestrian and bicyclist safety impacts of access management techniques, including weighing the potential for increased speeds against integration of pedestrian and bicyclist safety measures for crossings, driveways, and turning maneuvers. Best practice and tech transfer projects in this area could explore how to maximize bicycle and pedestrian safety when implementing access management techniques, including what project elements should be included in different contexts. Additional evaluations, focusing on impacts on active transportation road users, of specific AM treatments may also be needed to better inform practitioners on allowed and preferred approaches.
Research Type	 Empirical Data  Best Practices
Research Review	Access management and active transportation
Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process **Other:** FHWA; Transportation Pooled Fund

Research Timeline	***2021 – 2022***	***2023 – 2026***	***2027 and later***
	Best practices scan; assessment of research needs	Complete research; development of guidance	

Research Partners	**AASHTO Committees**: Design/JTCNMT; Safety **TRB Committees**: Pedestrians; Bicycle Transportation; Safety Performance and Analysis; Access Management **US DOT**: FHWA

Related Projects	***Description/Connection***	***Status***
	NCHRP 25-47: How to Measure and Communicate the Value of Access Management	
	While not focused on active transportation, this project may include findings related to the value of access management for active transportation users.	Start 2018, End 2021
	NCHRP 17-106: Motorist behavior and safety impacts on bicyclists from centerline and shoulder rumble strips on high-speed two-lane highways	
	Not specific to access management, but may include some related research questions.	Start 2021-22
Other Ongoing Research	NCREP: The Impact of Access Management Techniques on Driver Behaviors (Start 2018, End 2021).	
Related RNSs	Determining Target Speeds for Setting Posted Speed Limits (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=43248 Designing for Target Speed (AFB10, Geometric Design) https://rns.trb.org/details/dproject.aspx?n=42542	

Other safety needs

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D4: Bicyclist safety impacts of driver and bicyclist distraction	Distraction and impairment: Impacts on pedestrian and bicyclist safety	None identified	FHWA: Mainstreaming and Awareness for the Safe Use of Walking and Bicycling Facilities (Anticipated, PBSP Strategic Plan) FLDOT: Determining Sample Measures of Distracted Driving, Distracted Pedestrian Activities and Impacts of Such Behavior on Traffic Operations at Signalized Intersections (Start 2019, End 2021)
D23: Helmet use and impacts on cycling behavior (amount and risk compensation behavior)	Bicycle and pedestrian data: Safety	None identified	FHWA: Mainstreaming and Awareness for the Safe Use of Walking and Bicycling Facilities (Anticipated, PBSP Strategic Plan)
D26: Impact of functional declines on older adults' safety and mobility as pedestrians/ bicyclists	Distraction and impairment: Impacts on pedestrian and bicyclist safety	Active Transportation Design for All Ages and Abilities (ACH10, Pedestrians)	None identified
D27: Impact of vehicle design on pedestrian and bicycle safety, including impacts on crash severity and visibility	Autonomous and connected vehicles Bicycle and pedestrian data: Safety Speed management and active transportation	Intersection Sight Distance for Bicyclists (ACH20, Bicycle Transportation) https://rns.trb.org/details/dproject.aspx?n=43238	None identified
D29: Impacts of new micromobility modes including e-scooters on pedestrian safety	Micromobility, including e-scooters	None identified	None identified

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D30: Impaired pedestrians and safety	Distraction and impairment: Impacts on pedestrian and bicyclist safety	None identified	FHWA: Mainstreaming and Awareness for the Safe Use of Walking and Bicycling Facilities (Anticipated, PBSP Strategic Plan) TX DOT: Identify Risk Factors that Lead to Increase in Fatal Pedestrian Crashes and Develop Countermeasures to Reverse Trend (Start 2019, End 2021)
D32: Improving data on pedestrian and bicyclist crashes not involving motor vehicles, including on trails		None identified	TX DOT: Identify Risk Factors that Lead to Increase in Fatal Pedestrian Crashes and Develop Countermeasures to Reverse Trend (Start 2019, End 2021)
D38: Pedestrian and bicycle safety at freeway ramp termini	Bicycles at intersections: Design and safety	None identified	None identified
D40: Pedestrian safety impacts of distraction among drivers and pedestrians	Distraction and impairment: Impacts on pedestrian and bicyclist safety	None identified	FHWA: Mainstreaming and Awareness for the Safe Use of Walking and Bicycling Facilities (Anticipated, PBSP Strategic Plan) TX DOT: Identify Risk Factors that Lead to Increase in Fatal Pedestrian Crashes and Develop Countermeasures to Reverse Trend (Start 2019, End 2021) FLDOT: Determining Sample Measures of Distracted Driving, Distracted Pedestrian Activities and Impacts of Such Behavior on Traffic Operations at Signalized Intersections (Start 2019, End 2021)
D43: Qualitative methodologies for understanding active transportation safety and the built environment	Bicycle and pedestrian data: Safety	Creating and Integrating Relevant Nonmotorized Datasets (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=42354 Improving Bicyclist and Pedestrian Safety Using Perceived Risk and Surrogate Safety Measures (NCHRP Balloting)	FHWA: Guide to Using Alternative Data Sources to Enhance Police Crash Reporting (Anticipated, PBSP Strategic Plan) TX DOT: Identify Risk Factors that Lead to Increase in Fatal Pedestrian Crashes and Develop Countermeasures to Reverse Trend (Start 2019, End 2021)

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D44: Risk analysis and guidance on the time frame for renewing safety performance function development	Bicycle and pedestrian data: Safety Policy, planning and decision-making	None identified	FHWA: Implementing Systemic Safety for Pedestrians and Bicyclists (Anticipated, PBSP Strategic Plan) TX DOT: Identify Risk Factors that Lead to Increase in Fatal Pedestrian Crashes and Develop Countermeasures to Reverse Trend (Start 2019, End 2021) NCHRP 17-84: Pedestrian and Bicycle Safety Performance Functions for the Highway Safety Manual (Start 2017, End 2021) TX DOT: Addressing Bicyclist Safety through the Development of Crash Modification Factors for Bikeway Facilities (Start 2019, End 2022) FHWA: Development of Crash Modification Factors for Different Separated Bike Lane Configurations
D48: Safety and operation of shared streets/yield roadways	Bikeways: Safety and design	Edge Lane Roads: Operations and Safety in Rural and Urban Areas (ACH20, Bicycle Transportation) https://rns.trb.org/details/dproject.aspx?n=43240 Safety Effectiveness Evaluation of Innovative On-Street Bikeway Designs (OR) Development of Crash Modification Factors and Design Guidelines for Innovative On-Street Bikeway Designs (AFB10, Geometric Design) https://rns.trb.org/dproject.asp?n=42538 Advisory Bicycle Lanes – A New Facility for North America Needing Investigation (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=42163 Safety Evaluation of Innovative On-Street Bikeway Designs (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=42636	FHWA: Enhancing Highway Safety Manual Guidance on Pedestrian and Bicyclist Countermeasures (CMF/SPF Development) (Anticipated, PBSP Strategic Plan) NCHRP 15-74: Safety Evaluation of On-Street Bicycle Facility Design Feature (Start 2020, End 2023)

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D49: Safety and operation of shared bus and bike lanes		None identified	FHWA: Enhancing Highway Safety Manual Guidance on Pedestrian and Bicyclist Countermeasures (CMF/SPF Development) (Anticipated, PBSP Strategic Plan) NCHRP 15-74: Safety Evaluation of On-Street Bicycle Facility Design Feature (Start 2020, End 2023) UMEC (UTC): Shared Bus/Bike Lane Safety Analysis: Assessing Multimodal Access and Conflicts (Start 2018, End 2020)
D50: Safety effects and design of bicycle contraflow lanes	Bikeways: Safety and design	Safety Effectiveness Evaluation of Innovative On-Street Bikeway Designs (OR) Development of Crash Modification Factors and Design Guidelines for Innovative On-Street Bikeway Designs (AFB10, Geometric Design) https://rns.trb.org/dproject.asp?n=42538 Safety Evaluation of Innovative On-Street Bikeway Designs (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=42636	FHWA: Enhancing Highway Safety Manual Guidance on Pedestrian and Bicyclist Countermeasures (CMF/SPF Development) (Anticipated, PBSP Strategic Plan) NCHRP 15-74: Safety Evaluation of On-Street Bicycle Facility Design Feature (Start 2020, End 2023)
D51: Safety effects of bicycle lane extensions through intersections	Bicycles at intersections: Design and safety	Design Options to Reduce the Turning Vehicle and Bicycle Crashes at Intersections (AFB10, Geometric Design) https://rns.trb.org/dproject.asp?n=42772	FHWA: Evaluations of Innovative Intersection Designs for Pedestrian and Bicyclists (End 2022) FHWA: Enhancing Highway Safety Manual Guidance on Pedestrian and Bicyclist Countermeasures (CMF/SPF Development) (Anticipated, PBSP Strategic Plan) NCHRP 15-73: Design Options to Reduce Turning Motor Vehicle – Bicycle Conflicts at Controlled Intersections (Start 2020, End 2023) OR DOT: Impacts of Intersection Treatments and Traffic Characteristics on Bicyclist Safety (Start 2019, End 2021) D DOT: Pedestrian and Cyclist Intersection Safety Sandbox (Start 2020, End 2022)

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D52: Safety effects of bicycle signals	Bicycles at intersections: Design and safety	Optimal Methods to Communicate Allowable Protected, or Permissive Movements to Bicyclists at Signalized Intersections (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=43256	FHWA: Evaluations of Innovative Intersection Designs for Pedestrian and Bicyclists (End 2022) FHWA: Enhancing Highway Safety Manual Guidance on Pedestrian and Bicyclist Countermeasures (CMF/SPF Development) (Anticipated, PBSP Strategic Plan)
D53: Safety effects of bike boulevards	Bikeways: Safety and design	None identified	FHWA: Enhancing Highway Safety Manual Guidance on Pedestrian and Bicyclist Countermeasures (CMF/SPF Development) (Anticipated, PBSP Strategic Plan) NCHRP 15-74: Safety Evaluation of On-Street Bicycle Facility Design Feature (Start 2020, End 2023)
D54: Safety effects of bike boxes	Bicycles at intersections: Design and safety	Design Options to Reduce the Turning Vehicle and Bicycle Crashes at Intersections (AFB10, Geometric Design) https://rns.trb.org/dproject.asp?n=42772	FHWA: Evaluations of Innovative Intersection Designs for Pedestrian and Bicyclists (End 2022) FHWA: Enhancing Highway Safety Manual Guidance on Pedestrian and Bicyclist Countermeasures (CMF/SPF Development) (Anticipated, PBSP Strategic Plan) NCHRP 15-73: Design Options to Reduce Turning Motor Vehicle – Bicycle Conflicts at Controlled Intersections (Start 2020, End 2023) OR DOT: Impacts of Intersection Treatments and Traffic Characteristics on Bicyclist Safety (Start 2019, End 2021) D DOT: Pedestrian and Cyclist Intersection Safety Sandbox (Start 2020, End 2022)

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D55: Safety effects of crossing barriers	Bicycles at intersections: Design and safety Pedestrian crossings: Design and safety	None identified	FHWA: Evaluations of Innovative Intersection Designs for Pedestrian and Bicyclists (End 2022) FHWA: Enhancing Highway Safety Manual Guidance on Pedestrian and Bicyclist Countermeasures (CMF/SPF Development) (Anticipated, PBSP Strategic Plan) CAMMSE (UTC): Estimation of Pedestrian Compliance at Signalized Intersections Considering Demographic and Geographic Factors (Start 2020, End 2021) NCHRP 03-141: Midblock Pedestrian Signal Warrants and Operation (Start 2021)
D56: Safety effects of edge lanes/advisory bike lanes	Bikeways: Safety and design	Edge Lane Roads: Operations and Safety in Rural and Urban Areas (ACH20, Bicycle Transportation) https://rns.trb.org/details/dproject.aspx?n=43240 Safety Effectiveness Evaluation of Innovative On-Street Bikeway Designs (OR) Development of Crash Modification Factors and Design Guidelines for Innovative On-Street Bikeway Designs (AFB10, Geometric Design) https://rns.trb.org/dproject.asp?n=42538 Advisory Bicycle Lanes – A New Facility for North America Needing Investigation (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=42163 Safety Evaluation of Innovative On-Street Bikeway Designs (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=42636	FHWA: Enhancing Highway Safety Manual Guidance on Pedestrian and Bicyclist Countermeasures (CMF/SPF Development) (Anticipated, PBSP Strategic Plan) NCHRP 15-74: Safety Evaluation of On-Street Bicycle Facility Design Feature (Start 2020, End 2023)

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D57: Safety effects of gateway treatments and in-street pedestrian crossing signs	Bicycles at intersections: Design and safety Bikeways: Safety and design Pedestrian crossings: Design and safety	None identified	CAMMSE (UTC): Estimation of Pedestrian Compliance at Signalized Intersections Considering Demographic and Geographic Factors (Start 2020, End 2021)
D58: Safety effects of leading bicycle intervals	Bicycles at intersections: Design and safety	Optimal Methods to Communicate Allowable Protected, or Permissive Movements to Bicyclists at Signalized Intersections (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=43256	FHWA: Evaluations of Innovative Intersection Designs for Pedestrian and Bicyclists (End 2022) FHWA: Enhancing Highway Safety Manual Guidance on Pedestrian and Bicyclist Countermeasures (CMF/SPF Development) (Anticipated, PBSP Strategic Plan)
D59: Safety effects of roundabouts for pedestrians and bicyclists	Bicycles at intersections: Design and safety	Bicycles at Roundabouts (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=43246 Estimation of Roundabout Capacity Using Intersection Perspective (ANB75, Roundabouts) https://rns.trb.org/details/dproject.aspx?n=41880 Pavement Materials for Roundabouts (ANB75, Roundabouts) https://rns.trb.org/details/dproject.aspx?n=41881	MPC (UTC): Investigating Bicyclist Safety Perceptions and Behaviors at Roundabouts (Start 2019, End 2022)

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D60: Safety effects of two-stage bicycle turn queue boxes	Bicycles at intersections: Design and safety	None identified	FHWA: Evaluations of Innovative Intersection Designs for Pedestrian and Bicyclists (End 2022) FHWA: Enhancing Highway Safety Manual Guidance on Pedestrian and Bicyclist Countermeasures (CMF/SPF Development) (Anticipated, PBSP Strategic Plan) NCHRP 15-73: Design Options to Reduce Turning Motor Vehicle – Bicycle Conflicts at Controlled Intersections (Start 2020, End 2023) OR DOT: Impacts of Intersection Treatments and Traffic Characteristics on Bicyclist Safety (Start 2019, End 2021) D DOT: Pedestrian and Cyclist Intersection Safety Sandbox (Start 2020, End 2022)
D62: Understanding local control of speed limit-setting process	Policy, planning and decision-making Speed management and active transportation	Determining Target Speeds for Setting Posted Speed Limits (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=43248 Designing for Target Speed (AFB10, Geometric Design) https://rns.trb.org/details/dproject.aspx?n=42542	None identified
D63: Use of surrogate measures for bicyclist and pedestrian safety analysis and monitoring	Bicycle and pedestrian data: Safety	Quantifying the Relationship between Perceived Risk, Surrogate Measures and Crashes for Safety Analysis of Bicyclist and Pedestrians (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=43250 Creating and Integrating Relevant Nonmotorized Datasets (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=42354 Improving Bicyclist and Pedestrian Safety Using Perceived Risk and Surrogate Safety Measures (NCHRP Balloting)	FHWA: Guide to Using Alternative Data Sources to Enhance Police Crash Reporting (Anticipated, PBSP Strategic Plan)

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D64: Using GPS direction-finding and routing to reduce conflicts in high-risk locations, especially in rural areas	Autonomous and connected vehicles Rural and small urban areas	None identified	CSET (UTC): Barriers and Opportunities for Using Rail-Trails for Safe Travel in Rural, Isolated, and Tribal Communities (Start 2018, End 2020)

Research Needs: Technology and Micromobility

Highest Prioirty: Research Problem Statements

No technology and micromobility needs were in the highest-priority tier.

High Priority: Research Need Briefs

B1 Connected and autonomous vehicles and active transportation users

Medium Priority: Research Need Briefs

C6 Curb space access, AVs, and shared mobility: Impacts on active transportation

C9 Effectiveness of programs and policies to increase bike share use among underrepresented populations

C10 Effects of bike sharing systems on mode shift

Lower Priority

D1 Appropriateness of bicycle infrastructure for e-scooters and other new micromobility modes

D5 Bike share data: assessment, use, data sharing

D18 Effects of e-bikes in bicycling behavior/demand, including among different demographic groups

D21 Health impacts of bike sharing systems

D22 Health impacts of e-scooters and other micromobility

D39 Pedestrian safety effects of e-scooters and other new micromobility modes

D47 Safety and design considerations to accommodate the increasing use of e-bikes

Research Topic	***B1: Connected and autonomous vehicles and active transportation users***
Overview	Although safety improvements are a frequently cited reason for adopting connected and autonomous vehicles (CAVs), questions remain around the safety impacts related to active transportation users. The potential value of CAVs for pedestrians and cyclists relies on clear and consistent communication between vulnerable road users (VRUs) and vehicles, making all parties more aware of each other's behavior and better able to predict and negotiate conflict points. Communication of intent must be clear to make other road users comfortable around autonomous vehicles. The potential negative impacts of CAVs on pedestrian and bicycle safety are understudied. Much of the existing research on active transportation interactions with CAVs is about the evolution of the different types of detection systems. Research has studied the performance and improvement of automated systems' ability to help vehicles and AVs detect people walking, but has minimal inclusion of diverse types of pedestrians (e.g., people in wheelchairs, people carrying children) and people with bicycles. While most of the research has focused on motor vehicle technology, there is a growing amount of research on smart technologies for bicycles and pedestrians, including sensors on bicycles, scooters, mobile phones, and other wearables.
Research Objectives	Research is needed to identify how CAVs can affirmatively help active transportation users by improving safety and the walking, bicycling, and rolling experience: • The potential for reducing injuries and fatalities under varying automation scenarios. • Evaluation of the pedestrian and bicycle detection capabilities of different advanced driver-assistance systems (ADAS) under various conditions (e.g., low light, glare, adverse weather conditions, visually cluttered landscapes, crowded streets, amid horizontal and vertical curves, with obstacles such as parked cars, etc.), in different environments, and in detecting people with diverse geometric shapes (e.g., people in wheelchairs, different types of bicycles, etc.). • Understanding what and how much information should be communicated between active transportation users and CAVs and how frequently. • Roadway design enhancements that can provide additional contextual warnings to improve detection of people walking, bicycling, and rolling. • Needs, desires, comfort level and safety of people walking, bicycling, and rolling in relation to traveling around and communicating with CAVs, including pedestrian crossing behavior. • Safety issues that arise with pick-up/drop-off, particularly for children or people with disabilities who may be using AVs for independent transportation and people using bike lanes.
Research Type	 Empirical Data

<table>
<tr><td>Research Review</td><td colspan="3">Autonomous and connected vehicles</td></tr>
<tr><td>Potential Funding Pathways</td><td colspan="3">TRB Cooperative Programs: NCHRP regular process; BTSCRP
Other: FHWA; Transportation Pooled Fund; SBIR/STTR</td></tr>
<tr><td rowspan="2">Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td>Scope and initiate research
Monitor and coordinate with ongoing research</td><td>Complete and implement research
Scope and initiate new research</td><td>Continue to complete and implement research/tools</td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees: Safety
TRB Committees: Pedestrians; Bicycle Transportation; Vehicle-Highway Automation
US DOT: FHWA; NHTSA</td></tr>
<tr><td rowspan="5">Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td colspan="3">NCHRP 20-102(33): Safety of Vulnerable Road Users in a C/AV Future</td></tr>
<tr><td colspan="2">This project will help address one of the objectives listed above.</td><td>Start date: 10/19/2020</td></tr>
<tr><td colspan="3">FHWA, Mitigating Safety Risks of Pedestrian and Bicyclist Interactions with Automated Vehicles</td></tr>
<tr><td colspan="2">Research on this topic should coordinate with this project described in FHWA’s Pedestrian and Bicycle Safety Program Strategic Plan, which will likely cover some of the objectives listed above.</td><td>Anticipated, 2021-2022</td></tr>
<tr><td>Other Ongoing Research</td><td colspan="3">NCDOT: Enhancing AV Traffic Safety through Pedestrian Detection, Classification, and Communication (Start 2018, End 2021).
CAMMSE (UTC): Pedestrian Behavior and Interaction with Autonomous Vehicles (End: 2021).
SBA: The Multimodal Alerting Interface with Short-Range Transmissions (MAIN-ST).</td></tr>
<tr><td>Related RNSs</td><td colspan="3">Explore Communication Needs Between Highly Automated Vehicles and Other Road Users (ACH30, Human Factors of Vehicles) https://rns.trb.org/dproject.asp?n=43274
Non-Motorized Behavior Changes and Communication with Autonomous Vehicles (ACH10, Pedestrians) https://rns.trb.org/details/dproject.aspx?n=42721
Autonomous Vehicle Communication and Interaction with Vulnerable Road Users (ACH20, Bicycle Transportation).</td></tr>
</table>

Research Topic	***C6: Curb space access, AVs, and shared mobility: Impacts on active transportation***
Overview	Current new mobility options, such as ride hailing, on-demand delivery platforms and microtransit, are increasing curbside traffic and demand while picking up and dropping off passengers. This traffic poses potential conflicts with people on bicycles and e-scooters, who are often riding in the area closest to the curb or in bike lanes between the traffic and parking lanes, and pedestrians walking or rolling on the sidewalk and crossing the street. The introduction of shared autonomous vehicles (AVs) for passenger pick-up/ drop-off or deliveries (including robots) may further increase the volume of curbside activity. On the other hand, experts predict that AVs for personal travel will allow more efficient use of roadways, narrower travel lanes, and less on-street parking, which may open up more space for bicycle and pedestrian infrastructure. AVs' quickly evolving technologies, and filling existing gaps in knowledge and practice, can help to understand potential impacts to the safety and comfort of people walking, bicycling, and rolling.
Research Objectives	Research is needed to do the following: • Provide guidance on how agencies can manage curbside space and the operation of new and future mobility options to ensure the safety of people walking, bicycling, rolling and people with disabilities. This would include identifying opportunities to reduce on-street parking and increase space for active transportation. • Identify actions to ensure that safety data collection methods are adequate to assess and track curbside interactions, including crashes involving AVs, delivery vehicles, and other new mobility modes. • Safety issues unique to a transition time period, before reaching a fully autonomous stage.
Research Type	 
Research Review	Autonomous and connected vehicles Micromobility, including e-scooters
Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process; TCRP **Other:** FHWA; Transportation Pooled Fund

Research Timeline	***2021 – 2022***	***2023 – 2026***	***2027 and later***
	Monitor and coordinate with ongoing research	Scope and initiate research Complete research/tools	Implement research/tools
Research Partners	**AASHTO Committees**: Design/JTCNMT **TRB Committees**: Pedestrians; Accessible Transportation and Mobility **US DOT**: FHWA **Other organizations**: NACTO		
Related Projects	***Description/Connection***		***Status***
	NCHRP 20-102(26): Dynamic Curbside Management in the Era of CAVs, SAVs, Scooters, Transportation Network Companies (TNCs), and Traditional Vehicles		
	The objective of this research is to develop a guidebook for state, regional, and local transportation agencies on developing and implementing a dynamic curbside management program.		Expected completion date: 5/15/22
	BTSCRP BTS-10: E-Scooter Safety: Issues and Solutions		
	This project will identify safety issues and provide guidance for mitigating safety problems. This will likely include safety of other road users, including pedestrians.		Expected Completion Date: 12/5/2022
	NCHRP Synthesis 20-05/Topic 52-13: Micromobility Policies, Permits, and Practices		
	This project will document policies, permits, and practices that state DOTs are engaged with in regard to micromobility. It may complement, but not directly address, the objectives above.		In progress
	FHWA, Outreach and Awareness Program on Strategies to Effectively Manage the Curbside to Serve All Users		
	Research on this topic should coordinate with this project described in FHWA's Pedestrian and Bicycle Safety Program Strategic Plan.		Anticipated, 2021-2022
Other Ongoing Research	Pactrans (UTC): Managing Increased Demand for Curb Space in the City of the Future (Start 2019, End 2021).		
Related RNSs	None identified		

Research Topic	***C9: Effectiveness of programs and policies to increase bike share use among underrepresented populations***
Overview	Multiple studies have shown that bike share users are often not representative of area demographics. Additionally, research identifies some of the barriers to using bike share for underrepresented groups, including lower-income people and Black, Indigenous, and people of color (BIPOC). Aside from safety concerns related to bicycling, common barriers include station locations, cost, cost structures, access to smartphones, data plans, and credit cards, lack of awareness and accurate information about bike share systems, language barriers, and other factors. Unique barriers for people with disabilities or physical limitations are related to the types of bicycles available. Programs and policies to promote bike share among underserved populations are common. However, there is limited research on the efficacy of such programs in meeting the needs of these communities and increasing their use of bike share. A better understanding of the effectiveness of such programming would help improve investments and management of such programs.
Research Objectives	This research would inventory efforts to increase bike share use among different demographic groups and collect data to assess the effectiveness of such efforts. The research should attempt to isolate the effectiveness of specific programs and policies (e.g., outreach, subsidies, station placement, vehicle type, cash payment systems, etc.). Methods would likely involve before-and-after studies or natural experiments. The research needs to examine key demographic factors – race, income, gender – and the intersectionality of those factors. The research can also examine the ability of such efforts to improve access to transit and employment. Further, research may be needed to identify how well such programming matches a community's goals and needs. Similar research is necessary to evaluate programs improving access for disabled people, also known as adaptive bike share. Complementary research would identify best practices for data collection and metrics for tracking equity goals. Similar research could also address other micromobility services, such as e-scooters.
Research Type	 Empirical Data  Best Practices
Research Review	Bike share
Potential Funding Pathways	**TRB Cooperative Programs:** TCRP

	Other: UTCs; NIH funding may be appropriate if the research also included health outcomes		
Research Timeline	***2021 – 2022***	***2023 – 2026***	***2027 and later***
	Monitor findings from ongoing research	Scope and initiate research Complete and implement research	Monitor application of research
Research Partners	AASHTO Committees: Civil Rights TRB Committees: Bicycle Transportation; Equity in Transportation; City Transportation Issues US DOT: FHWA Other organizations: NABSA, NACTO		
Related Projects	Description/Connection		***Status***
	TCRP B-47: Impact of Transformational Technologies on Underserved Populations		
	Monitor this study for findings related to the benefits for underserved populations and potential disparities of on-demand mobility and new mobility tools.		Start 2019, End 2021
Other Ongoing Research	TOMNET (UTC): Consumer Attitudes and Behavioral Implications in the New Era of Shared Mobility (Start 2019, End 2021). NCST (UTC): Dock-based and Dockless Bikesharing Systems: Analysis of Equitable Access for Disadvantaged Communities (Start 2020, End 2021). NCST (UTC): Examining Market Segmentation to Increase Bike-share Use: The Case of the Greater Sacramento Region (Start 2020, End 2021). NITC (UTC): Mobility for the People: Evaluating Equity Requirements in Shared Mobility Programs (Start 2020, End 2021).		
Related RNSs	TRB Circular E-C270 Problem Statement A5 (Assess policy mechanisms such as means-based fare systems to address the challenges of transportation affordability and access for low-income and other vulnerable persons across all modes) includes a research question about applying means-based fares for bike sharing.		

Research Topic	*C10: Effects of bike sharing systems on mode shift*
Overview	Bike share systems have expanded throughout the U.S., including both docked and dockless systems and systems using electric assist bikes (e-bikes). Research exists for some systems estimating whether bike share trips are replacing driving, walking, transit or other trips. Most current and prior research on non-recreational mode shift is based on user survey data and stated trip alternatives (e.g., what mode(s) the rider would have taken if not with bike share). Existing research and ongoing user surveys provide considerable evidence of utilitarian and work/school-based trip mode shift. Longitudinal data that tracks longer-term shifts in mode, changes in mode availability options and choices (e.g., car or transit pass purchases), and sustained use, is less common and a more substantial gap.
Research Objectives	This research could address the following questions: • What would be the impact on use if bike share systems increased significantly in geographic scale? What if this was combined with improved bicycle networks and infrastructure and other complementary modes (increased transit, car sharing, etc.)? Most research from the U.S. is based on systems that are limited in scope. • Does incorporating e-bikes into bike share fleets increase demand (number and length of trips) and private motor vehicle mode substitution? • How can bike share be incorporated into travel demand models and other demand estimation tools used in transportation planning? • Are current models for providing bike share systems sustainable as long-term modal options? Many current systems rely on private investments, which can be inconsistent and limit the reliability of the mode and its ability to shift travel away from private motor vehicles. • What are effective models to integrate bike share into regional public transportation systems? See also the research need titled “Effectiveness of programs and policies to increase bike share use among underserved populations”.
Research Type	
Research Review	Bike share
Potential Funding Pathways	**TRB Cooperative Programs:** NCHRP regular process; TCRP **Other:** FHWA; Transportation Pooled Fund; FTA

<table>
<tr><td rowspan="2">Research Timeline</td><td>2021 – 2022</td><td>2023 – 2026</td><td>2027 and later</td></tr>
<tr><td>Monitor NCHRP 20-101(29) and TCRP J-11/Task 37</td><td>Scope and initiate research
Complete research</td><td>Implement research</td></tr>
<tr><td>Research Partners</td><td colspan="3">AASHTO Committees:
TRB Committees: Bicycle Transportation
US DOT: FHWA; FTA
Other organizations: NABSA; NACTO</td></tr>
<tr><td rowspan="8">Related Projects</td><td colspan="2">Description/Connection</td><td>Status</td></tr>
<tr><td colspan="3">NCHRP 20-101(29): Incorporating New Mobility Options into Transportation Demand Modeling</td></tr>
<tr><td colspan="2">This project may address one of the research objectives identified above.</td><td>RFP in 2021</td></tr>
<tr><td colspan="3">TCRP J-11/Task 37: Transit and Micro-Mobility (Bikeshare, Scooter-share, etc.)</td></tr>
<tr><td colspan="2">This project aims to identify the impact of bike share (and other micromobility options) on transit ridership. The effort would complement the objectives outlined above.</td><td>In progress</td></tr>
<tr><td colspan="3">NCHRP Synthesis 20-05/Topic 52-13: Micromobility Policies, Permits, and Practices</td></tr>
<tr><td colspan="2">This project will document policies, permits, and practices that state DOTs are engaged with in regard to micromobility, which includes bike share, e-scooters, and other modes. The synthesis does not overlap with the objectives outline above.</td><td>In progress</td></tr>
<tr><td>Other Ongoing Research</td><td colspan="3">TOMNET (UTC): Consumer Attitudes and Behavioral Implications in the New Era of Shared Mobility (Start 2019, End 2021).
STRIDE (UTC): Evaluation of Transportation Network Infrastructure, Safety, and Travel Route Characteristics of Bike Share, Electric-Powered Pedal-Assist Bike Share, and Electric Scooter System Operation (Start 2020, End 2021).
Mobility21 (UTC): Analysis of the Potential for Micromobility to Replace Short Car Trips in Urban Areas, And Impacts on Congestion (Start 2020, End 2021).</td></tr>
<tr><td>Related RNSs</td><td colspan="3">None identified</td></tr>
</table>

Other technology and micromobility needs

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D1: Appropriateness of bicycle infrastructure for e-scooters and other new micromobility modes	Bikeways: Ridership and demand Micromobility, including e-scooters	None identified	FHWA: Outreach and Awareness on Micromobility Safety (Anticipated, PBSP Strategic Plan) CTEDD (UTC): E-bike sharing and the infrastructure implications and environmental impacts of new technology in transportation systems (Start 2020, End 2021)
D5: Bike share data: assessment, use, data sharing	Bicycle and pedestrian data: Emerging user-based data Micromobility, including e-scooters	Public Bike Share: Bicycle Repositioning (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=38924	STRIDE (UTC): Evaluation of Transportation Network Infrastructure, Safety, and Travel Route Characteristics of Bike Share, Electric-Powered Pedal-Assist Bike Share, and Electric Scooter System Operation (Start 2020, End 2021) NCST (UTC): Examining Market Segmentation to Increase Bike-share Use: The Case of the Greater Sacramento Region (Start 2020, End 2021)
D6: Bike share fleet rebalancing	Micromobility, including e-scooters	Public Bike Share: Bicycle Repositioning (ACH20, Bicycle Transportation) https://rns.trb.org/dproject.asp?n=38924	None identified
D18: Effects of e-bikes in bicycling behavior/ demand, including among different demographic groups	Bikeways: Ridership and demand Micromobility, including e-scooters	None identified	TCRP B-47: Impact of Transformational Technologies on Underserved Populations (Start 2019, End 2021) CTEDD (UTC): E-bike sharing and the infrastructure implications and environmental impacts of new technology in transportation systems (Start 2020, End 2021) STRIDE (UTC): Evaluation of Transportation Network Infrastructure, Safety, and Travel Route Characteristics of Bike Share, Electric-Powered Pedal-Assist Bike Share, and Electric Scooter System Operation (Start 2020, End 2021) Mobility21 (UTC): Analysis of the Potential for Micromobility to Replace Short Car Trips in Urban Areas, And Impacts on Congestion (Start 2020, End 2021)

Need	Relevant Research Reviews	Related Research Statements	Related Current Research
D21: Health impacts of bike sharing systems	Micromobility, including e-scooters	None identified	None identified
D22: Health impacts of e-scooters and other micromobility	Micromobility, including e-scooters	None identified	SAFER-SIM (UTC): Driver Behavior in the Presence of E-Scooters within Varying Infrastructure (Start 2020, End 2021) NITC (UTC): E-Scooters and Public Health: Understanding the Implications of E-Scooters on Chronic Disease (Start 2019, End 2021) CAMMSE (UTC): Impacts of Speed on Dockless Electric Scooter Crashes (Start 2020, End 2021)
D39: Pedestrian safety effects of e-scooters and other new micromobility modes	Micromobility, including e-scooters	None identified	FHWA: Outreach and Awareness on Micromobility Safety (Anticipated, PBSP Strategic Plan) BTSCRP BTS-10: E-Scooter Safety: Issues and Solutions (Start 2020, End 2022) SAFE-D (UTC):Micromobility Safety Regulation: Municipal Best Practices Review (Start 2020, End 2022) CSCRS (UTC): Understanding micromobility safety behavior and standardizing safety metrics for transportation system integration (Start 2019, End 2021)
D47: Safety and design considerations to accommodate the increasing use of e-bikes	Bikeways: Safety and design Micromobility, including e-scooters	None identified	FHWA: Outreach and Awareness on Micromobility Safety (Anticipated, PBSP Strategic Plan) CTEDD (UTC): E-bike sharing and the infrastructure implications and environmental impacts of new technology in transportation systems (Start 2020, End 2021)

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