SPR RESEARCH PROGRAM
SECOND-STAGE PROPOSAL SUMMARY

PROBLEM NUMBER AND TITLE

25-81 - Advancing pedestrian safety at intersections: Temporal modeling of pedestrian crash frequency and severity and measuring the effectiveness of signal timing strategies for improving safety.

PROBLEM SUMMARY

Pedestrian fatalities and injuries are increasing at a rapid pace in the United States. Between 2010 and 2021, pedestrian fatalities increased by 77% nationally. Specifically, in Oregon, pedestrian fatalities increased 41% in 2022, compared to 2021. A number of these fatalities occur at signalized intersections, where many modes converge, thus increasing the propensity for conflicts. Therefore, it is necessary to understand factors associated with pedestrian safety at different times, so that appropriate countermeasures can be deployed to improve pedestrian safety at signalized intersections. Also, traditional traffic signal timing strategies at signalized intersections have prioritized vehicle throughput at the expense of other users such as pedestrians. This research would test signal operational strategies to see how they affect behavior and associated safety outcomes for pedestrians.

ODOT OBJECTIVES

1. Explore the temporal trends in the frequency and severity of pedestrian crashes and identify the factors affecting pedestrian safety at signalized intersections through the development of temporally-disaggregate models using exposure data from traffic signals.
2. Assess the effectiveness (in terms of safety and operational impacts) of alternative traffic signal strategies designed to improve pedestrian safety.

BENEFITS

Outcomes and findings from this research are expected to include information about the intersection design and traffic signal operational factors, as well as built and social environmental characteristics, associated with pedestrian safety outcomes (crash frequency and severity, surrogate safety measures) at signalized intersections. It will also help identify the extent to which signal timing strategies can improve pedestrian safety, using surrogate measures of safety such as conflicts and near misses.

SUPPORT

Estimated Project Length: 24 months.
Estimated Project Budget: $210,000
ODOT/Agency Support:
Jessica Horning – Bicycle and Pedestrian Program Manager
Peter Koonce – Portland Bureau of Transportation Manager, Signals, Street Lighting, ITS, & Electrical Maintenance

FOR MORE INFORMATION

For additional detail, please see the complete STAGE 2 RESEARCH PROBLEM STATEMENT online at:
https://www.oregon.gov/odot/Programs/ResearchDocuments/25-81.pdf

SPR RESEARCH PROGRAM
SECOND-STAGE PROBLEM STATEMENT
FY 2025

PROBLEM NUMBER AND TITLE

25-81 - Advancing pedestrian safety at intersections: Temporal modeling of pedestrian crash frequency and severity, and measuring the effectiveness of signal timing strategies.

RESEARCH PROBLEM STATEMENT

Pedestrian fatalities and injuries are increasing at a rapid pace in the United States. Between 2010 and 2021, pedestrian fatalities increased by 77% nationally. Specifically, in Oregon, pedestrian fatalities increased 41% in 2022, compared to 2021. A number of these fatalities occur at signalized intersections, where many modes converge, thus increasing the propensity for conflicts. A majority of these fatalities also occur at night. Therefore, it is necessary to understand factors associated with pedestrian safety at different times, so that appropriate countermeasures can be deployed to improve pedestrian safety at signalized intersections.

Also, traditional traffic signal timing strategies at signalized intersections have prioritized vehicle throughput at the expense of other users such as pedestrians. Traditional signal timing settings do not directly account for the safety of road users. Strategies to improve the operational experience for pedestrians (in addition to pedestrian safety) include decoupling pedestrian phases from vehicle phases to allow for greater flexibility in timing, changing operations from fixed to free, time of day schedule changes where progression speeds are set at or lower than the speed limit, setting side street to coordinated phasing at certain intersections, etc. Most strategies are targeted at reducing motor vehicle speeds, since pedestrians are much more likely to be seriously injured or killed when involved in a higher-speed crash.

The novelty of this proposed research is a two-stage approach towards further understanding pedestrian safety. The first phase involves the development of temporally-disaggregate models of pedestrian safety (by time-of-day, day-of-week, season, etc.), which has rarely been studied before, with specific focus on nighttime fatalities, made possible by a new continuously collected source of exposure data (from traffic signals). The second phase employs a before-after approach using field data collection to determine the impacts on operations and surrogate safety outcomes resulting from implementations of the signal timing changes (designed to improve pedestrian safety) in the City of Portland or other jurisdictions. For instance, can signal operations that reduce pedestrian delay improve compliance and improve safety?

RESEARCH OBJECTIVES

One of ODOT's goals is to prevent traffic fatalities and serious injuries and ensure the safety of the users of the transportation system. This proposed study directly addresses the **safety** focus area for pedestrians at intersections, by (a) better understanding time-varying patterns in pedestrian crash risks and contributing factors, and (b) measuring the effectiveness of traffic signal strategies to improve pedestrian safety and operations. This research study has two main objectives.

1. Explore the temporal trends in the frequency and severity of pedestrian crashes and identify the factors affecting pedestrian safety at signalized intersections through the development of temporally-disaggregate models using exposure data from traffic signals.
2. Assess the effectiveness (in terms of safety and operational impacts) of alternative traffic signal strategies designed to improve pedestrian safety.

WORK TASKS, COST ESTIMATE AND DURATION

This work will be conducted in two phases. Phase 1 will involve the development of temporal models; Phase 2

will include the findings of a before-after approach to assess the impacts of traffic signal safety strategies. Below are the expected work tasks to achieve the research objectives.

Phase 1

Task 1: Literature Review – Review research including models, factors (e.g., time-of-day, nighttime, length of crossing etc.), signal timing strategies and their impacts on pedestrian safety.

Task 2: Data Assembly – Assemble the estimated pedestrian volume data at signalized intersections from SPR 857. At the same locations, 3-5 years of crash data will be gathered. Other supplemental data such as geometric features at the intersection (e.g., length of crossing, number of lanes etc.) and operational features (e.g., AADT, signal timing parameters, automated traffic signal performance measures, etc.) will also be obtained and appended to the crash and volume datasets.

Task 3: Data Analysis – Development of temporal models to understand how pedestrian safety (and factors affecting it) varies by time-of-day, day-of-week, season, etc. The analysis will pay special attention to the role of pedestrian exposure (as measured by estimated pedestrian volumes) and night-time conditions when pedestrian crash risk is hypothesized to be elevated.

Task 4: Phase 1 Report – Prepare a report and presentation that summarizes the Phase 1 research effort, findings, and recommendations.

Phase 2

Task 5: Site and Strategy Selection – Select 3-5 sites in consultation with partner agencies for field data collection. It is expected that sites will include several locations in the City of Portland, and potentially other jurisdictions. In consultation with the TAC and other partners (including the Portland Bureau of Transportation), select signal timing strategies (designed to improve pedestrian safety) for implementation at the study sites. Strategies will likely focus on reducing motor vehicle speeds, and may include:

- Rest-in-red (until a vehicle is detected) at signals where/when uncoordinated.
- Decouple pedestrian from vehicle phases to allow rest-in-walk without rest-in-green.
- Changing some operations from fixed or coordinated to free, during certain times-of-day.
- Adjust coordination to ensure progressing speeds are at or lower than the speed limit.
- Adjust settings to capture fewer vehicles outside of platoon, and avoid extending green for a speeding vehicle.

Task 6: Field Data Collection and Extraction, Data Assembly – At the selected sites, collect field data using videos, ideally before and after the implementation of the selected strategies. Extract information about road user behaviors and surrogate safety measures (conflicts, near misses). Obtain traffic signal logs during the same time periods and calculate automated traffic signal performance measures (ATSPMs).

Task 7: Data Analysis – Analyze the assembled data to measure the effectiveness of the selected signal timing strategies. This will likely involve a before/after analysis of surrogate safety measures and operational outcomes, controlling for any other changes in site characteristics, traffic flows, ATSPMs, etc.

Task 8: Development of Guidance and Final Report – Prepare a final report that includes the findings and recommendations from Phases 1 and 2.

Key Deliverables: The first deliverable is a temporal analysis of pedestrian crashes using high fidelity pedestrian traffic volumes from traffic signal push buttons data to understand how pedestrian delay effects crash risk. The second deliverable will assess signal operations changes that aim to improve conditions for the pedestrian users to determine how safety and operations are impacted. The second deliverable fills a major gap in our understanding of how signal operations can impact pedestrian safety.

Estimated Project Length: 24 months.
Estimated Project Budget: $210K.

IMPLEMENTATION

The first phase of this work builds upon a recently completed research project SPR-857: "Active Transportation Counts from Existing On-Street Signal and Detection Infrastructure." In that project, researchers compared observed pedestrian counts with pedestrian push-button data from high-resolution traffic signal controller logs and developed methods to estimate pedestrian crossing volumes with high accuracy and relatively low error. Thus, hundreds of traffic signals throughout Oregon can become permanent pedestrian monitoring devices and provide estimates of pedestrian exposure for safety analysis at a fine temporal resolution: every hour. This proposed research will also build upon yet go further than existing work currently underway in Oregon developing safety performance functions for pedestrian safety. That effort is developing models based on yearly crashes and annual average daily pedestrian exposure at intersections. While useful, it is not able to examine pedestrian safety performance for time periods less than one year. This proposed research would fill this gap, offering insights about how pedestrian safety (and factors affecting it) varies by time-of-day, day-of-week, season, etc., and provide guidance on reducing fatalities especially at night, when the majority of crashes occur.

In the second phase of this work, impacts of signal timing strategies (aimed at improving pedestrian safety) on safety and operations in the corridors where they are implemented will be studied. Compared to other pedestrian safety countermeasures that involve building infrastructure, signal timing strategies can be relatively lower-cost and quicker to implement. If they are shown to improve pedestrian safety (as measured by surrogate safety metrics) without degrading other performance measures, they could be quickly implemented in more places state-wide to help improve pedestrian safety at intersections.

POTENTIAL BENEFITS

Outcomes and findings from this research are expected to include information about the intersection design and traffic signal operational factors, as well as built and social environmental characteristics, associated with pedestrian safety outcomes (crash frequency and severity, surrogate safety measures) at signalized intersections. Importantly, it will also identify how these relationships (including pedestrian exposure) with pedestrian crashes might vary at different times-of-day, weekdays, seasons, etc. Thus, this proposed research will be able to offer insights into places and times at which pedestrian crashes may be more likely or pedestrians are at risk of more serious injury. It will also help identify the extent to which signal timing strategies can improve pedestrian safety, using surrogate measures of safety such as conflicts and near misses.

One of ODOT's goals is to prevent traffic fatalities and serious injuries and ensure the safety of the users of the transportation system. This proposed study directly addresses the **safety** focus area by exploring temporal trends in the frequency and severity of pedestrian crashes at signalized intersections. This proposal also investigates the safety and operational impacts of alternative signal timing strategies, which could be useful for ODOT engineers to manage corridor operations. Insights from implementations in the City of Portland and/or other jurisdictions will be discussed with ODOT staff for potential implementation at ODOT signals.

PEOPLE

ODOT champion(s): Peter Koonce – Portland Bureau of Transportation Manager, Signals, Street Lighting, ITS, & Electrical Maintenance

Problem Statement Contributors: Sirisha Kothuri (Portland State University), Patrick Singleton (Utah State University)

REFERENCES

Kothuri, S., Singleton, P., Vahedi Saheli, M., Yates, E., & Broach, J. (2024). *Active transportation counts from existing on-street signal and detection infrastructure* (SPR 857). Oregon Department of Transportation. https://rosap.ntl.bts.gov/view/dot/73447

STAFF REVIEW PAGE

Literature Check

TRID&RIP

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

This research will fill major gaps in the state of the practice for how safety interventions based on signal operation changes

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 stakeholders

- List ODOT partners or impacted units. ODOT Traffic Signals staff could are interested and keen to learn more from the city of Portland's experience with these 'safe signals' interventions.
- Identify any issues of concern raised by an ODOT partners. Note expected mitigation that addresses these concerns.