Research Project Work Plan

for

SAFETY ASSESSMENT OF FREEWAY ACTIVE TRAFFIC MANAGEMENT BY EXPLORING THE RELATIONSHIP BETWEEN SAFETY, CONGESTION AND WEATHER

SPR793

Submitted by

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for

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1.0 Identification

1.1 Organizations Sponsoring Research

Oregon Department of Transportation (ODOT)
Research Section
555 13th Street NE
Salem, OR 97301 Phone: (503) 986-2700

(If federal funds are used)
Federal Highway Administration (FHWA)
Washington, D.C. 20590

1.2 Principal Investigator (ODOT requests only one per institution or firm)

Xiugang (Joe) Li
Research Section
Oregon Department of Transportation
555 13th St NE
Salem, OR 97301 Phone: 503-986-4115

1.3 Technical Advisory Committee (TAC) Members

[Names, Affiliations] [*indicate which member is Chair, research proposer*]
Zahidul Siddique, Highway Safety Engineer
Robin Ness, Crash Data Analysis
Dennis Mitchell, ODOT Region 1 Traffic Engineer
Brian Dunn, ODOT Transportation Planning Analysis Unit Manager

1.4 Friends of the Committee (if any)

[Names, Affiliations]

1.5 Research Coordinator

Tony Knudson, ODOT Research Section Phone: 503-986-2848

1.6 Project Champion

2.0 Problem Statement

Oregon Department of Transportation (ODOT) has deployed Active Traffic Management Systems (ATMS) on freeways (http://www.oregon.gov/odot/hwy/traffic-roadway/docs/pdf/2013_conference/session_3c_mitchell.pdf). For example, these systems include variable advisory speed system (VAS), adaptive ramp metering and weather responsive curve warning system along OR 217, I-5 and I-405. Many of these systems are deployed with safety as a primary objective. However, the safety assessment of these ATMS lacks of an effective analysis method, especially the method to assess the real-time safety impacts during the adverse weather condition.

The ATMS safety assessment should be done before the deployment and during the operation to achieve better safety improvement. Currently there is not an effective method to do this. The ATMS operation strategies and algorithms are usually based on the traffic operation performance, but not the safety performance because of the lack of research. Currently the long-term safety assessment needs 3 to 5 years of historical crash data before and after the ATMS deployment. It does not provide proactive and real-time safety assessment, which is crucial for ATMS deployment.

We propose to develop real-time assessment methods for the ATMS, emphasizing on the variable advisory speed system.

2.1 Background and Significance of Work

Freeway ATMS have been used, especially in metropolitan areas, to mitigate traffic congestion, improve safety and reduce emissions. Traffic operation performance could be assessed by real-time data and algorithms to effectively operate the systems. However, the ATMS lack of an effective real-time safety assessment method. The Highway Safety Manual is used to evaluate the safety of freeway design in long term. For example, the models in the manual adopt Annual Average Daily Traffic (AADT), not catching the traffic dynamics of ATMS. The ATMS are not in operation for all the time, and are activated depending on the traffic and weather conditions.

Recent research from the SHRP Reliability Project L07 found that treatments reducing congestion may also reduce crashes on urban freeways. This research created relationship between traffic congestion and crash frequency by using traffic and crash data aggregated by 15-minute intervals. This research does not include Oregon data, and is not designed for the real-time safety assessment of ATMS, especially during the adverse weather condition.

The freeway real-time safety assessment has been explored, such as by using data from California and Florida. These research used traffic data archived around the crash times and locations to develop statistical models to assess the crash risk. It has been identified that the models may have transferability issue to use in other

places, such as Oregon. These models did not consider weather conditions, and have not been verified for the ATMS safety assessment.

The proposed research aims to develop real-time safety assessment methods for Oregon ATMS. The transferability will be explored. This research would focus on the AMTS; however, it could be extended for the real-time safety assessment of freeway sections without the ATMS.

3.0 Objectives of the Study

The goal of this project is to evaluate the safety effectiveness of ATMS featuring VAS in a real-time way. The real-time safety assessment helps create ATMS operation strategies not only based on traffic performance, but also based on safety performance because many systems are deployed with safety as a primary objective. It also helps assess the ATMS safety effects before the deployment and during the operation, not only after several years of operation with historical crash data. It is anticipated that the proposed methods can be used for ATMS implementation across the state. Towards that goal, the research objectives are as follows.

- Achieve real-time assessment by using real-time data, such as at 5-minute intervals, including traffic operation, crash and weather data.
- Create statistical models by exploring the relationship between safety, congestion and weather.
- Explore transferability so the proposed methods can be used at other places.
- Develop a prototype and a user's guide for easily use.
- Prepare guidance and recommendations for implementations

3.1 Benefits

The proposed real-time safety assessment methods would help ATMS implementation across the state. It could be used for the real-time safety assessment of freeway corridors, especially during the adverse weather condition, for improved safety planning. The proposed research would help better ATMS operation to reduce crashes and mitigate congestion. Because crash reduction improves travel time reliability, the proposed research would contribute to the SHRP 2 implementation objectives. The benefits include enhancing traffic safety, mitigating congestion, enhancing mobility and accessibility, improving travel time reliability, and reducing vehicular exhaust pollutants.

4.0 Implementation

ODOT TPAU, ITS Unit and Region 1 will be involved in implementation and support the project. The project will focus on ODOT need and try to have a product that can be directly applied by ODOT. The project will result in a database for real-time safety assessment of freeway operational conditions along with a prototype for ATMS

assessment for multiple Oregon freeway corridors. The guidelines and procedure for applying the prototype would be developed. The research results may also be implemented in the ongoing development of ODOT Analysis Procedures Manual (Version 2) Chapter on Transportation Systems Management and Operations.

Research results would be disseminated by a final report, a research note, and conference presentations (or journal articles) for various audiences. Presentations would include ODOT internal training, APM users conference, Northwest Transportation Conference, and national conferences.

5.0 Research Tasks

The project is estimated to be 20 months in duration. The project will consist of the tasks listed below.

5.1 Expected tasks:

Task 1: TAC Meeting #1

Project kick off meeting. The TAC will review and understand project research problem statement, research question, the limits of the research, and the project schedule. The TAC will recommend freeway corridors for data collection and for ATMS safety assessment.

Time Frame: Jan. 2016
Responsible Party: PI, ODOT Research Coordinator, TAC
Estimated Cost: $500
Deliverable: TAC meeting attendance, TAC meeting presentation, TAC Meeting Minutes
TAC Action: Advise ODOT Research Coordinator regarding any critical issues with the project's scope or schedule. Advise PI's regarding related professional practices, standards, methods and context for the project.
ODOT Action or Decision: Review TAC advice, discuss with PI, and if necessary direct PI to make changes to project documents.

Task 2: Draft Literature Review

This part of research will review the state of the art and the state of the practice of the ATMS real-time safety assessment. The data sources (including traffic, crash and weather), freeway corridor limits and key locations for safety assessment will be identified.

Time Frame: Dec. 2015 – Feb. 2016
Responsible Party: PI
Estimated Cost: $10,300
Deliverable: Draft Literature Review
TAC Action: Read Draft Literature Review and advise ODOT Research Coordinator regarding any gaps in the literature.

ODOT Action or Decision: Review TAC advice, discuss with PI, and if necessary direct PI to make changes to project documents.

Task 3: Data Collection

Collect archived traffic operation and weather data from sources such as PORTAL. Review the existing data for traffic operation of Variable Advisory Speed System, and determine if good for this project. Collect crash data and ATMS operation data from ODOT. We may procure the storage and then create the database. Merge the crash data, traffic operation data and weather data into one database.

Time Frame: Jan. – Jun. 2016
Responsible Party: PI
Estimated Cost: $31,000
Deliverable: A Memo documenting data collection, and any specialized data collection tools or algorithms. Provide documentation that the raw data is securely stored and protected from data corruption. (Federal projects may require delivery of raw data to the Agency)
TAC Action: None
ODOT Action or Decision: Review

Task 4: Draft Research Methodology.

This task will develop a methodology for the ATMS real-time safety assessment. This task will describe the research design and statistical analysis methods and do some exploratory analysis. The TAC will review the results and decide the adoption of the research design and statistical analysis methods for this project.

Time Frame: Mar. – Jun. 2016
Responsible Party: PI
Estimated Cost: $10,700
Deliverable: Draft Research Methodology Report Section.
TAC Action: Read Draft Research Methodology in preparation for TAC Meeting # 2.
ODOT Action or Decision: Schedule TAC Meeting #2

Task 5: TAC Meeting #2

This TAC meeting will review the research design, the collected data and the proposed statistical analysis methods. The TAC will discuss the Tasks 3 and 4 deliverables. The PI will present and discuss the following tasks.
Time Frame: July 2016
Responsible Party: PI, ODOT Research Coordinator, TAC
Estimated Cost: $500
Deliverable: TAC meeting attendance, TAC meeting presentation, TAC Meeting Minutes, meeting agenda
TAC Action: TAC review of Draft Research Methodology and Draft Data Collection Report. Advise ODOT Research Coordinator regarding any critical issues with the project's research design. If possible reach consensus regarding the content and methods

contained in the draft research design. Advise ODOT Research Coordinator regarding project next steps.
ODOT Action or Decision: Review TAC advice. Assess project potential for successful completion. If necessary direct PI to make changes to project documents. Provide formal acceptance of Draft Research Methodology.

Task 6: Data Analysis

Explore the relationship between safety, congestion and weather by using statistical methods. The data collected in Task 3 will be used. The proposed statistical methods may include Support Vector Machines or Classification Trees. Safety measure is the crash risk. Traffic parameters include speed, speed variation and congestion levels. Highway geometric design will be considered. Explore the transferability of the statistical models to other freeways corridors.

Time Frame: July 2016 – Mar. 2017
Responsible Party: PI
Estimated Cost: $49,990
Deliverable: Draft Analysis Report Section
TAC Action: Review and comment
ODOT Action or Decision: Review

Task 7: ATMS Real-Time Safety Assessment

Develop a prototype for the AMTS real-time safety assessment. Use the prototype for selected freeway corridors. Document the analysis results.

Time Frame: Dec. 2016 – Mar. 2017
Responsible Party: PI
Estimated Cost: $29,000
Deliverable: Draft Safety Assessment Report Section
TAC Action: Review and comment
ODOT Action or Decision: Review

Task 8: TAC Meeting #3

This TAC meeting will review Tasks 6 and 7 deliverables. Discuss the data analysis results and the ATMS safety assessment results. The PI will present and discuss the following tasks.
Time Frame: Apr. 2017
Responsible Party: PI, ODOT Research Coordinator, TAC
Estimated Cost: $500
Deliverable: TAC meeting attendance, TAC meeting presentation, TAC Meeting Minutes, meeting agenda
TAC Action: TAC review of the data analysis report and the ATMS safety assessment report. Advise ODOT Research Coordinator regarding project next steps.
ODOT Action or Decision: Review TAC advice.

Task 9: Draft Final Report

Prepare the draft final report in the prescribed ODOT report format. Formatting includes correct fonts, spacing, citations and graphics. Contents include: an updated abstract, acknowledgement, disclaimer, introduction, Updated Lit Review (Task 2), Final Research Methodology (Task 4), Draft Analysis Report Section (Task 6), conclusions, and potential for future research.

Time Frame: Apr. – Jun. 2017
Responsible Party: PI
Estimated Cost: $11,000
Deliverable: Draft Final Report using ODOT's report template
TAC Action: TAC review and feedback to the ODOT Research Coordinator
ODOT Action or Decision: Review and counsel prior to TAC meeting

Task 10: Draft ODOT Research Note

Write 1000 to 1500 word summary of the research project. The summary will concisely document the research findings, value of the research to the agency, science and society, and any limitations on the use of the findings.

Time Frame: Jun. 2017
Responsible Party: PI
Estimated Cost: $1,000
Deliverable: Draft ODOT Research Note using ODOT's report template
TAC Action: None
ODOT Action or Decision: Review and advise

Task 11: TAC Meeting #4.

This TAC meeting will include a review of the Draft Final Report, and Draft Research Note prior to the TAC meeting. The TAC will offer advice on the content and clarity of these work products. The TAC will also advise on post research implementation.

Time Frame: July 2017
Responsible Party: PI, assisted by the ODOT Research Coordinator, TAC
Estimated Cost: $500
Deliverable: TAC meeting attendance, TAC meeting presentation, TAC Meeting Minutes
TAC Action: TAC review of Draft Final Report, and Draft Research Note. Advise ODOT Research Coordinator regarding any critical issues with the project's research design. Advise ODOT Research Coordinator regarding any required final edits to the Draft Final Report, and Draft Research Note.
ODOT Action or Decision: Review TAC advice. If necessary direct PI to make changes to project documents.

Task 12: Final Report

Edit Draft Final Report to incorporate edits identified by the ODOT research Coordinator after the last TAC meeting

Time Frame: July – Sept. 2017
Responsible Party: PI
Estimated Cost: $5000

Deliverable: Final Report
TAC Action: None
ODOT Action or Decision: Review. Provide formal acceptance of Final Report. Publish Final Report on ODOT's research website

Task 13: Final Research Note

Edit Draft Research Note to incorporate edits identified by the ODOT research Coordinator after the last TAC meeting
Time Frame: Sept. 2017
Responsible Party: PI
Estimated Cost: $500
Deliverable: Final Research Note
TAC Action: None
ODOT Action or Decision: Review. Provide formal acceptance of Research Note. . Publish Final Report on ODOT's research website

5.2 Reporting

All reports shall be produced in the standard ODOT Research Section report format provided to the Project Investigator by the Research Coordinator unless some other format is deemed to be more appropriate. The Project Investigator shall be responsible for submitting deliverables as professional-level written composition equivalent to the writing standards of peer-reviewed journals. These writing considerations include grammar, spelling, syntax, organization, and conciseness.

The Project Investigator, in consultation with the TAC and Research Coordinator, shall deliver to ODOT in electronic format the data produced during the project. The Project Investigator shall ensure the data is labeled and organized to facilitate future access. ODOT shall warehouse the data.

5.3 Safety and Related Training

Prior to accessing ODOT right-of-way (ROW), all personnel who will work on ODOT ROW shall complete safety training appropriate to the work to be performed within the ROW. The Project Investigator shall notify Project Coordinator in writing (email accepted) prior to the first day of work within the ROW that all project personnel who will access ODOT ROW have been trained. Until all ROW work is completed, the Project Investigator shall notify Project Coordinator in writing (email accepted) annually that an active safety training appropriate to the work to be performed within the ROW has been completed by all personnel who will work on ODOT ROW.

6.0 Time Schedule

The time line for the project is given in the matrix below. The matrix also shows interim and final deliverables for each of the tasks.

Task	2015	2016												2017								
	FY2016								FY2017											FY18		
	Oct - Dec			Jan - Mar			Apr - Jun			Jul - Sep			Oct - Dec			Jan - Mar			Apr - Jun			Jul - Sep		
1: TAC Meeting #1				*																				
2: Literature Review					*																			
3: Data Collection									*															
4: Draft Research Methodology									*															
5: TAC Meeting #2										*														
6: Data Analysis																		*						
7: ATMS Safety Assessment																		*						
8: TAC Meeting #3																			*					
9: Draft Final Report																					R			
10: Draft ODOT Research Note																					R			
11: TAC Meeting #4																						*		
12: Final Report																								F
13: Final Research Note																								F

*Deliverables
R - Draft report submitted for ODOT review.
F - Revised report submitted to ODOT for publication. End of contract.

7.0 Budget Estimate

An itemized budget, showing expenditures for each task by fiscal year is given below.

Task	FY16	FY17	FY18	Total
1: TAC Meeting #1	$500			$500
2: Literature Review	$10,300			$10,300
3: Data Collection.	$31,000			$31,000
4: Draft Research Methodology	$10,700			$10,700
5: TAC Meeting #2	$500			$500
6: Data Analysis		$49,990		$49,990
7: TAC Meeting #3		$500		$500
8: ATMS Safety Assessment		$29,000		$29,000
9: Draft Final Report		$11,000		$11,000
10: Draft ODOT Research Note		$1,000		$1,000
11: TAC Meeting #4			$500	$500
12: Final Report			$5,000	$5,000
13: Final Research Note			$500	$5,00
Total for tasks (Contract amount)	**$53,000**	**$91,490**	**$6,000**	**$150,490**
Support/management				
Total for ODOT				