

# SPR RESEARCH PROGRAM

## SECOND-STAGE PROPOSAL SUMMARY

### PROBLEM NUMBER AND TITLE

**27-44: Systemic Safety Analysis and Assessment of Bicycle and Pedestrian Crash Risk: Developing Risk Factors using the Multimodal Inventory Project Data**

### PROBLEM SUMMARY

Inconsistent and incomplete data on multimodal infrastructure and operations limits ODOT's ability to develop data-driven risk factors. Accurate and up-to-date bicycle and pedestrian risk factors are necessary inputs for ODOT programs aiming to proactively address active transportation safety, as they can help identify locations with geometric and operational characteristics that lead to increased crash risk for active transportation users. The Multimodal Inventory Project offers new data and a unique opportunity to develop more rigorous, data-driven bicycle and pedestrian risk factors. Leveraging these new data and methodologies, in addition to crash data and exposure data, will enable analysis that can identify roadway and operational characteristics most strongly associated with bicycle and pedestrian crash risk.

### ODOT OBJECTIVES

This research will provide ODOT with up-to-date, high-quality bicycle and pedestrian risk factors to be used for proactive safety analysis. The anticipated outcome of this research is to develop these new bicycle and pedestrian risk factors by leveraging new multimodal data from the Multimodal Inventory Project and by applying more rigorous risk factor methodologies. The latter will be accomplished by developing a Risk Factor Tool that relies on data inputs and analysis results to provide site-specific bicycle and pedestrian risk assessments. Objectives of this research include: (1) A comprehensive review of studies that develop bicycle and pedestrian risk factors and/or apply them, methods used to derive bicycle and pedestrian risk factors, and current policies and practices implemented through Active Transportation Safety Plans and Vulnerable Road User Safety Assessments; (2) A data collection and fusion process that combines existing and new Multimodal Inventory Project data; and (3) Development of bicycle and pedestrian risk factors using an integrated approach that leverages descriptive statistics and safety modeling techniques, resulting in a Risk Factor Tool to conduct site-specific risk assessments.

### BENEFITS

This research will provide ODOT with up-to-date data and risk factors to improve bicycle and pedestrian safety, addressing Transportation Plan Safety Objectives, Social Equity Objectives, and Mobility Objectives.

### SCHEDULE, BUDGET AND AGENCY SUPPORT

**Estimated Project Length:** 24 months.

**Estimated Project Budget:** \$200,000

**ODOT Support:** Jiguang Zhao, PhD., P.E., RSP1, State Traffic Safety Engineer, and Ian T. Davidson, MPP, Bicycle and Pedestrian Program Manager

### FOR MORE INFORMATION

For additional detail, please see the complete STAGE 2 RESEARCH PROBLEM STATEMENT online at:  
<https://www.oregon.gov/odot/Programs/ResearchDocuments/27-44.pdf>

# SPR RESEARCH PROGRAM

## SECOND-STAGE PROBLEM STATEMENT

### FY 2027

#### PROBLEM NUMBER AND TITLE

**27-44: Systemic Safety Analysis and Assessment of Bicycle and Pedestrian Crash Risk: Developing Risk Factors using the Multimodal Inventory Project Data**

#### RESEARCH PROBLEM STATEMENT

Many roadway environments continue to pose disproportionate risks to people walking and biking due to design and operational characteristics, such as vehicle speeds, crossing distances, lack of sidewalks, and roadway configuration (Lagerwey et al., 2015). Despite years of research, the ability for ODOT to develop data-driven risk factors using Oregon data has been limited due to inconsistent and incomplete data on multimodal infrastructure and operations. Accurate and up-to-date bicycle and pedestrian risk factors are necessary inputs for ODOT programs aiming to proactively address active transportation safety, as they can help identify locations with geometric and operational characteristics that lead to increased crash risk or severity for active transportation users. ODOT's Active Transportation Needs Inventory currently utilizes bicycle and pedestrian risk factors from an analysis that is more than five years old (Foster et al., 2020). During this time, the active transportation safety picture has changed, and without current data, ODOT staff are using the tool less than when it was first released. In addition, methods to compute vulnerable road user risk factors have evolved, resulting in more rigorous and robust approaches to developing bicycle and pedestrian risk factors (Mukherjee and Mitra, 2020; Wang et al., 2021; Kuşkan et al., 2022; Rahman et al., 2022). To address these needs and gaps, risk factors used in the Active Transportation Needs Inventory tool need to be updated with current roadway inventory data and current crash data. Additionally, current risk factors are based on equivalent property damage only weights and raw frequencies, leaving opportunity to apply more rigorous and robust methodologies to achieve more accurate risk factors by accounting for local variables.

The Multimodal Inventory Project, managed through the Metropolitan Transportation Planning Program, now provides a comprehensive, statewide dataset across 48 cities in Oregon. The data focuses on roadway-, bicycle-, and pedestrian-related infrastructure characteristics. The roadway data offers consistent data on roadway classification, primary users, context, roadway condition, travel lanes, turn lanes, lane widths, interchange information, vehicle speed, exposure, and access density. The bicycle data offers consistent data on type of bicycle facility, width, and condition. The pedestrian data offers consistent data on type of facility, use, width, condition, and pedestrian crossing information. This new data offers a unique opportunity to develop more rigorous, data-driven bicycle and pedestrian risk factors. Leveraging these new data, in addition to crash data and exposure data, will enable analysis that can identify roadway and operational characteristics most strongly associated with bicycle and pedestrian crash risk and severity. Development of these new, more rigorous, and data-driven risk factors can support proactive, systemic safety analysis and countermeasure implementation that targets high-risk roadways and intersections before crashes occur. In addition to safety improvements, this approach can better guide resource allocation towards more effective and equitable projects that are expected to have a positive return on investment.

## RESEARCH OBJECTIVES

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This research will equip ODOT with current, high-quality information on bicycle and pedestrian risk factors to modernize and strengthen agency decision-making tools. The anticipated outcome of this research is to develop these new bicycle and pedestrian risk factors by leveraging new multimodal data from the Multimodal Inventory Project and by applying more rigorous risk factor methodologies. The expected results include a suite of bicycle and pedestrian risk factors that are accurate, up-to-date, and can be determined for site-level investigations. The latter will be accomplished by developing a Risk Factor Tool that relies on data inputs and analysis results to provide site-specific bicycle and pedestrian risk assessments. Results from this research are expected to directly impact bicycle and pedestrian safety, and are expected to be implementation-ready at the conclusion of the research. A current and updatable set of risk factors will help guide resource allocation towards more effective and equitable projects that are expected to have a positive return on investment. The primary objectives of this research include:

1. A comprehensive review of studies that develop bicycle and pedestrian risk factors and/or apply them, methodologies used to derive bicycle and pedestrian risk factors, and current policies and practices being implemented through Active Transportation Safety Plans and Vulnerable Road User Safety Assessments.
2. A detailed data collection and data fusion process that incorporates the Multimodal Inventory Project data to existing data sources.
3. Development of bicycle and pedestrian risk factors using an integrated approach that leverages raw frequency-based processes and safety modeling techniques. Utilizing these results, a Risk Factor Tool will be developed to conduct site-specific risk assessments (crash frequency and severity).

Additionally, the findings will support an update to the Active Transportation Needs Inventory (ATNI), ODOT's project prioritization tool used to guide investments based on access to essential destinations, potential demand, impacts to transportation-disadvantaged populations, and crash risk. Although the ATNI has been instrumental in advancing data-informed investment decisions, much of the underlying crash risk data was developed several years ago and no longer reflects current roadway conditions, travel patterns, or emerging safety trends. As a result, the tool's risk metrics may not fully capture today's exposure and injury patterns.

This research will provide updated and defensible crash risk factors that can be integrated directly into the ATNI framework, ensuring that future project prioritization decisions are grounded in current safety conditions and aligned with ODOT's goals to reduce fatal and serious injuries among vulnerable road users.

## WORK TASKS, COST ESTIMATE AND DURATION

### Task 1: TAC Meeting #1 [1 month]

The objective of this task is to hold a project kick-off meeting within one-month of the Notice to Proceed (NTP). The research team, research coordinator, and the TAC will review the workplan. The research team will take meeting minutes and share with the research coordinator.

Deliverables: TAC Meeting #1 Slide Deck, Meeting Minutes

### Task 2: Collect, Review, and Analyze Current Literature on Bicycle and Pedestrian Risk Factor Development and Application [4 months]

The objective of this task is to conduct a comprehensive review of studies that develop bicycle and pedestrian risk factors and/or apply them. The review will focus on methodologies used to derive bicycle and pedestrian risk factors, while documenting successes and challenges for different methods. Throughout the review, the research team will draw on NCHRP Report 893 (Thomas et al., 2018), NCHRP Report 803 (Lagerwey et al., 2015), and NCHRP 20-44(13) (Foster et al., 2020) to compare and contrast new approaches

to risk factor development and application.

In addition to reviewing current literature, the research team will review current policies and practices being implemented by conducting a DOT scan. The DOT scan will also focus on Active Transportation Safety Plans and Vulnerable Road User Safety Assessments to determine how other agencies consider bicycle and pedestrian risk factors in their safety analysis and decision-making processes.

Deliverables: Draft Literature Review and DOT Scan Report Section

#### Task 3: Draft Research Methodology [3 months]

Drawing on insights obtained from Task 2, Task 3 will propose a research methodology to achieve the project's objectives. This will include identifying key data sources and where/how they can be obtained, and document any potential challenges to obtaining the data. In addition, the research team will provide details on the proposed approach to develop new bicycle and pedestrian risk factors, including anticipated statistical methods, modeling approaches, and tool development. The Draft Research Methodology will be reviewed by the research coordinator and the TAC to ensure the proposed approach is in alignment with ODOT's needs and can be replicated.

Deliverables: Draft Research Methodology Report Section

#### Task 4: TAC Meeting #2 [1 month]

Prior to TAC Meeting #2, the research team will deliver Interim Report #1 at least two weeks prior to the meeting date. TAC Meeting #2 is intended to set the course for project completion. During this meeting, the research team will present key findings from Task 2 and present the proposed research methodology. The meeting will allow the research coordinator and the TAC to provide insights and considerations on the project's next steps.

Deliverables: Interim Report #1, TAC Meeting #2 Slide Deck, Meeting Minutes

#### Task 5: Data Collection and Inventory [3 months]

The objective of this task is to collect all required data identified in Task 3. The research team will work closely with the research coordinator and the TAC to collect this data. Through the data collection process, the research team will keep records of data collection tools or methods, and any specialized data collection tools or algorithms will be documented and prepared as a deliverable to ODOT.

Deliverables: Draft Data Collection Report Section, Specialized Data Tools and/or Algorithms

#### Task 6: Descriptive Analysis and Data Fusion [4 months]

Taking the data collected in Task 5, the research team will conduct a thorough descriptive analysis to highlight broad trends and correlations between bicycle and pedestrian safety and infrastructure and operational characteristics. The descriptive analysis will highlight characteristics to be considered in more detail as part of Task 7. This task will also take the collected data and prepare it for bicycle and pedestrian risk factor development, including specific data fusion and network conflation methodologies.

Deliverables: Draft Descriptive Analysis and Data Fusion Report Section

#### Task 7: Bicycle and Pedestrian Risk Factor Development [6 months]

The objective of this task is to develop new bicycle and pedestrian risk factors following the proposed methodology. Risk factor development will consider location type (e.g., intersection, crossing, segment) and urban/rural splits that consider roadway context definitions given in the Oregon Speed Zoning Manual. The research team expects to apply an integrated approach to identifying risk factors. The approach will leverage both a raw frequency-based analysis as conducted in previous work, which will be supplemented by bicycle and pedestrian crash risk behavior models that utilize novel statistical and econometric methods, and feature-based machine learning models. Risk factors will be developed for both crash frequency and crash severity. During risk factor development, the research team will identify specific crash risk behavior models

that best supplement a raw frequency-based analysis and can be implemented and updated in the long-term.

Deliverables: Draft Risk Factor Development Report Section

#### Task 8: Bicycle and Pedestrian Risk Factor Tool [3 months]

Utilizing the results from previous tasks, the research team will develop a bicycle and pedestrian risk factor tool. The tool will leverage both raw frequency-based analyses and the results from the crash risk models to provide site-specific bicycle and pedestrian risk assessments. For example, an analyst is conducting a safety assessment at an intersection in Ashland. The analyst will collect all required data, as provided in the instructions in the tool, and input this data to determine site-level risk based on raw frequencies (historical crash trends) and crash risk model estimates. The crash risk behavior model estimates allow for site-level risk to account for variations in exposure, roadway context, roadway design, operations characteristics, and other built-environment characteristics. Calculated risk factors will be associated with appropriate countermeasures, linked to expected reductions in crashes, and monetized to illustrate both engineering and fiscal effectiveness. Note, the Risk Factor Tool proposed in this research is intended to supplement existing tools, not replace them.

Deliverables: Draft Risk Factor Tool

#### Task 9: Draft Final Report [3 months]

The research team will prepare and submit and publication-ready Draft Final Report in the prescribed ODOT report format (correct fonts, spacings, table requirements, figure requirements, citations). Contents will include an Abstract, Acknowledgement Section, Disclaimer, Introduction, Literature Review (updated as appropriate), Final Research Methodology, Analysis Section, Discussion Section, Conclusions Sections, Recommendations Section, and Potential for Future Research, Application, or Technology Transfer. Other sections or appendix material will be added as appropriate.

Deliverables: Draft Final Report

#### Task 10: TAC Meeting #3 [1 month]

During TAC Meeting #3, the research team will present findings, conclusions, and recommendations from the analysis. The TAC will offer advice on the content and clarity of these aspects. The TAC will provide advice on post-research implementation. TAC Meeting #3 also serves as the opportunity for the TAC to offer final input on any additional considerations that should be added to the Final Report.

Deliverables: TAC Meeting #3 Slide Deck, Meeting Minutes

#### Task 11: Final Report [3 months]

The research team will address comments and feedback from the TAC by incorporating into the Final Report.

Key Deliverables: Final Report

Tasks	2026			2027						2028					
				FY2027			FY2028			FY2029					
	Oct. - Dec.	Jan. - Mar.	Apr. - Jun.	Jul. - Sep.	Oct. - Dec.	Jan. - Mar.	Apr. - Jun.	Jul. - Sep.	Oct. - Dec.	Jan. - Mar.	Apr. - Jun.	Jul. - Sep.			
01. TAC Meeting #1	★														
02. Literature Review															
03. Draft Research Methodology			IR												
04. TAC Meeting #2				★											
05. Data Collection and Inventory															
06. Descriptive Analysis and Data Fusion															
07. Risk Factor Development															
08. Risk Factor Tool															
09. Draft Final Report										DR					
10. TAC Meeting #3											★				
11. Final Report												FR			
Project Phase	Review and Methods Phase			Data Collection and Fusion Phase			Risk Factor and Tool Phase			Publication Phase					

★ =TAC Meeting and TAC Meeting Deliverables

IR = Interim Report

DR = Draft Final Report Submitted to ODOT for Review

FR = Final Report Submitted to ODOT for Publication. End of Contract.

**Key Deliverables:**

- Draft Literature Review and DOT Scan Report Section
- Draft Data Collection Report Section, Specialized Data Tools and/or Algorithms
- Draft Risk Factor Development Report Section
- Draft Risk Factor Tool
- Interim Report
- Final Report and Risk Factor Tool

**Estimated Project Length: 24 months.**

**Estimated Project Budget: \$200,000**

**EXPECTED ODOT IMPLEMENTATION ACTIONS**

To best serve ODOT’s needs, this study is expected to be implemented through:

- coordinating with updates for the ODOT Multimodal Inventory Project,
- supporting updates to the ODOT Active Transportation Needs Inventory (ATNI),
- reviewing data inputs and revising information used in ODOT’s Vulnerable User Crash Response Program,
- assessing projects under review by the ODOT Bicycle and Pedestrian Program, including state highway system projects and local priorities, such as Safe Routes to School, All Roads Transportation Safety (ARTS), and others.

ODOT can also support other transportation stakeholders by disseminating this study’s findings at local and national transportation conferences, peer-reviewed journals, and presentation to university students in classes and seminars.

**POTENTIAL BENEFITS**

This research primarily addresses safety—a key agency and Oregon Research Advisory Committee priority.

Depending on agency implementation, it can also have ancillary benefits to social equity and mobility.

Considering safety, this research will update and augment ODOT's ability to proactively target locations on the roadway network that have higher bicycle and pedestrian crash risk by fusing existing data with the new Multimodal Inventory Project data, and by updating risk factor development methodologies. This will allow ODOT to more accurately assess current bicycle and pedestrian crash risk. This proactive approach is directly in-line with Objective SA.1 in the Oregon Transportation Plan, as well as Objective SA.2 (provide safety and secure transportation facilities) and Objective SA.3 (leverage data and technology). Additional benefits from the results from this research can include:

1. Safety performance-based planning and design (Objective MO.5, Policy MO.5.1).
2. Improve multimodal transportation facilities (Objective MO.1).
3. Improve safety and comfort of walking and biking (Objective MO.1, Policy MO.1.1, Strategy MO.1.1.2)
4. Invest in projects that would clearly benefit the safety, climate resilience, and public health outcomes of systemically excluded or underserved populations (Objective SE.3, Policy SE.3.1, Strategy SE3.1.1, Strategy SE.3.1.2).

## PEOPLE

### **ODOT champion(s):**

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### **Problem Statement Contributors:**

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Greg Griffin, Ph.D., Oregon Department of Transportation

## REFERENCES

- Foster, N., Gross, N., Braughton, M., Ray, B., Brown, L., Chandler, B., and Monsere, C., 2020. *Implementation of NCHRP Research Report 893: The Oregon DOT Statewide Pedestrian and Bicycle Plan*. Washington, DC. National Cooperative Highway Research Program. Transportation Research Board, National Acadamey of Sciences. Project No. NCHRP 20-44(13).
- Kuşkapan, E., Sahraei, M.A., Çodur, M.K., and Çodur, M.Y., 2022. Pedestrian Safety at Signalized Intersections: Spatial and Machine Learning Approaches. *Journal of Transport and Health* 24, 101322.
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- Mukherjee, D. and Mitra, S., 2020. Identification of Pedestrian Risk Factors Using Negative Binomial Model. *Transportation in Developing Economies* 6 (1), 4.
- Rahman, M., Kockelman, K.M., and Perrine, K.A., 2022. Investigating Risk Factors Associated with Pedestrian Crash Occurrence and Injury Severity in Texas. *Traffic Injury Prevention* 23 (5), 283–289.
- Thomas, L., Sandt, L., Zegeer, C., Kumfer, W., Lang, K., Lan, B., Horowitz, Z., Butsick, A., Toole, J., and Schneider, R.J., 2018. *NCHRP Report 893: Systemic Pedestrian Safety Analysis. Systemic Pedestrian Safety Analysis*. Washington, DC. National Cooperative Highway Research Program. Transportation Research Board, National Acadamey of Sciences.
- Wang, Z., Huang, S., Wang, J., Sulaj, D., Hao, W., and Kuang, A., 2021. Risk Factors Affecting Crash Injury

Severity for Different Groups of e-Bike Riders: A Classification Tree-Based Logistic Regression Model.  
*Journal of Safety Research* 76, 176–183.

## STAFF REVIEW PAGE

### LITERATURE CHECK

#### TRID&RIP

A review of TRID & RIP databases found no existing research that answers the research question

A related study from Florida, “Pedestrian and Bicycle Crash Risk for Low Income and Minority Populations: An Examination of At-Risk Population Segments and Environmental Risk Factors” (2021) uses Florida-specific risk factors that are not transferrable to the Oregon context. However, it may support the literature review and methodology for this problem statement. Similarly, Oregon produced “Risk Factors for Pedestrian and Bicycle Crashes” in 2017, but many of the underlying datasets have significantly changed and the approach should be revised.

#### ODOT DECISION LENSES

**Climate:** This research is not focused on climate and will not include analysis of climate.

**Equity:** This research is not focused on equity and will not include analysis of equity.

**Safety:** This research is anticipated to support safety culture both through its implementation role within the agency and with partners, and through completed projects that impact social use of the transportation system. It will support safety through healthy and livable communities. The study will help ODOT leverage the best available technologies, including new multimodal inventory data. This research project will update and augment ODOT’s ability to proactively target locations on the roadway network that have higher crash risks by integrating the data and updating methods to better account for current risk across the system.

#### TECHNOLOGY & DATA ASSESSMENT

No Identified T&D output

At the end of this project, the implementing unit(s) within ODOT will need to coordinate the adoption of new technology or data in order to realize the full potential of this research.

#### CROSS-AGENCY IMPACTS

- List ODOT partners or impacted units.
  - DOT Highway Safety in the Traffic Engineering Section, contact [jiguang.zhao@odot.oregon.gov](mailto:jiguang.zhao@odot.oregon.gov)
  - Pedestrian and Bicycle Program, contact [ian.t.davidson@odot.oregon.gov](mailto:ian.t.davidson@odot.oregon.gov)
- Identify any issues of concern raised by an ODOT partner. Note expected mitigation that addresses these concerns.
  - None raised