



RESEARCH PROJECT WORK PLAN

Project Title:	Cloud Based Dynamic Warning System
*MnDOT or LRRB Need Statement Number:	485
*LRRB Knowledge Building Priority Number:	<i>(if applicable)</i>
Total Project Budget:	\$ 79,629
Total Project Duration:	17 months
Public Agency Champion (state, county, city, or township employee):	Rick West Otter Tail County Engineer
Key Words (for cataloging):	Safety, ITS, Dynamic Speed Warning
Date Submitted:	06/21/2017

1. PROJECT TEAM

- Principal Investigator:
 - Name: Brad Wentz. P.E.
 - Position Title: Director
 - Organization/University: Advanced Traffic Analysis Center – Upper Great Plains Transportation Institute – North Dakota State University
 - Phone: 701-231-7230
 - Email: bradley.wentz@ndsu.edu
- Co-Investigator:
 - Name: Mohammad Smadi
 - Position Title: Associate Research Fellow
 - Organization/University: Advanced Traffic Analysis Center – Upper Great Plains Transportation Institute – North Dakota State University
 - Phone: 701-231-8085
 - Email: m.smadi@ndsu.edu
- Programmer:
 - Name: Megan Bouret
 - Position Title: IT Research Assistant
 - Organization/University: Upper Great Plains Transportation Institute – North Dakota State University
 - Phone: 701-231-6263
 - E-Mail: megan.s.bouret@ndsu.edu



RESEARCH PROJECT WORK PLAN

2. PROJECT ABSTRACT AND OBJECTIVE(S)

Over 25% of roadway fatal crashes are associated with a horizontal curve. Research shows that dynamic curve speed warning systems are more effective than static signs in reducing vehicle speeds while traversing curves. Due to cost and operational limitations, dynamic warning systems deployment is limited to locations with historical high crash numbers.

The goal of the proposed system is to expand the benefits of dynamic curve speed warning (CSW) to virtually all potentially dangerous curves within a jurisdiction by providing on-board dynamic warning to vehicles entering a horizontal curve at speeds that may be too high for safe travel. The proposed system will utilize a smart phone and an existing mobile application developed by the research team featuring geo-fencing technologies for warning locations and an online database containing the coordinates for curve locations. This proposed system is also intended to serve as a proof of concept to give automobile manufactures with existing adaptive cruise control and lane assist technology an option for access to local road authority information which these technologies presently do not have.

3. HOW DOES THIS RESEARCH BENEFIT MINNESOTA TAXPAYERS?

The benefits of the proposed system are twofold: improved safety and cost reduction over traditional dynamic curve speed warning systems.

The safety benefits come in the form of reduction in travel speed while traversing a curve. Existing in-car safety features such as adaptive cruise control and lane departure warning systems are fast becoming standard features for many manufacturers. While these features create many safety improvements there are some safety concerns with the inability to identify and adjust to hazards such as reduced speed curves, bumps, and construction and maintenance activities. This proposed system will provide a potential basis for road authorities to provide this information to any manufacturer or safety system.

Roadside dynamic warning systems consist of a detection component to capture vehicle speeds and a warning component to relay a message to drivers. The detection component may include technologies such as in-pavement inductive loops, or non-intrusive applications such as radar and cameras. The warning component may be in the form of a dynamic message sign or a static sign with flashing beacons. In order to operate these devices, roadside warning systems require power and communication at the warning location.



RESEARCH PROJECT WORK PLAN

Whereas existing dynamic warning systems rely on roadside infrastructure and thus are only deployed at high crash locations (typically greater than or equal to 10 crashes in a 24 month period and greater than or equal to 7 crashes in a 12 month period), the proposed system eliminates the need for any roadside devices and takes the warning system entirely onboard the vehicle resulting in cost savings and the advantage of spreading the potential safety benefits system wide.

4. SUMMARY OF RESEARCH METHODOLOGY (SCOPE)

The proposed approach is to utilize an existing smartphone application developed by the research team to provide dynamic cloud-based warnings to motorists. The Android smartphone application collects the vehicle speed and direction of travel from the Google Maps navigation software and crosschecks that information against advisory speeds posted in an online database. The application utilizes geo-fencing perimeters to determine whether a warning is warranted as a vehicle enters the potential warning area.

The online database consists of fields containing the coordinates of warning locations; with the direction of travel the warning is meant for; and the advisory speed. As part of this project, the research team will develop an online tool for editing the warning database so agencies can easily add warning locations as needed.

The existing application was developed as proof of concept for generating location specific speed-based warnings to drivers without the use of any roadside infrastructure. The research team will work on revising the application to fine tune appropriate geo-fence radius selections and perform speed averaging and smoothing from GPS.

The research team will work with a county in Minnesota to test the application for dynamic curve speed warning and other location-based speed warning situations.

Further, the research team proposes contacting automobile manufacturers regarding onboard safety features such as adaptive cruise control and lane departure warning systems to establish formats and standards of how speed advisory data from local agencies can be incorporated to enhance the effectiveness of such systems.

The research team will utilize a previously developed location and speed based warning mobile application. The research team will utilize smartphones and data collection equipment available at the Advanced Traffic Analysis Center.

5. TASK DESCRIPTIONS, DURATIONS, SCHEDULED DATES, AND KEY MILESTONES

Task 1: Initial Memorandum on Research Benefits and Implementation Steps

- **Description:** During the proposal phase and in Section 3, 1 or 2 key benefits were selected to clearly define the benefits the state will receive from the results and conclusions of this research. This task will provide an initial estimate of research benefits, a proposed methodology, and potential implementation steps.
- **Anticipated Start Date:** August 1, 2017
- **Scheduled Date to Submit Draft Deliverable:** October 31, 2017
- **Scheduled Date for Task Final Approval:** December 31, 2017
- **Duration:** 5 months including the TAP review and comment period
- **Deliverable:** A memorandum providing initial estimates of research benefits, documentation of the methodology, and potential implementation steps.

Task 2: Literature Review and Automobile Manufacturer Contact

- **Description:** The research team will conduct a literature review on existing dynamic warning systems and summarize the results in a document. The research team will also initiate contact with vehicle manufacturers to gauge their interest in data from local agencies that could enhance their onboard vehicle safety systems.
- **Anticipated Start Date:** August 1, 2017
- **Scheduled date to submit draft deliverable:** September 30, 2017
- **Scheduled date for task approval:** November 30, 2017
- **Duration:** 4 months including the TAP review and comment period
- **Deliverable:** Literature review summary and a list of contacted automobile manufacturers along with the contact letter.

Task 3: Warning Database Management Tool Creation

- **Description:** The research team will create an online application for editing the warning location database. The tool will include credentialed access and automated quality control for data entry.
- **Anticipated Start Date:** October 1, 2017
- **Scheduled date to submit draft deliverable:** January 31, 2017
- **Scheduled date for task approval:** March 31, 2018
- **Duration:** 6 months including the TAP review and comment period
- **Deliverable:** An online application for editing the database of warning locations.



RESEARCH PROJECT WORK PLAN

Task 4: Field Testing and Warning System Application Refinement

- **Description:** The research team, with input from Minnesota agency engineers, will select a test location and begin testing and refining the warning mobile application to ensure that warnings are triggered far enough in advance for the driver to take corrective action or reduce travel speed.
- **Anticipated Start Date:** October 1, 2017
- **Scheduled date to submit draft deliverable:** May 31, 2018
- **Scheduled date for task approval:** July 31, 2018
- **Duration:** 10 months including the TAP review and comment period
- **Deliverable:** Summary of test results and Android smartphone warning application in executable format and source code.

Task 5: Final Memorandum on Research Benefits and Implementation Steps

- **Description:** During the proposal phase and in Section 3, 1 or 2 key benefits were selected to clearly define the benefits the state will receive from the results and conclusions of this research. This task will produce a final memorandum that clarifies and documents the methodology used to calculate benefits, including any assumptions and steps required. The memorandum will also include key steps that MnDOT should take to implement the research
- **Anticipated Start Date:** December 1, 2017
- **Scheduled Date to Submit Draft Deliverable:** August 30, 2017
- **Scheduled Date for Final Task Approval:** October 31, 2017
- **Duration:** 11 months
- **Deliverable:** A final technical memorandum at the end of the project that provide details of the methodology, steps and approach for evaluating benefits, benefits quantification results, and discussion of next steps for implementation.

Task 6: Compile Report, Technical Advisory Panel Review and Revisions

- **Description:** A draft report will be prepared, following MnDOT publication guidelines, to document project activities, findings and recommendations. This report will need to be reviewed by the Technical Advisory Panel (TAP), updated by the Principal Investigator to incorporate technical comments, and then approved by Technical Liaison before this task is considered complete. Holding a TAP meeting to discuss the draft report and review comments is strongly encouraged. TAP members may be consulted for clarification or discussion of comments.
- **Anticipated Start Date:** December 1, 2017



RESEARCH PROJECT WORK PLAN

- **Scheduled Date to Submit Draft Report:** August 30, 2018
- **Schedule Date for Final Report Approval:** October 31, 2018
- **Duration:** 11 months including TAP review, discussion, and PI revisions
- **Deliverables:** A Draft Report and Final Report Approved for Publication.

Task 7: Editorial Review and Publication of Final Report

- **Description:** During this task the Approved Report will be processed by MnDOT’s Contract Editors. The editors will review the document to ensure it meets the publication standard. This task must be completed within the Contract time because the editors will provide editorial comments and request information from the Principal Investigator.
- **Scheduled Start Date:** November 1, 2018
- **Scheduled End Date:** December 31, 2018
- **Duration:** 2 months (required)
- **Deliverables:** Final Published Report.

Task 8: Out-of-State Conference Travel

- **Description:** Presenting at the 2018 National Rural ITS Conference for increased exposure of the research project.
- **Potential Attendees:** PI/co-I
- **Scheduled Date:** Conference not yet scheduled, likely date is August 2018.
- **Deliverables:**
 - Submit the Travel Authorization Form for each trip, which must be approved by MnDOT before travel occurs (allow one month for approval).
 - After completing the trip, provide a brief summary to the TL and PC to initiate payment for the Out-of-State Conference Travel task.

KEY MILESTONES

Key Milestone	Target Date	Description
1. Project initiation	August 2017	After TAP approval of project scope and tasks
2. Field testing	September 2018	Field testing and application development and refinement must be concluded by this date

RESEARCH PROJECT WORK PLAN

6. BUDGET DETAILS

BUDGET BY LINE ITEM	Description	Budget (Round to nearest dollar)
Salaries		\$ 40,449
Brad Wentz, PI		\$ 12,941
Mohammad Smadi, Co-Investigator		\$ 11,080
Megan Bouret, Programmer		\$ 5,248
Graduate Research Assistant		\$ 8,280
Undergraduate RA		\$ 2,900
Fringe Benefits		\$ 10,468
Brad Wentz, PI	Fringe rate: 35%	\$ 4,529
Mohammad Smadi, Co-Investigator	Fringe rate: 35%	\$ 3,878
Megan Bouret, Programmer	Fringe rate: 35%	\$ 1,837
Graduate Research Assistant	Fringe rate: 2%	\$ 166
Undergraduate RA	Fringe rate: 2%	\$ 58
Non-Salary		\$ 4,000
Equipment:		\$
Supplies:		\$
Travel:	Travel to TAP meetings and test site	\$ 3,000
Conference Travel:	Travel to present research results at NRITS	\$ 1,000
Subconsultants¹		\$
Total Direct Costs		\$ 54,917
Indirect Costs	Indirect Cost Rate: 45%	\$ 24,712
TOTAL		\$ 79,629

* Cost for non-academic sub-consultants cannot exceed 50% of the total proposal budget

7. BUDGET JUSTIFICATION

The proposed budget includes:

Brad Wentz (PI): 16% of effort for project management.

Mohammad Smadi: 21% of effort for research tasks and report preparation.

Megan Bouret: 15% of effort for leading the graduate and undergraduate students programming effort.

Graduate RA: 33% of effort graduate student programmer.

Undergrad RA: 15% of effort undergraduate student programmer.



RESEARCH PROJECT WORK PLAN

Travel to technical advisory panel and test sites: \$3,000.

Travel to present at 2018 National Rural ITS Conference: \$1,450. This would provide more visibility to the research project which could potentially interest other states in implementing the warning application, and can increase the chance for discussions with vehicle manufacturers for integrating the warning information into their vehicle safety systems.

8. OVERVIEW OF PROJECT SCHEDULE AND BUDGET

FY18 (7/1/17 – 6/30/18)														
Month of Contract														Budget
Calendar Month	J	A	S	O	N	D	J	F	M	A	M	J		
Task 1		X	X	X	X	X							\$ 1,629	
Task 2		X	X	X	X								\$ 8,825	
Task 3				X	X	X	X	X	X				\$ 14,009	
Task 4				X	X	X	X	X	X	X	X	X		
Task 5					X	X	X	X	X	X	X	X		
Task 6					X	X	X	X	X	X	X	X		
FY18 Total:													\$ 24,463	

FY19 (7/1/18 – 6/30/19)														
Month of Contract														Budget
Calendar Month	J	A	S	O	N	D	J	F	M	A	M	J		
Task 4	X												\$ 35,090	
Task 5		X	X	X									\$ 2,351	
Task 6		X	X	X									\$ 11,766	
Task 7					X	X							\$ 4,509	
Task 8		X											\$ 1,450	
FY19 Total:													\$ 55,166	
PROJECT TOTAL													\$ 79,629	

**The cost of the draft final report task and the final report publication task must each be at least 5% of the total project cost without the benefit quantification cost.*

9. SUBCONTRACTOR INFORMATION

NA.

10. ADMINISTRATIVE REQUIREMENTS

A work order will be issued under the terms and conditions of the Master Contract between the State of Minnesota and the University. The proposal submitted to MnDOT must comply with the terms and



RESEARCH PROJECT WORK PLAN

conditions of the Master Contract. It is understood that PIs, through the University Authorized Representative for the Master Contract, are aware of the Master Contract requirements, including those related to budgeting, quarterly progress reporting, final deliverables, invoicing, reimbursement of travel expenses and payments. A copy of the Master Contract can be obtained from the Office of Sponsored Projects Administration.

In addition, it is expected that the PIs will make themselves available to meet with MnDOT Research Services staff, if necessary, to formally review the project progress on semi-annual basis. In most cases this will occur if the project falls behind schedule. PIs shall prepare necessary documentation and information to facilitate meaningful project reviews.

11. MATCHING FUNDS, IN-KIND, OR OTHER CONTRIBUTIONS

NA.

12. INTELLECTUAL PROPERTY/TRADE SECRET INFORMATION

Per the MnDOT/North Dakota State University master agreement.

13. AGENCY ASSISTANCE (MNDOT OR OTHER)

The research team will need the assistance of a Minnesota County or a MnDOT district for testing the warning system on local roads. This assistance will include selecting a warning location by providing coordinates for a warning location along with warning direction and advisory speed. The location can be from the agency's existing or desired/planned curve speed warning locations. An additional area of assistance is with testing the warning application, the research team would provide the agency with mobile devices that have the application installed for testing of the accuracy and the user interface.