

National Cooperative Highway Research Program FY 2023 Program

Compendium of Problem Statements



PART I– Candidates for Continuation Funding

PART II – New Problems (Problem Statements with Evaluations and Submitter Responses)

February 2022

INTRODUCTION

In formulating the fiscal year 2023 program for the National Cooperative Highway Research Program, the Special Committee on Research and Innovation will consider candidate studies in two broad categories: (1) continuations of projects initiated in earlier years and (2) new projects. Corresponding to these categories, this report is in two parts.

Part I contains write-ups for 12 continuation candidates. These write-ups were prepared by the NCHRP staff and project panels and provide the specifics of project objectives, funding, accomplishments, and recommendations for needed additional research. The continuations have been further subdivided as follows: Annual Projects (e.g., Project 20-05) and Research Projects (recommended extensions to individual objective-specific projects). You will find 'Accountability Reports' attached to continuation requests under the Annual Projects category.

Part II contains 137 problem statements for consideration as new projects. For each candidate problem, the problem statement write-up, which was to be submitted in a format specified by NCHRP, is presented first. The problem statement is then followed by evaluations that may be from among 3 sources: FHWA staff, NCHRP staff, and/or AASHTO committee or council. Lastly, there may be a response from the original submitter to the evaluation comments. Submitters were given the opportunity to support or rebut the evaluations or to withdraw the statement. In 3 instances B - 37, G-30 and G-33), the submitter submitted a revised problem statement. These revisions have not been provided because they could not be reviewed by AASHTO, FHWA and NCHRP. One problem statement (F-01) was withdrawn by the submitter.

ACTIONS REQUIRED

This report is accompanied by a ballot for assigning priorities to both the continuation problems and the new problems. The questions to be considered in completing the ballot are:

- a. Does the proposed study represent a current problem that needs researching?
- b. Is the proposed study appropriate for NCHRP or should it be performed elsewhere?
- c. Is the problem of interest to a majority of states?
- d. Are similar efforts already underway elsewhere? If so, will this unnecessarily duplicate the efforts of others?
- e. What is the probability of this research being successful?
- f. If the research is successful, what is the anticipated return with respect to its cost?

By whatever means research committee members choose to employ, the evaluation of each problem by these questions is to be translated into a single rating number from 0 (no need) to 5 (absolute need) that will be used to rank the problem according to ballots returned by R&I and RAC.

The ballot is due on April 1, 2022, and a summary of the results will be distributed early in April. When R&I meets on April 14 and 15, the order in which continuation candidates and new problems will be considered will be based on the composite rankings by R&I and RAC.

Part I

CANDIDATES FOR CONTINUATION FUNDING

FY 2023 CANDIDATES FOR CONTINUATION FUNDING

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Part 1.1

ANNUAL PROJECTS

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
Transportation Research Board
The National Academies of Sciences, Engineering and Medicine

Continuation Request
Project 20-05, FY 1968 & Continuing
Synthesis of Information Related to Highway Problems

Present Expiration Date: Continuing
Recommended Allocation: \$810,000

1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended

The purpose of NCHRP Project 20-05 is to synthesize the useful knowledge and practice on particular subjects and prepare well documented state-of-knowledge and -practice reports. This is a systematic way to bring such useful information together and to make it available to the entire highway community.

With the rapid advancements that are taking place in highway and transportation planning, location, design, construction, maintenance, and operations, and as result of the broad spectrum of information input to these fields from a multitude of sources, it is imperative that a means of synthesizing this information into usable form be maintained and augmented. This service has been provided since 1967 through NCHRP Project 20-05 under the guidance of Project Panel SP20-05 and has been highly responsive to the needs of highway and transportation organizations. The synthesis program continues to be highly rated by R&I and RAC and has consistently been ranked as a very high priority.

The substantial interest that the program has generated is evidenced by the number of subjects that are proposed for synthesis each year—typically between 110 and 150. As of November 30, 2021, 577 syntheses had been published, three reports are in the final editorial and publication process, and 30 others are in the research stage. A review of TRB's web page shows that 16 NCHRP synthesis studies were published in 2019.

2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended

For the FY2022 series, the NCHRP 20-05 project committee requested and AASHTO R&I approved a budget of \$810,000 to execute 18 topics. The budget recommended by the NCHRP 20-05 project committee for FY2023 is \$810,000 to support 18 topics.

3. Funds (in thousands)

	FY 1968 – 2017	FY 2018	FY 2019	FY 2020	FY2021	FY2022	FY2023
Continuation allocation	37,440	1,830	1,830	765**	810	810	810

Transfers to proj. 20-05	1,720*	-0-	-0-	90	45	0	
Less obligation	<u>39,160</u>	<u>1,830</u>	<u>1,830</u>	<u>855</u>	<u>855</u>	<u>810</u>	
Balance (earmarked)	-0-	-0-	-0-	-0-			
Reallocation	<u>-0-</u>	<u>-0-</u>	<u>-0-</u>	<u>-0-</u>			
Total available	-0-	-0-	-0-	-0-			
Recommended addition	-0-	-0-	-0-	-0-	855	810	810

* These transfers were for additional synthesis projects funded by R&I or FHWA.

** Beginning in FY 2020, funds reflect the amount for research contracts only.

4. Interpretation of AASHTO Problem Statement by Panel

Administrators, practicing engineers, and researchers are continually faced with highway problems on which much information already exists, either in documented form or in terms of undocumented experience and practice. Unfortunately, this information is often fragmented, scattered, and unevaluated. Often it is unknown to the persons normally responsible for initiating changes related to the topic (changes in specifications, procedures, etc.). As a consequence, full information on what has been learned about a problem is frequently not brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

Another type of waste occurs if a number of people who have similar problems make independent efforts to assemble the appropriate information, especially if the assemblies are incomplete and not made available to others.

Textbooks, monographs, and state-of-the-art papers represent conventional methods for maximizing the use of existing information and for minimizing the total effort expended in bringing together useful information. All such documents involve the synthesis of information from various sources and can, therefore, be looked upon as information syntheses.

In this project, particular highway problems, or sets of closely related problems will be designated as topics for information syntheses. For each topic, the project objectives are: (1) To locate and assemble all documented information on the topic; (2) To learn what the practice has been for solving or alleviating problems within the topic; (3) To identify all ongoing research on the topic; (4) To learn what problems remain largely unsolved; (5) To organize, evaluate, synthesize, and document the useful information that is acquired; and (6) To evaluate the effectiveness of the synthesis after it has been in the hands of its users for a period of time.

The document produced by attainment of the foregoing objectives will be called a synthesis of existing information on the topic. The first and third objectives imply full use of the Transportation Research Database (TRID) and other information systems for

documented information. It is expected that information obtained for the second and fourth objectives will be largely undocumented and will, therefore, be obtained through interviews in federal, state, and local agencies that have had first-hand experience with problems within the topic.

5. Original AASHTO Problem Statement Number

Problem Statement is on file.

6. Research Assignment to Date

NCHRP Project 20-05, "Synthesis of Information Related to Highway Problems"

7. Review Dates

April 29 – 30, 2021 (Panel/staff)

Accountability Report for NCHRP Project 20-05
“Synthesis of Information Related to Highway Problems”

Purpose:	To provide summaries of the state of highway practice and knowledge.
Started:	Project 20-05 began in 1968.
Funding:	Allocated for FY 2022: \$810,000 Requested for FY 2023: \$810,000
Problem Solicitation:	Once each year, NCHRP specifically solicits topics from state DOTs, AASHTO and TRB committees, and FHWA. TRB staff also encourages submittals by TRB committees during the TRB annual meeting. Topics for FY 2023 are due by February 17, 2022.
Process for Selecting Studies:	Requests are considered at an annual meeting of the 20-05 panel, and a list of topics and alternates are selected.
Consultant Selection:	The synthesis program is managed by staff in TRB's National Cooperative Highway Research Program. Each year's new studies are announced publicly (NCHRP email list and the TRB Weekly newsletter) to solicit interest in being a topic panel member or an author. Staff then forms a topic panel for each selected synthesis. The topic panel reviews expressions of interest and selects principal investigators.
Studies Requested Last Year:	111 topics were proposed for the FY2022 program.
Studies Funded Last Year:	18 studies, totaling \$810,000, were funded for the FY2022 program (see attachment A).
Studies Completed Last Year:	18 NCHRP Syntheses will be completed in calendar year 2021.
Distribution of Findings:	NCHRP syntheses are distributed widely by TRB to sponsors, subscribers, and affiliates. All NCHRP synthesis reports are posted on the TRB website as well.
Use of Findings:	By all indications, the NCHRP Synthesis Series is one of the most popular of the NCHRP activities.

Next Year's Studies: FY 2023 studies will be selected in April 2022 from topics submitted by February 17, 2022.

ATTACHMENT A

NCHRP SYNTHESIS TOPICS INITIATED in 2021

53-01	Practices to Promote Equity in Transportation Funding
53-02	Practices to Motivate Safe Behaviors with Highway Construction and Maintenance Crews
53-03	Practices Leveraging Social Media Data for Emergency Preparedness and Response
53-04	Practices in the Collection and Use of Utility As-Built Information for Minimizing Project Risks
53-05	Practices for Stormwater Bioretention
53-06	Local Calibration of LRFD Geotechnical Resistance Factors
53-07	Curing Practices for Concrete Pavement
53-08	Strategies and Programs For Electric Vehicle Charging
53-09	Use of Unmanned Aerial Systems for Highway Stormwater Inspections
53-10	Practices for Contrast Pavement Markings
53-11	Resilient Design with Distributed Rainfall Modeling
53-12	Practices for Adding Bicycle and Pedestrian Access on Existing Vehicle Bridges
53-13	Practices for Steel Bridge Fabrication and Erection Tolerances
53-14	Use of Probe Data for Freight Planning and Operations
53-15 cancelled	Streamlining Information Technology Updates Required by Traffic Operations and Maintenance
53-16	Critical Findings for Tunnel Functional Systems
53-17	Integrating Freight into Policies, Planning, and Project Development for Active Transportation
53-18	Moisture Measurement for Foundations and Slopes
53-19	State DOT Product Evaluation Processes

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
Transportation Research Board
The National Academies of Sciences, Engineering, and Medicine

Continuation Request
Project 20-24, FY 1988 & Continuing
Administration of Highway and Transportation Agencies

Present Expiration Date: Continuing
Recommended Allocation: \$1,250,000

1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended

The objectives of NCHRP Project 20-24 are to (1) identify critical problems facing top management officials in state highway and transportation agencies and AASHTO and (2) design and conduct research projects to address those problems. Fiscal year allocations are used to fund projects selected by NCHRP Panel SP20-24 in response to initiatives of interest to state DOT and AASHTO leadership.

The NCHRP Panel currently meets at least twice a year, typically in conjunction with the AASHTO Annual and Spring meetings, with teleconferences as needed to address specific matters. At the two regularly scheduled meetings, the panel considers new topics for research, reviews progress on individual studies and the 20-24 project series as a whole, and discusses current issues facing DOTs and top AASHTO leadership. Recent funding has been used to address enterprise knowledge management; workforce development; enterprise-level decision making frameworks; measurement and management of transportation system performance and asset condition; economic and social benefits of transportation system performance; transportation system resilience; and the significance of new technologies and societal trends that are shaping transportation. Section 6 presents a comprehensive listing of project titles.

2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended

Interest in the "20-24 series" concept remains high among top management of state DOTs and the leadership of AASHTO. State transportation agency leadership generally as well as the AASHTO Board of Directors and staff have a continuing need for research to produce factual information and analysis in support of their strategic planning, capacity building, and current decision making to address an evolving set of such critical issues as change and uncertainty in revenues and financing mechanisms, travel demand, workforce development, and the balance among governments' roles in transportation system management. The project panel requests \$1,200,000 to maintain their efforts to address these continuing research needs. As in previous years, the NCHRP 20-24 panel is expected to convene in association with the AASHTO Spring and Annual Meetings and on other occasions as needed to consider pressing funding

requests, new initiatives, and the status of the 20-24 series and ongoing and recently completed projects in the series.

3. Funds (in thousands)

	FY 1989- 1990	FY 1991- 1995	FY 1999	FY 2002- 2010^a	FY 2011- 2022	FY 2023
AASHTO Initial Allocation	125					1,250
Continuation Allocation	600	1,825	500	9,500	15,000	
Less Obligation	<u>725</u>	<u>1,750</u>	<u>500</u>	<u>9,500</u>	<u>14,863^b</u>	
Balance (earmarked)	-0-	75	-0-	-0-	337 ^b	
Reallocation	-0-	<u>75</u>	<u>-0-</u>	<u>-0-</u>	<u>-0-</u>	
Total Available	-0-	-0-	-0-	-0-	337	
Recommended Addition						\$1,250

^a \$1M per year for FY 2002-2009, \$1.5M for FY 2010; \$1.25M per year for FY 2011-2022.

^b Obligation of funds based on panel's 10/27/2021 meeting; other commitments pending.

4. Interpretation of AASHTO Problem Statement by Panel

At a special session held during the 1986 Annual Meeting of the Transportation Research Board (TRB) a number of Chief Administrative Officers (CAOs) from state departments of transportation identified areas of concern in the management of transportation agencies. Economic considerations and management of financial resources were judged to be the most important areas. Others included the management of people, information systems, public affairs, and technology transfer. In each area discussed, problems were identified that are in need of research. At the same meeting, members of the academic community reported the findings of the NSF seminar on "Transportation Research: The State of the Art and Research Opportunities." Although their recommendations called for more fundamental research, some of the problems identified were very similar to those listed by the CAOs.

As a consequence, a need was recognized for a research program specifically directed to the management, administration, and policy planning needs of senior management of state transportation agencies. Accordingly, the AASHTO Standing Committee on Research directed that a study be undertaken under the NCHRP to develop a plan for research focused on these needs.

5. Original AASHTO Problem Statement Number

Problem No. 1988-A-08

6. Research Assignments to Date

NCHRP Project 20-24 "Research Program Design -- Administration of Highway and Transportation Agencies"

- NCHRP Project 20-24(01) "Using Market Research to Improve Management of Transportation Systems"
- NCHRP Project 20-24(02) "Executive Management Information Systems for State Departments of Transportation"
- NCHRP Project 20-24(03) "Expanding the Civil Engineering Pool"
- NCHRP Project 20-24(03)A "Civil Engineering Careers in Transportation – Outreach Program"
- NCHRP Project 20-24(04) "Senior Executive Service Participant's Manual"
- NCHRP Project 20-24(05) "Public Outreach in Transportation Management"
- NCHRP Project 20-24(06)A "Performance Measures Used by State Highway and Transportation Agencies"
- NCHRP Project 20-24(06)B "Business Systems Plan for Highway Engineering Information"
- NCHRP Project 20-24(06)C "Information Systems for Transportation Agencies"
- NCHRP Project 20-24(07) "Alternatives to Motor Fuel Taxes for Financing Surface Transportation Improvements"
- NCHRP Project 20-24(07)A "Alternative Approaches to Taxation of Heavy Vehicles"
- NCHRP Project 20-24(08) "Project 20-24 Series -- Revisited"
- NCHRP Project 20-24(09) "State Departments of Transportation: Strategies for Change"
- NCHRP Project 20-24(10) "Customer-Based Quality in Transportation"
- NCHRP Project 20-24(11) "AASHTO Guide for Asset Management"
- NCHRP Project 20-24(12) "Issues Involving Delays in Completing Federal-aid Highway and Bridge Projects"
- NCHRP Project 20-24(13) "Innovative Financing Clearinghouse"
- NCHRP Project 20-24(14) "Managing Change in State Departments of Transportation: Topic Scans"
- NCHRP Project 20-24(15) "AASHTO Support Activities for Reauthorization"
- NCHRP Project 20-24(16) "AASHTO Experience in Transportation Enhancements"
- NCHRP Project 20-24(17) "National Conference on Historic Preservation"
- NCHRP Project 20-24(18) "Outsourcing of State DOT Delivery of Capitol Programs"

- NCHRP Project 20-24(19) "How State DOTs Can Learn to Thrive in an E-Business Environment"
- NCHRP Project 20-24(20) "Transportation Outcomes and Other Strategic Performance Impact Measures: A Framework for State Departments of Transportation"
- NCHRP Project 20-24(21) "Characteristics of the 21st Century Operations-Oriented State DOT"
- NCHRP Project 20-24(22) "Best Practices in Partnering with Public Resource Agencies"
- NCHRP Project 20-24(23) "Assessing the Importance of Transportation for Major Industries and Sectors of the U.S. Economy" -- A. Agriculture; B. International Trade; C. Congestion; D. Travel, Tourism, and Recreation
- NCHRP Project 20-24(24) "Transportation Mobility, Access, and Safety for an Aging Population"
- NCHRP Project 20-24(25) "Improving Project Costing and Incorporation of New Attributes -- Highways and Transit"
- NCHRP Project 20-24(26) "Finance Trends in Non-Federal Funding and Debt
- NCHRP Project 20-24(27) "Expanded State and National Investment Analysis Capability -- Highway"
- NCHRP Project 20-24(28) "Rate of Return from Highway Investment"
- NCHRP Project 20-24(29) "CEO Peer Exchange Workshop for Strategic Leadership"
- NCHRP Project 20-24(30) "Performance Measurement in Context Sensitive Design"
- NCHRP Project 20-24(31) "Financial Management for Effective Program Management"
- NCHRP Project 20-24(32) "New CEO Briefings"
- NCHRP Project 20-24(33)A "21st Century Freight Mobility"
- NCHRP Project 20-24(33)B "Transportation, Technology, and the 21st Century Vehicle"
- NCHRP Project 20-24(33)C "Transportation Vision 2010" (Active)
- NCHRP Project 20-24(34) "Commuting-in-America Reporting Base"
- NCHRP Project 20-24(35) "Communicating Urban Congestion Information"
- NCHRP Project 20-24(36) "Updating AASHTO's Strategic Plan in CY 2004"
- NCHRP Project 20-24(37) "Five Workshop Sessions to Discuss Strategic Measures for State DOTs" (Strategic Performance Measures for State DOTs)
- NCHRP Project 20-24(37)A "Construction Project Cost and Schedule Performance"

NCHRP Project 20-24(37)B "Pavement Smoothness"

NCHRP Project 20-24(37)C "Safety "

NCHRP Project 20-24(37)D "Operations Performance Using Incident Response Time"

NCHRP Project 20-24(37)E "Bridge Conditions"

NCHRP Project 20-24(37)F "Establishment of Comparative Performance Measures program infrastructure to support national system performance data collection and analysis"

NCHRP Project 20-24(37)G "Standards and guidance for national level performance measurements"

NCHRP Project 20-24(37)H "Workshop on transportation-system performance measures suitable for national use"

NCHRP Project 20-24(37)I "Congestion (speed-based measures)"

NCHRP Project 20-24(37)J "Pavement health (composite/structural measures)"

NCHRP Project 20-24(37)K "Safety - Serious Injuries"

NCHRP Project 20-24(37)L "State DOT Comparative Performance Measurement: A Progress Report"

NCHRP Project 20-24(38) "CEO Engagement Options for Discussing Strategic Issues and Sharing Best Practices"

NCHRP Project 20-24(39) "Alternative Organizational Designs for State Transportation Departments"

NCHRP Project 20-24(40) "Analysis and Benchmarking of State DOT Human Resource Activities"

NCHRP Project 20-24(41) "Project Summaries for state DOT CEOs"

NCHRP Project 20-24(42) "Comparison of State DOT Quality Management Systems"

NCHRP Project 20-24(43) "Innovative Contracting for Major Transportation Projects"

NCHRP Project 20-24(44) "Highway Safety Leadership Organizational Issues: A Survey of States and Recommendations for Sustaining Progress"

NCHRP Project 20-24(45) "Executive Seminar, Coordinating Transportation and Land Development: Outlook, Challenges, Success"

NCHRP Project 20-24(46) "Freight Transportation: New Roles for State DOTs"

NCHRP Project 20-24(47) "Benchmarking Diversity in the Transportation Industry: A Scoping Study"

NCHRP Project 20-24(48) "Analysis and Benchmarking of State DOT Human Resource Activities (Ph. 2)"

NCHRP Project 20-24(49) "Future Financing to Meet Highway and Transit Needs"

NCHRP Project 20-24(50) "In-Service Training Needs for State DOTs"

NCHRP Project 20-24(51) "State DOT Leadership Forum – 2006"

NCHRP Project 20-24(52) "Future of the National System of Interstate and Defense Highways"

NCHRP Project 20-24(53) "Twenty-first Century Leadership and Management Techniques for State DOTs"

NCHRP Project 20-24(54) "2006 Bottom Line Report, State and National Investment Analysis: Highways"

NCHRP Project 20-24(55) "National Summit for Funding and Finance Strategies"

NCHRP Project 20-24(56) "State and Local Officials: To Advance a Vision for the Transportation System Required to Meet Future Needs"

NCHRP Project 20-24(57) "Management and Leadership Information for a Dialogue with New State DOT CEOs"

NCHRP Project 20-24(58) "Toward Developing Performance Based Federal-Aid Highway Programs"

NCHRP Project 20-24(59) "Strategies for Reducing the Impacts of Surface Transportation on Global Climate Change"

NCHRP Project 20-24(60) "Updating AASHTO's Strategic Plan in CY 2008"

NCHRP Project 20-24(61) "Executive Forum on Performance Based Maintenance and Operations Practices"

NCHRP Project 20-24(62) "The Identification of Marketing Tools that Resonate with Lawmakers and Key Stakeholders to Support and Increase Funding and Revenue for the Nation's Transportation System"

NCHRP Project 20-24(63) "Partnership Approaches to Identify, Promote, and Implement Congestion Management Strategies"

NCHRP Project 20-24(64) "Implications for Transportation of a Conformity-Style Approach to Reduce Greenhouse Gases, and Assessment of Alternative Policies to Integrate GHG Objectives into Transportation Decisions"

NCHRP Project 20-24(67) "State DOT CEO Leadership Forum- Spring/Summer 2009; Pilot Study of State Driven Performance Based Management Reporting"

- NCHRP Project 20-24(68) "Estimating the Costs to State Governments due to Highway Related Debilitating Injury and Fatal Crashes"
- NCHRP Project 20-24(69) "Implementable Strategies for Shifting to Direct Usage-Based Charges for Transportation Funding"
- NCHRP Project 20-24(70) "Update the 2003 Report Reducing Greenhouse Gas Emissions from U.S. Transportation"
- NCHRP Project 20-24(71) "Expediting NEPA: Practitioner Strategies for Early Identification of and Response to High Risk Issues"
- NCHRP Project 20-24(72) "Maximizing Highway Operational Strategies to Reduce Greenhouse Gas (GHG) Emissions"
- NCHRP Project 20-24(73) "Economic and Employment Benefits of Highway Investments in Response to Economic Downturns: A Scoping Study"
- NCHRP Project 20-24(74) "Risk Management Practices in State Departments of Transportation"
- NCHRP Project 20-24(75) "Development of a Performance Management Roadmap"
- NCHRP Project 20-24(77) "Support for a TRB-sponsored conference on Strategies for Meeting Critical Data Needs for State and Metropolitan Transportation Agencies"
- NCHRP Project 20-24(78) "Integrating Performance Measures into a Performance-Based Planning and Programming Process"
- NCHRP Project 20-24(79) "Specifications for a national study of the future 3R, 4R, and capacity needs of the Interstate System"
- NCHRP Project 20-24(80) "Assessing the Economic Benefit of Transportation Infrastructure Investment in a Mature Surface Transportation System"
- NCHRP Project 20-24(81) "Leading in Lean Times: Maximizing Resources in a Constrained Environment"
- NCHRP Project 20-24(82) "Increasing Consistency in the Highway Performance Monitoring System for Pavement Reporting"
- NCHRP Project 20-24(83) "Alternative State DOT Organizational Models for Delivering Services"
- NCHRP Project 20-24(84) "State DOT CEO Leadership Forum- Summer/Fall 2012, a Focus on State DOT Current Organizational and Management Issues"
- NCHRP Project 20-24(85) "Scoping support for new NCHRP 20-24 projects"
- NCHRP Project 20-24(86) "Critical Assessment for Future Surface Transportation Needs Analyses"

- NCHRP Project 20-24(87) "State DOT Administration of Local Road Safety Aid"
- NCHRP Project 20-24(88) "Performance Measure Coordination, Engagement and Reporting"
- NCHRP Project 20-24(89) "Role and Value of Transportation for U.S. Industries and Sectors"
- NCHRP Project 20-24(90) "Defining and Communicating a National Vision for Transportation"
- NCHRP Project 20-24(91) "State DOT CEO Safety Leadership Forum -- May 2013 (Support)"
- NCHRP Project 20-24(92) "Evaluation of State-of-the-Art Transportation Funding and Finance Methods"
- NCHRP Project 20-24(93)A "Improving Public Communication Influence and Effectiveness Through Better Understanding of Transportation Users' Expectations and Language – Public Outreach"
- NCHRP Project 20-24(93)B(01) "Improving Public Communication Influence and Effectiveness Through Better Understanding of Transportation Users' Expectations and Language – Management Planning"
- NCHRP Project 20-24(93)B(02) "Improving Public Communication Influence and Effectiveness Through Better Understanding of Transportation Users' Expectations and Language – Management Outreach"
- NCHRP Project 20-24(94) "Support for Development of AASHTO'S 2013-2018 Strategic Plan"
- NCHRP Project 20-24(95) "Next Generation Workforce Management"
- NCHRP Project 20-24(96) "Improving Organizational Traffic Safety Culture in DOTs"
- NCHRP Project 20-24(97) "Advancing Performance Management Under a National Framework"
- NCHRP Project 20-24(98) "Connected and Automated Vehicle Research Roadmap"
- NCHRP Project 20-24(99) "New CEO Orientation and Peer Exchange on Teamwork Between an Agency CEO and a Transportation Board or Commission"
- NCHRP Project 20-24(100) "State DOT CEO Leadership Forum – a Focus on Transportation Futures"
- NCHRP Project 20-24(101) "An Introduction to Knowledge Management and Workforce Issues for CEOs: A CEO Leadership Workshop"
- NCHRP Project 20-24(102) "Executive Strategies to Deliver Practical Design"

- NCHRP Project 20-24(103) "Peer Exchange on Issues and Communication to Support Economic Competitiveness through Transportation Investments"
- NCHRP Project 20-24(104) "State DOT Implementation of MAP21 Performance Measure Rules"
- NCHRP Project 20-24(105) "Launching U.S. Transportation Enterprise Risk Management Programs"
- NCHRP Project 20-24(106) "Evaluation Guidance for Automated Vehicle Pilot and Demonstration Projects"
- NCHRP Project 20-24(107) "Update to Transportation Governance: A 50-State Review of State Legislatures and Departments of Transportation"
- NCHRP Project 20-24(108) "CEO Leadership Peer Exchange"
- NCHRP Project 20-24(109) "Research on Enhancing Transportation System Resilience"
- NCHRP Project 20-24(110) "Development of Resources to Support State DOT Communications on Safety"
- NCHRP Project 20-24(111) "State DOT CEO Leadership Forum on "Connected & Autonomous Vehicles and Transportation Infrastructure Readiness" in conjunction with 2017 ITSWC, Montreal, Canada"
- NCHRP Project 20-24(112) "Connected Road Classification System (CRCS) Concept Development"
- NCHRP Project 20-24(113) "CEO Peer Exchange 2017"
- NCHRP Project 20-24(114) "Supplement to NCHRP 20-07 New project on "flexible" or "urban" design, "Green Book" update"
- NCHRP Project 20-24(115) "Development of Strategic Plan for Transportation Workforce Planning and Development"
- NCHRP Project 20-24(116) "Guidance on Roles and Responsibilities in Operation of Automated Vehicles"
- NCHRP Project 20-24(117) "TSMO Workforce Development"
- NCHRP Project 20-24(118) "Strategic Planning Support for AASHTO Committees"
- NCHRP Project 20-24(119) "Strategic Research in Support of the Connected and Automated Vehicle Executive Leadership Team"
- NCHRP Project 20-24(120) "Building a Bridge: A Guide to Communicating Revenue Needs"
- NCHRP Project 20-24(121) "Road Usage Charge: Applying Lessons Learned in New Zealand to the United States"

- NCHRP Project 20-24(122) "A Comprehensive Study of Future Competencies for Transportation Planners"
- NCHRP Project 20-24(123) "Roadmap for Supporting Specialty Personnel Recruitment, Development, and Retention in the DOT Workforce"
- NCHRP Project 20-24(124) "Performance Management Messaging Peer Exchange"
- NCHRP Project 20-24(125) "Scoping Study to Develop the Basis for a Highway Standard to Conduct an All-Hazards Risk and Resilience Analysis"
- NCHRP Project 20-24(126) "National Automation Readiness Framework: Coast-to-Coast Automated Mobility by 2025"
- NCHRP Project 20-24(127) "Performance Management Implementation Concerns, Issues and Challenges"
- NCHRP Project 20-24(128) "State DOT Executive Leadership Review of State-of-the-Art of Cooperative Automated Transportation (CAT) Systems"
- NCHRP Project 20-24(129) "CEO Peer Exchange 2019 and Strategy Planning"
- NCHRP Project 20-24(130) "Support for AASHTO Strategic Planning 2019-2024"
- NCHRP Project 20-24(131) "Mapping the Common Interests of AASHTO Committees"
- NCHRP Project 20-24(132) "Understanding Knowledge Management in Context with Other Organizational Practices"
- NCHRP Project 20-24(133) "Update to 'Transportation Governance: A 50-State Review of State Legislatures and Departments of Transportation'"
- NCHRP Project 20-24(134) "Practices for Transportation Agency Procurement and Management of Advanced Technologies"
- NCHRP 20-24(135) "Operational Oversight of Drones - UAS Development and Deployment: Jurisdictional Issues and Options"
- NCHRP 20-24(136) "Enabling Knowledge Management through Leadership Strategy and Culture"
- NCHRP 20-24(137) "Messages for Communicating the Economic and Quality of Life Benefits of Transportation Infrastructure Investments"
- NCHRP 20-24(138) "Collective and Individual Actions for State Departments of Transportation Envisioning and Realizing the Next Era of America's Transportation Infrastructure"
- NCHRP 20-24(139) "Into the 2020s: A Peer Exchange Series for State DOT CEOs"
- NCHRP 20-24(140) "Strategies to Strengthen Data Driven Decision-making"

NCHRP 20-24(141) "The Art of Decision-Making"

NCHRP 20-24(142) "Revenue Generation Models for Electric Vehicles: In-road and Roadside Charging"

NCHRP 20-24(143) "Template for gathering and disseminating telemetric data for safety and operational uses by state DOTs" (Phase 1: state of practice survey and synthesis)

7. Review Date

October 27, 2021

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
Transportation Research Board
The National Academies of Sciences, Engineering, and Medicine

Continuation Request
Project SP 20-30, FY 1992 & Continuing
NCHRP-IDEA Program

Present Expiration Date: Continuing
Recommended Allocation: \$950,000

1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended

The DEA (Innovations Deserving Exploratory Analysis) program explores the feasibility of unproven technical concepts, novel applications of proven concepts, or advances that have not yet been tried or tested for application in transportation practice. The focus is on high-payoff concepts, products, systems, tools, or techniques that accelerate the development and deployment of advanced technologies, methods, or processes for highway and intermodal transportation systems.

The IDEA is a unique concept to traditional transportation research programs. Unlike most transportation research solicitations where competitive proposals are requested on a specific topic and objective, IDEA makes a general solicitation, seeking out proposals from entrepreneurs, inventors, forward thinkers, and problem solvers -- anybody who has a possible solution to a vexing transportation problem.

Two types of IDEA projects, designated Type 1 and 2, are funded. Type 1 projects address technical feasibility of the proposed concepts and Type 2 projects deal with prototyping and evaluation. The maximum funding for a Type 1 project is \$150,000 and for a Type 2 \$100,000. Additional funding from other sources as cost sharing is encouraged, not mandatory for Type 1 projects but required (at least a 25% match) for Type 2 projects.

The NCHRP Project SP 20-30 Panel provides oversight to the NCHRP-IDEA Program. The Panel also evaluates proposals and, based on available funding, selects those with most merit. The selected proposals are then funded, recognizing the high degree of risk but also the potential for scientifically-founded solutions that have high value to transportation practice. The Project Panel meets twice a year to make new IDEA selections and review follow-on requests. The meeting is held in the spring and fall (generally in June and December) every year. To date, the NCHRP-IDEA Program has awarded 233 contracts, out of which 205 have been completed or closed out, 27 are currently active, and one is in the contracting process. Ongoing activity for the NCHRP-IDEA Program can be found on the NCHRP website under the Project SP 20-30.

The NCHRP-IDEA Program's annual report, *New IDEAs for Highway Systems*, is published every January for the preceding fiscal year. The report summarizes research performed on NCHRP-IDEA projects active or completed during a particular fiscal year along with one-page summaries of all previously completed projects. The report for FY 2021 is currently under preparation and will be available by the end of December 2021. The report is now being published electronically.

Proposals Received and Selected for Funding during FY 2021

During FY 2021, a total of 82 proposals were received by the NCHRP IDEA Program for its 53rd and 54th review cycles. The NCHRP Project SP 20-30 Panel, after reviewing and discussing these proposals, selected 8 projects for funding.

53rd Review Cycle (December 2020)

Number of Proposals Received: 34

Number of Proposals Selected for Funding: 4 (see below)

Proposal N-2357: *Measuring Concrete Permeability with the CHIP* (Oklahoma State University)

Proposal N-2360: *Automated Data and Feature Extraction from Bridge Plans* (Iowa State University)

Proposal N-2361: *AI Analyzer for Revealing Insights of Traffic Crashes* (University of Nevada-Las Vegas)

Proposal N-2387: *Development of an Innovative Bio-Mediated Self-Healing Concrete Technology* (Case Western Reserve University)

54th Review Cycle (June 2021)

Number of Proposals Received: 48

Number of Proposals Selected for Funding: 4 (see below)

Proposal N-2389: *High Bond Steel Fibers for Ultra High Performance Concrete (UHPC)* (HiPer Fiber, LLC)

Proposal N-2390: *A Practical Method to Determine Reclaimed Asphalt Pavement (RAP) Binder Availability* (North Carolina State University)

Proposal N-2391: *Field Test and Evaluation of a Solar Snow Fence* (Longboard Power, LLC)

Proposal N-2431: *Machine Learning-Based Tool to Protect the Retroreflectivity of Pavement Markings in the U.S.* (Louisiana State University)

Projects Completed during FY 2021

The following NCHRP-IDEA projects were completed during FY 2021. The COVID-19 pandemic has caused significant work delays for several projects that otherwise would have been completed during FY 2021.

NCHRP- 203: *Safer Cushions*

NCHRP- 211: *Reducing Stormwater Runoff and Pollutant Loading with Biochar Addition to Highway Greenways*

NCHRP-220: *Bridge Deck Sealant Monitor -- Thermal Sealcheck*

2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended

The NCHRP-IDEA Program continues to receive a high level of interest as evidenced by the number of proposals it receives, averaging about 50 proposals for each of its half-yearly review, and also by the number of products entering or being evaluated for actual practice. The NCHRP Project SP 20-30 Panel continues to believe that the NCHRP-IDEA Program, although a modest investment, provides a unique opportunity to innovators and entrepreneurs to pursue their innovative concepts in a variety of technological areas for highway infrastructure applications. Until 2018, the funding level of the NCHRP IDEA Program was \$1.40 million, which, in addition to funding the projects, also covered the cost to administer the program. Now, as a result of the integration of the NCHRP-IDEA Program into the NCHRP, the administrative costs for the program are included in the overall NCHRP administrative costs. Therefore, since FY 2020, funds are requested for research projects only. It is anticipated that a sum of \$950,000 will be needed to fund 6-7 projects at \$150,000 per project in the next two 6-month cycles to keep the program viable and attractive to innovators, particularly those in the private sector.

3. Funds (in thousands)

	FY 1992- 93	FY 1994- 97	FY 1998- 99	FY 2000- 05	FY 2006- 09	FY 2010- 17	FY 2018- 19	FY 2020- 22	FY 2023
Funding from FHWA	1125	3,000	1,500						
Continuation allocation	375	1,000	750	6,000	4,750	10,000	2,800	2,850	
Less obligation	<u>1,500</u>	<u>4,000</u>	<u>2,250</u>	<u>6,000</u>	<u>4,750</u>	<u>10,000</u>	<u>2,800</u>	<u>2,850</u>	
Balance (earmarked)	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	
Reallocation	<u>-0-</u>	<u>-0-</u>	<u>-0-</u>	<u>-0-</u>	<u>-0-</u>	<u>-0-</u>	<u>-0-</u>	<u>-0-</u>	
Total available	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	

Recommended addition		950

4. Interpretation of AASHTO Problem Statement by Project Panel

This project represents a new approach under the National Cooperative Highway Research Program (NCHRP), for short-term, focused research on new and innovative concepts that have the potential to provide leapfrog technological advances. The NCHRP-IDEA Program is a continuation of the SHRP-IDEA Program which funded exploration of innovative concepts from the public and private sectors in focus areas of SHRP research. The NCHRP-IDEA projects will concentrate on innovative approaches aimed at solving problems in the highway infrastructure area. Unsolicited proposals related to any aspect of the highways or intermodal facilities will be accepted; however, the Project Panel may designate specific technological areas for emphasis.

The NCHRP-IDEA Program is being administered as a special project ((NCHRP Project SP 20-30) under the NCHRP, similar to the NCHRP Synthesis Program (Project 20-05). Until June 2017, the NCHRP contracted with TRB's Studies and Special Programs Division (now Consensus and Advisory Studies Division) for administering the NCHRP IDEA Program. Since June 2017, the NCHRP-IDEA Program has been integrated into the NCHRP. Research investigations for the program are selected by the NRC-appointed NCHRP Project SP20-30 Panel.

5. Original AASHTO Problem Statement Number

Problem No. 1993-SP-23

6. Research Assignment To-Date

NCHRP Project SP 20-30, "NCHRP-IDEA"

7. Last Review Date

October 31, 2021

Accountability Report for NCHRP Project SP 20-30, *NCHRP-IDEA*

Purpose:	To support deserving proposals from entrepreneurs, inventors, forward thinkers, and problem solvers – anybody who has an innovative solution to a vexing transportation problem. The NCHRP-IDEA includes projects that address technical feasibility or prototyping.
Started:	Project SP 20-30 began in 1992; it was co-funded by FHWA through FY 1999. The NCHRP is now the sole sponsor of the NCHRP-IDEA.
Funding:	Allocated in FY2022: \$950,000 Requested for FY2023: \$950,000
Problem Solicitation:	An announcement is distributed to solicit submittals throughout the year. Proposals are collected twice a year (deadlines: March 1 and September 1) and reviewed. The announcement is posted on the TRB website and highlighted in the <i>TRB Weekly</i> (previously <i>TRB E-Newsletter</i>).
Process for Selecting Studies:	The NCHRP Project SP 20-30 Panel meets semi-annually to select proposals for award. Proposals are evaluated on the basis of the following four criteria for a total of 100 points: (i) Quality of Innovation (50 points); (ii) Research Approach (15 points); (iii) Potential Benefits (20 points); and (iv) Implementation/Commercialization Plan (15 points). Requested funds must not exceed \$150,000 for a Type 1 project and \$100,000 for a Type 2. Cost sharing is encouraged, which is not mandatory for a Type 1 project but required (at least a 25% match) for a Type 2 project. A high degree of risk will be assumed for scientifically-founded proposals with potentially high value to transportation practice.
Consultant Selection:	The project is managed by the NCHRP staff in the TRB's CRP Division under the oversight of the NCHRP Project SP 20-30 Panel that selects projects for investigation. No contract may exceed \$150,000, and many are for much less.
Studies Requested Last Year:	82 proposals were submitted in two cycles in FY 2021.
Studies Funded Last Year:	Eight studies were funded during FY 2021 (see Section 1, above).

Studies Completed Last Year:	Three studies were completed between October 1, 2020 and September 30, 2021 (see Section 1 above).
Distribution of Findings:	A summary of all completed and active IDEA projects is published each year and made available to sponsors, subscribers, and affiliates. All project final reports are posted on the TRB website.
Use of Findings:	IDEA projects are intended to help jump-start the product-development process and eventual commercialization. Some products have been commercialized, others are in the process, and some have been identified as promising. Projects/products in all these categories are identified each year in the continuation request.
Next Year's Studies:	Funding is requested to support approximately 6-7 new or continuing studies each year.

A Sample Listing of IDEA Projects Implemented or with a High Implementation Potential

The product development process encompasses many steps and may also require substantial resources. An IDEA project is only intended to help initiate this process – that is, give it a jump start. Before a product is implemented, it usually must go through further development and refinement, testing and evaluation, commercialization, and marketing. These phases can be quite involved and resource-intensive. Considering what it takes to do all this, an IDEA project is a very modest investment (\$100,000-150,000 per project). There is also a high risk associated with untried and unproven approaches; not every IDEA concept is expected to materialize into an implementable product. Still, despite the modest investment of resources and the high risk and uncertainty, a number of NCHRP IDEA projects have not only proved the technical feasibility of their innovative concepts but also led to the development of products that have been implemented and made to the marketplace.

Following is a sample listing of the NCHRP-IDEA projects in three categories. The first category includes products known to be available in the marketplace. The second category includes completed projects that have known follow-on activity, most likely being applied on a trial or experimental basis. The third category includes active projects that are likely to continue beyond the NCHRP-IDEA contract.

Products in the Marketplace

- A sacrificial anode system using sprayed zinc for protecting reinforcing steel (acting as the cathode) from corrosion in marine bridge substructures – Project #3

- A composite material layer system called, Interlayer Stress Absorbing Composite (ISAC) that helps eliminate or mitigate reflection cracking in asphalt concrete overlays – Project #6
- An organic compound-based additive that inhibits corrosion of reinforcing steel and waterproofs the concrete – Project #13
- A bridge-mounted automated de-icing system to prevent snow and ice on bridge decks – Project # 27.
- A dual phase ferritic martensitic (DFM) steel with improved mechanical properties and corrosion resistance – Project #28
- Lightweight composite bridge made of fiberglass-reinforced polymer honeycomb structural panels – Projects #30 and 46
- A low-cost asphalt pavement density measuring device based on capacitance energy dissipation as a rapid, convenient, and safe alternative to the nuclear gauge – Projects #32 and 47
- A high strength and lightweight hybrid composite beam for bridge structures consisting of an outer fiber-reinforced plastic shell, a compression reinforcement and a tension reinforcement – Project #60
- The application of horizontal wick drains to stabilize slopes and landslides – Projects #57 and 76
- An automated computer controlled image analysis system for measuring aggregate shape characteristics – Projects #77 and 114
- Test methods, based on fracture mechanics, for predicting low temperature performance of asphalt binders – Projects #84 and 104
- A palm-sized video event data recorder (DriveCam) that monitors driving activity by continuously recording video of the roadway, audio, and acceleration/deceleration forces into a digital looping memory – Project ITS #84
- The adaptation of self-compacting concrete (SCC) technology for the U.S. market using domestic concrete-making materials and practice for use in highway structures – Project #89
- A system of vertical composite drains (Earthquake Drains) to dissipate pore pressure to prevent liquefaction during an earthquake – Projects #94 and 103

- A device providing a simple, reliable field-like test for determining thermal cracking temperature of asphalt (Asphalt Binder Thermal Cracking Device) – Project #99
- A hand-held impact echo scanner for non-destructive evaluation of grout /void inside post-tensioned bridge ducts for tendon – Project #102
- A new mobile geophysical method based on electromagnetic induction technology to perform surveys to detect and identify subsurface features and objects for highway-related projects – Project #107
- A real-time hand-held microwave imaging device using smart array antenna for the nondestructive condition evaluation of fiber-reinforced polymer (FRP)-wrapped concrete bridge members (GAP-CAT-110 and 1200) – Project #109
- A portable equipment using a bending plate for rapid measurement of soil modulus for compaction control both in the laboratory and the field – Project #118
- A software system based on 3-D laser scan surveys for the identification, evaluation, and management of unstable highway slopes – Project #119
- A software system consisting of new image pattern recognition algorithms for automatic processing and extraction of information on roadway signs from the roadway video logging images – Project #121
- An accelerometer system based on optical fibers and moiré phenomena to assess structural integrity of highway bridges under traffic, earthquakes, and other dynamic loads – Project #124
- A laser measurement-based technology to improve bridge fabrication quality control by rapid and accurate measurements and reduce overall production costs of steel bridge fabrication – Project #127
- A vehicle-mounted scanner system based on nondestructive evaluation methods such as impact echo, impulse response, spectral analysis of surface waves and acoustic sounding for condition evaluation of concrete bridge decks – Project #132
- Simple test methods to obtain low-temperature creep and strength parameters of asphalt binders and mixtures using small-scale specimens on bending beam rheometer and requiring no additional equipment – Projects #133, 151
- A software package (Bridge Doctor) along with a user's manual for a baseline-free methodology for real-time structural health monitoring and post-event damage assessment of highway bridges for integrity and safety – Project #137

- A methodology based on vision-based object recognition algorithms and integrated GPS and vision technologies to recognize and warn against intruding vehicles – Project #139
- A vibration absorbing system based on magnetic dampers to reduce fatigue in traffic signal support structures exposed to excessive wind-induced vibrations – Project #141
- An asphalt pavement raveling detection system based on an algorithm developed using 3-D line laser imaging technology – Project #163
- A traffic sensor based on computer vision technology (TrafficVision) for use on fixed and pan-tilt-zoom cameras for detecting and tracking vehicles, including motorcycles without the need of having to install additional hardware – Project #140
- A software tool for assessing physico-mechanical properties of subgrade, subbase, and base, and lift layers based on intelligent compaction rollers data during construction – Project #145
- A mobile unit for rapid and reliable measurement of pavement marking retroreflectivity – Project #146
- A low-cost cleaning device using pneumatic power and rotary wire brushes to remove debris and chemicals from cracks and joints prior to sealing treatment – Projects #148, 159
- An advanced laser measurement system (Bridge RLS) to accelerate the bridge retrofit process, reducing the time between identifying repair needs and resuming service on a bridge – Project #153
- Drained timber piling for cost-effective liquefaction mitigation and ground improvement strategy for transportation infrastructure and for improving a structure's seismic resilience – Project #180
- Automated turning movement counts at signalized intersections both for exclusive and shared lanes using vehicle trajectory data (obtained from an existing vehicle detection system) for improved traffic safety and operation – Projects #177,198
- A portable field instrument, based on ultrasonic technology, for in-situ measurement of total stress (both dead and live loads) in steel bridge members – Project #179
- A small specimen geometry for uniaxial dynamic modulus and fatigue testing in

asphalt mixture performance tester (AMPT) – Project #181

- An event simulation and data fusion system for synthesizing individual travel diaries from multiple passive data sources, including consumer and anonymous location data – Project #184
- A simple performance-based indirect tensile asphalt cracking test for asphalt mix design, quality control, and quality assurance – Project #195
- A multi-channel vertical impedance scanner with large area electrode to detect corrosion in concrete bridge deck assessment without direct rebar connection – Project #202

Completed Projects with High Implementation/Commercialization Potential

- Basalt fibers and basalt fiber composite rebars made from domestic basalt for use as an alternative to steel fibers and rebars in reinforced concrete – Projects #25, 45, 86
- A geocomposite layer system placed between a base and subgrade to prevent pavement damage by controlling moisture movement in pavement subgrade and base course – Projects #68, 113.
- A mechanical system based on anvil and hammer concept for crushing and recycling concrete pavement – Projects #79, 95
- A robotic safety marker system consisting of mobile signs, cones, lighting and other safety devices to provide safety to workers in the highway work zone – Project #90
- A second generation improved detection control system (D-CS) for enhanced traffic safety at high speed signalized intersections – Project #115
- A sensor system for the autonomous monitoring and reporting of highway traffic noise data – Project #131
- An “active confinement” bridge rehabilitation techniques using shape memory alloy (SMA) reinforcement to retrofit concrete columns – Project #135
- A shape memory polymer-based sealant for use in expansion joints in pavements and bridges capable of preventing adhesive and cohesive failures through a self-healing mechanism, eliminating the need for replacing the sealant – Project #142
- An acoustic emission-based system for rapid and reliable characterization of asphalt binder embrittlement temperatures – Projects #144, 170

- A new class of bridge expansion joints based on shape memory alloys to provide superior resistance to fatigue, dynamic loads, and corrosion – Project #147
- Breakaway posts with new design and energy absorbing capability to enhance the safety performance of W-beam guardrail in frozen soil conditions – Project #149
- An automated real-time quality control aggregate monitoring system based on laser-induced breakdown spectroscopy to characterize aggregate properties – Projects #150, 168
- A rapid and reliable non-destructive method based on long-range ultrasound for inspecting bridge cables – Project #152
- An ultrasonic hand-held device for measuring for measuring cumulative stress at critical highway bridge components – Project #158
- A new “super” weathering, corrosion-resistant, and cost-competitive steel for the transportation infrastructure, including highways, bridges, and buildings – Project #160
- A hand-held device for nondestructively measuring in-situ yield strength of in-service steel gusset plates for use in bridge evaluation and rating – Project #161
- Scour-preventing products (scAUR and VorGAUR) for use on scour-critical bridges – Project #162
- A technique based on laser induced breakdown spectroscopy to rapidly identify and profile the presence and severity of corrosion under layers of coatings on steel structures and the presence of heavy metals imbedded in the coatings – Project #164
- Guidelines for using waste concrete fines (and the associated wastewater) in concrete by developing methods to rapidly characterize fines samples and evaluating the performance of concrete using these recycled materials – Project #166
- A prototype system for georeferenced augmented reality visualization of buried utility geospatial data and real-time monitoring of an excavator’s proximity to buried utilities in its vicinity – Project #167
- Bidirectional-ductile end diaphragm in straight and skewed bridge superstructures to provide resistance to bidirectional earthquake excitations – Project #172

- Asphalt binders and mixtures reinforced with grapheme nano-platelets as a multifunctional pavement material providing enhanced durability, the creep stiffness, and low-temperature flexural strength of asphalt binders and mixtures – Project #173
- A thermal zinc diffusion coating with improved corrosion resistance for concrete reinforcing bar with better ductility and durability than commercial coatings currently in use – Project #174
- A nondestructive test procedure based on the impulse response method for rapid detection of fatigue cracking in auxiliary highway structure anchor rods for timely repair and increased service life of highway structures – Project #175
- A class of renewable biopolymers for use in asphalt pavements. The developed polymers are expected to be used turnkey in asphalt production and construction facilities – Project #178
- Application of biochar to highway soils to increase stormwater infiltration and reduce the quantity and improve the quality (reduced nutrients) of stormwater runoff – Projects #182, 211
- An integrated remote-sensing system based on radio frequency identification (RFID) technology for monitoring, inspection, and life estimation of hydraulic structures for developing an effective scour countermeasure strategy – Project #183
- A prototype of CurvePortal, a web interface for extracting horizontal curve location and geometric information automatically from GIS roadway maps with improved curve data extraction algorithm – Project #185
- An electrical probe that measures the geometry and integrity of ground improvement columns (jet grout, soil mixed, auger cast) during construction or immediately after construction (within 30-60 minutes) – Project #186
- A smart IoT proximity alert system for highway work zone safety – Projects #187, 226
- V-connectors for bridge deck-piers and pier-footing joints to provide seismic isolation while facilitating accelerated bridge construction and retrofit – Project #188
- A camera-based vision sensor for highly accurate remote, multi-point measurement of bridge displacements enabled by a robust target tracking algorithm, an advanced image distortion filter, and a vibration cancellation technique – Project #189

- Microbial-facilitated soil stabilization to mitigate volume changes in expansive pavement subgrades – Project #192
- A self-contained, portable asphalt rheology tester to monitor the consistency and uniformity of asphalt binders in real-world product environment – Project #193
- Hexagonal boron nitride reinforced multifunctional concrete for transportation infrastructure applications – Project #197
- An imaging method using medical x-ray machine to measure the ion penetration of concrete material to predict the service life of a pavement or a bridge.– Projects #199, 232
- Use of native grass and weed seeded microbial induced calcite precipitation to mitigate wind and water erosion of highway slopes – Project #200
- An aerodynamic damping method to mitigate large vibrations in traffic signal structures – Project #201
- An automated, self-restoring crash cushion to help enhance safety of motoring public and workers on the highways while minimizing or eliminating maintenance and reducing life cycle costs – Project #203.
- A class of low-cost, non-toxic, biodegradable antifreeze biopolymers with behavior similar to natural antifreeze proteins found in fish, plants, insects, etc. to prevent ice formation on roadway and bridge surfaces during winter – Project #204. A glass fiber reinforced polymer (GFRP) strand for application in mild-prestressed concrete (MPC) elements to attain higher resiliency, sustainability, and corrosion resistance with respect to traditional steel prestressed concrete – Project #207
- A new method for measuring chloride quantities in bridge deck concrete using ground-penetrating radar (GPR) – Project #208
- Non-gating guardrail terminal for guardrail safety – Project # 212
- A method for assessing network-level curve safety conditions safely and cost effectively by collecting and analyzing vehicles' GPS trajectory and kinematic data using intra-agency, crowd-sourced, low-cost mobile devices – Project # 214
- Bridge deck sealant monitor – Thermal Sealcheck – Project # 220

Active Projects Showing Promise

- A new type of self-de-icing LED signals for highway and railroad intersections as replacement for existing LED signal lights that are too cool to deice or melt snow and may cause accidents in snowy conditions – Project #190

- A sensor-based inexpensive system for monitoring tension in anchor bolts in support structures for highway signs, luminaires, and traffic signals – Project #196
- An integrated technology of LiDAR and radio frequency inductive testing (RFIT) to detect discretely locate deep defects/damage in concrete bridge components – Project #205.
- An automated safety monitoring system for work zone safety based on a rule-based software program for location tracking and new generation ultra wide bandwidth (UWB) sensing – Project #206.
- A novel data collection system to automatically detect, classify, and measure specific types of major pedestrian facilities (i.e., sidewalks and crosswalks) from aerial images – Project #209
- Cu-Al-Mn (CAM) superelastic alloys (SEAs) for application in bridge columns to improve seismic performance of highway bridges – Project #210
- SEAHIVE, a novel modular, cost-effective, efficient and ecofriendly shoreline protection system – Project #213.
- Use of Buckling Restrained Braces (BRBs) to provide seismic resilience to multi-span bridges at low cost while keeping displacement within the allowed limit – Project #215.
- A portable single-lane traffic counting device based on LIDAR sensor and artificial intelligence video technologies – Project #216.
- A real-time intersection proactive safety visualization system (IPSV) based on vehicle and pedestrian trajectory data collected by radar sensors – Project # 217
- A rapid cost effective asphalt mixture fatigue test system – Project # 218
- A novel durable, healable and conveniently removable pavement marking material suitable for both permanent and temporary marking uses – Project # 219
- An in-situ cyclic borehole shear soil test device – Project # 221
- Mixed reality assisted infrastructure inspections – Project # 222
- Fatigue crack inspection using computer vision and augmented reality – Project # 223
- An automated and rapid conditioning and testing device for cracking and rutting – Project # 224

- An automated system for large-scale intersection marking data collection and condition assessment – Project # 225
- Adjustable cross-frames for the erection of steel girder bridges – Project # 227
- A retroreflective road lane marking tape 1,000X brighter than existing technology – Project # 228
- A laboratory dielectric measurement system for asphalt mixture bulk specific gravity determination – Project # 229
- Automated data and feature extraction from bridge plans – Project # 230
- AI analyzer for revealing insights of traffic crashes – Project # 231
- An Innovative bio-mediated self-healing concrete technology – Project # 233

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
Transportation Research Board
The National Academies of Sciences, Engineering, and Medicine

Continuation Request
Project 20-36, FY 1994 & Continuing
Highway Research and Technology—International Information Sharing

Present Expiration Date: Continuing
Recommended Allocation: \$500,000

1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended

This project supports a number of activities, including state DOT delegates' participation on international highway and technology research scans and as technical committee members of PIARC. In addition, project funds enable AASHTO delegates to present technical papers at conferences and symposia held outside of the United States.

As of December 2021, eighty international scans have been conducted, with none since 2011. In 2007, four international scans were completed on the following topics: Freight Mobility and Intermodal Connectivity Innovative Practices, Bridge Evaluation Quality Assurance, Linking Transportation and Land Use, and Warm Asphalt Technologies.

In 2008, four international scans were completed on the following topics: Transportation Research Program Administration; Survey of International Best Practices to Accommodate Older Road Users Public-Private Partnerships; and Integrating and Streamlining Right of Way and Utility Processes with Planning, Environment, and Design. Also, a special-purpose delegation to India was organized. However, due to the attacks in Mumbai, this delegation had to be postponed to Calendar year 2009.

In 2009, four international scans were conducted on the following topics: Reducing Congestion, Enhancing the Environment and Funding Transportation Using Road Pricing; Survey of Innovative Pedestrian and Bicyclist Infrastructure Improvements and Policies to Increase Safety and Mobility; Assuring Acceptable Safety and Performance of Highway Bridges through Advanced Load Rating; and Linking Performance and Accountability to National and State/Provincial/Metropolitan Budget and Revenue Increases.

In 2010, four international scans were completed on Flexible Geometric Design Practices to Improve the Performance of Freeway Facilities, Understanding the Policy and Program Structure of National and International Freight Corridor Programs, Successful Infrastructure Countermeasures to Mitigate Motorcycle Fatalities, and Outdoor Advertising Control: Best Practices Policy and Implementation.

This activity enhances the roles of AASHTO, TRB and FHWA in providing coordinated leadership for the exchange of international highway research and development, and

provides state departments of transportation with information on practices and technologies that could help accrue technical and economic benefits.

2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended

1. AASHTO member departments' participation in global benchmarking efforts.
2. Participation of AASHTO delegates on PIARC (World Road Association) technical committees.
3. Participation of AASHTO delegates in the ITS World Congress.
4. Participation of AASHTO delegates in other international conferences and/or sponsoring visits of foreign transportation experts to the U.S.

3. Funds (in thousands)

		FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2023
Continuation Allocation	Continuation Request	850	950	650	500	800	200	
Carried Forward	Prior Yrs' Unspent	60	110	310	320	20	820	
Less Obligation	Expended in Project	<u>800</u>	<u>750</u>	<u>710</u>	<u>800</u>	<u>-0-</u>	<u>520</u>	
Balance (earmarked)	Subtotal	110	310	250	20	820	500	
Reallocation	Carryforward	<u>110</u>	<u>310</u>	<u>320</u>	<u>20</u>	<u>820</u>	<u>425*</u>	
Total Available	Current Balance	-0-	-0-	-0-	-0-	-0-	75	
Recommended Addition								500

Note: Prior to FY 2008, \$7,284,000 was spent.

*Funds released to AASHTO R&I Committee for reprogramming

4. Interpretation of AASHTO Problem Statement by Panel

NCHRP Project 20-36 provides a coordinated approach to international information sharing and technology exchange. The project activities have a much broader scope than the typical NCHRP project in encompassing exchanges on all facets of highway technology, policy and management with our international partners. The project's overall objective is to improve highway safety, development, maintenance and operations through dissemination of innovative technology and successful practices from around the globe. This enhances the roles of the American Association of State Highway and Transportation Officials (AASHTO), Transportation Research Board (TRB), and Federal Highway Administration (FHWA) in providing coordinated leadership for the exchange of international highway research and development, and provides State departments of transportation with information on practices and technologies that could help accrue technical and economic benefits.

The project objective is achieved through AASHTO delegates' participation on international technology scans which bring back innovations that can serve U.S.

transportation needs. The project also supports State participation on technical committees of the World Road Association (PIARC), and on committees of the Joint OECD/ECMT Transportation Research Program, and enables State DOT officials to be represented at major international conferences such as the ITS World Congress. The benefits derived from these efforts result in cost-savings, improved safety and facilitation of transportation development and operations in the United States.

The NCHRP Project 20-36 also provides travel assistance for qualified individuals to participate in international highway technology meetings. Funding requests (unless otherwise noted) are reviewed and approved by an oversight panel of volunteer experts including AASHTO leadership.

5. Original AASHTO Problem Statement Number

Problem No. 1994-SP-09

6. Research Assignment to Date

NCHRP Project 20-36, "Highway Research and Technology--International Information Sharing"

7. Review Dates

December 5 2021, and December 12, 2011

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
Transportation Research Board
The National Academies of Sciences, Engineering, and Medicine

Continuation Request
Project 20-44, FY 1996 & Continuing
Accelerating the Application of NCHRP Research Results

Present Expiration Date: Continuing

Recommended Allocation: \$2,000,000

1. Anticipated Accomplishments When Funds Allocated Have Been Expended

Since 1996, NCHRP panels, researchers, and staff have addressed all the suggested activities listed under section 4 of this form using 20-44 funds. A much larger program was funded in FY2016, and we anticipate providing assistance to a wide range of activities split between implementation (85%) and information dissemination (15%). Candidate activities are suggested by active NCHRP panels, state DOTs, and AASHTO committees/councils. Funding requests are subject to the approval of the 20-44 Panel.

Information Dissemination Activities

- NCHRP Impact Report 2020 – The third edition of NCHRP Impact Reports, that present the value of the application of NCHRP research results. Containing data, case studies, and anecdotes compiled from a variety of different sources, this report presents an overview of recent NCHRP research results, how the results are disseminated, and the impacts of their application.
- NCHRP Implementation Showcases – 7 brief summaries of previously completed projects that were funded by the NCHRP Implementation Support Program. These showcases can be found on the program website.
- 2017 NCHRP Publications user survey – Covers 61 publications produced in 2017. The survey was distributed through RAC, sent to project panels, and to individual downloaders from the NAP site.
- NCHRP 2020 Annual Report – The report briefly showcases four examples of NCHRP implementation projects that were undertaken or concluded in 2020.
- NCHRP Impact Report 2019 – The second documentation effort to present the value, in the form of outcomes and impacts, of the application of NCHRP research results. Containing data, case studies, and anecdotes compiled from a variety of different sources, this report presents an overview of recent NCHRP research results, how the results are disseminated, and the impacts of their application.

- 2016 NCHRP Publications user survey: Following previous surveys conducted in 2017 and 2018/2019, a new survey of NCHRP research published in the year 2016 was rolled out in 2020. The survey was distributed through RAC, and was also sent to each available download email address from the NAP site. The results will be made available in April 2021.
- Session on “Implementing NCHRP Research: Case Studies and Discussion” and other outreach at 2019 TRB Annual Meeting: A 3 hour session on examples of implementation under the 20-44 program was held at the 2019 TRB Annual Meeting on Sunday, January 13, between 9AM and 12PM. The session was highlighted by 3 case studies on implementing NCHRP research, and also included an overview of the 20-44 program. Brief presentations on the 20-44 program were also made at several TRB committee meetings during the Annual Meeting, which have contributed to increased engagement with those committees on implementing research.
- 2015 NCHRP Publications user survey: Following the survey conducted in 2017 for NCHRP publications released in 2012, a new survey covering 66 NCHRP publications released in 2015 was rolled out in August 2018. 631 surveys were completed by 358 distinct respondents, and the results are summarized in a report that can be found in the Implementation Support Program webpage [here](#).
- Analysis of NCHRP research contributing to the states’ High Value Research: As part of the ongoing effort to better capture and understand how NCHRP research results are used in the states, an analysis was undertaken in 2019 to determine how NCHRP research results are referenced in High Value Research (HVR) submissions. The analysis found that in the period 2014 through 2018, HVR submissions from 42 states referenced at least 1 NCHRP research product, and a total of 425 individual NCHRP research products were referenced in that period.
- NCHRP Impact Report 2018 - First attempt to document and present the value, in the form of outcomes and impacts, of the application of NCHRP research results. Containing data, case studies, and anecdotes compiled from a variety of different sources, this report presents an overview of recent NCHRP research results, how the results are disseminated, and the impacts of their application.
- NCHRP Implementation Support Program webpage: A webpage on the Implementation Support Program has been developed and is live. The webpage is hosted within the current NCHRP program website (within the parent TRB website), and is intended to serve as an information repository for the Program.
- A one-page flyer was developed providing information on the Program, and was distributed at the TRB Annual Meetings in 2018 and 2019, and at various TRB and AASHTO meetings. The Implementation Program has received over fifty two enquiries on the Program from several states, and will continue to solicit requests

for funding from state DOTs, NCHRP panels, and AASHTO committees and councils.

- Research Makes the Difference - Annual eight-page brochure, drawing from the 2015, 2016 and 2017 AASHTO RAC High Value Research compilation and from NCHRP suggestions.
- Impacts on Practice - Readable narrative the impact of the selected NCHRP research projects on state DOT practice.
- Webinar Organization and Communication Services - Prepare the TRB Webinar Submission Forms detailing NCHRP's proposed research projects for the two cycles of the TRB webinar series; prepare moderator PowerPoint template and talking points, and speaker tips (first cycle only); coordinate with NCHRP manager and TRB webinar staff throughout the process; and follow up with presenters and moderators after TRB has made the webinar selections.
- Paths to Practice - Capture in an interesting, readable narrative successful approaches used for putting NCHRP research to use.
- CEO Briefing / Program Folio - Gather and develop content aimed at highlighting recent NCHRP program and project activities and accomplishments for DOT CEOs.
- Research Briefs - Two-page briefs to disseminate information about key new NCHRP projects. Finalize and deliver 15 briefs in electronic format each year.
- Field Folios / Subject Compilations - Summaries of NCHRP research in key topical areas (e.g. safety, traffic engineering, pavements, structures, etc). Finalize and deliver up to 10 Field Folios in electronic format each year.
- Report Distribution Assistance - Expand and customize alerts for new NCHRP reports by subject area to better promote use of the results. Develop distribution channels and lists that could be used to more effectively target research findings and communication approaches for pushing research results out to these target audiences.
- Tracking Implementation - Develop an online survey for use in gathering information about the use of NCHRP research results from panel members, principal investigators and other research stakeholders (such as DOT managers or field personnel). Create the survey recipient list, distribute the survey and analyze the results.

2. Anticipated Accomplishments When Funds Requested Have Been Expended

Since FY 2016, NCHRP project 20-44 has programmed \$9,656,037, representing 59 projects, and has a current balance of \$2,915,103 (as of November 1, 2021). \$300,000 in potential implementation requests are being discussed. Given the volume of interest the program has generated and the potential requests in the pipeline, \$2,000,000 is

being requested for FY 2023 to continue efforts to further the implementation and application of NCHRP research results.

3. Funds (in thousands)

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
Continuation Allocation	2,000	2,000	2,000	2,000	0	2,000	2,000	
(Add) Balance brought forward		512	1,341	2,106	2,094	564	915	
(Add) One time addition ¹					500			
(Less) Total funds programmed	1,487	1,171	1,234	2,011	2,029	1,720		
Balance	512	1,341	2,106	2,094	564	915	2,915	
Recommended Allocation								2,000
¹ In Dec 2020, R&I chose to make a one-time addition of \$500,000 to NCHRP 20-44 for FY 2020.								

4. Interpretation of AASHTO Problem Statement by Panel

In an applied research program like the National Cooperative Highway Research Program, application of results is the most important measure of success. The NCHRP has been successful by this measure; results of NCHRP research are used by AASHTO committees and member departments, but there is a need to continually look for ways to do better.

The following activities are examples of areas that benefit from greater attention: a) validating research products (e.g., testing NCHRP-developed computer software before widespread distribution); b) using innovative dissemination media to supplement or replace the written report; c) working with AASHTO committees and other code-writing groups to facilitate adoption of NCHRP recommendations; d) providing financial support for NCHRP researchers to assist potential users of NCHRP products; e) offering peer exchanges or demonstrations focused on new NCHRP research results, and f) tracking and documenting applications of NCHRP research.

5. Original AASHTO Problem Statement Number

Problem No. 1996-SP-32

6. Research Assignment to Date

NCHRP Project 20-44, "Accelerating the Application of NCHRP Research Results"

7. Review Dates

November 25, 2015, October 7, 2015, October 14, 2016, October 16, 2017, October 30, 2018, October 31, 2019, March 25, 2020, January 7, 2021, and November 1, 2021.

Implementation Projects Funded FY 2016 – FY 2021 (as of November 1, 2021)

Implementation project number	Original project number	Title	Funds
2016			
NCHRP Project 20-44(01)	NCHRP Project 09-43 et al	Increasing WMA Implementation by Leveraging the State-Of-The-Knowledge	\$101,000
NCHRP Project 20-44(02)	NCHRP Project 08-93	Implementation of the AASHTO Guide for Enterprise Risk Management	\$299,997
NCHRP Project 20-44(03)	NCHRP Project 20-89	Dissemination of NCHRP Report 799: Management Guide to Intellectual Property for State Departments of Transportation	\$97,600
NCHRP Project 20-44(04)	NCHRP Project 15-52	Implementing Products from NCHRP Research on Adhesive Anchor Systems	\$100,000
NCHRP Project 20-44(05)	NCHRP Project 20-59(30)	Dissemination of “NCHRP Domestic Scan 14-01: Leading Management Practices in Determining Funding Levels for Maintenance and Preservation”	\$119,968
NCHRP Project 07-22	NCHRP Project 07-22	Planning and Preliminary Engineering Applications Guide to the Highway Capacity Manual	\$130,816
NCHRP Project 20-44Q		Communication Services for NCHRP	\$374,264
NCHRP Project 20-44TS		Travel Support for Implementation Activities	\$9,156
NCHRP Project 15-52	NCHRP Project 15-52	Developing a Context-Sensitive Functional Classification System for More Flexibility in Geometric Design	\$50,001
NCHRP Project 20-59(30)A	NCHRP Project 20-59(30)A	Train-the-Trainer Regional Workshops for Incident Command System (ICS) Training for Field Level Transportation Supervisors and Staff	\$100,000
NCHRP Project SCOR-Tech		SCOR/RAC Website Enhancement	\$38,040
NCHRP Project 10-86A	NCHRP Project 10-86A	Software for Bidding Alternative Drainage Pipe Systems	\$66,580
		2016 Total	\$1,487,422

Implementation project number	Original project number	Title	Funds
2017			
NCHRP Project 20-44(08)		NCHRP Comprehensive Communications Plan	\$100,000
NCHRP Project 20-44(09)		Quantitative and Qualitative Methods for Capturing the Impacts and Value of NCHRP Research	\$1,000,000
NCHRP Project 15-50	NCHRP Project 15-50	Guidelines for Integrating Safety and Cost-Effectiveness into Resurfacing, Restoration, and Rehabilitation Projects	\$71,468
		2017 Total	\$1,171,468
2018			
NCHRP Project 20-44(06)	NCHRP Project 20-83	Consultant Support for Massachusetts DOT's Commission on the Future of Transportation in the Commonwealth	\$100,000
NCHRP Project 03-113	NCHRP Project 03-113	Guidance for Traffic Signals at Diverging Diamond Interchanges and Adjacent Intersections	\$99,934
NCHRP Project 03-121	NCHRP Project 03-121	Incorporating Freight, Transit and Incident Response Stakeholders into Integrated Corridor Management (ICM): Processes and Strategies for Implementation	\$149,743
NCHRP Project 03-127	NCHRP Project 03-127	Cybersecurity of Traffic Management Systems	\$32,200
NCHRP Project 20-44(13)	NCHRP Project 17-73	Implementation of NCHRP Research Report 893: The Oregon DOT Statewide Pedestrian and Bicycle Plan	\$154,000
NCHRP Project 20-44(07)	NCHRP Project 10-86A	Implementing Single-User Software for Bidding Alternative Drainage Pipe Systems	\$50,530
NCHRP Project 20-44(14)	NCHRP Project 24-42	Implementation of NCHRP Research Report 887 - Guidance for Underwater Installation of Filter Systems	\$50,000

Implementation project number	Original project number	Title	Funds
NCHRP Project 20-44(06) Phase 2	NCHRP Project 20-83	Consultant Support for Massachusetts DOT's Commission on the Future of Transportation in the Commonwealth	\$145,570
NCHRP Project 20-44R		Loaned staff for impact analysis	\$36,944
NCHRP Project 20-44(10)	NCHRP Project 15-44	Guidelines for the Use of Mobile LIDAR in Transportation Applications	\$6,000
NCHRP Project 20-44(11)	NCHRP Project 08-70 / 20-90	Advancing practices for data governance, information management, and managing the impact of digitization on DOT workforces	\$80,000
NCHRP Project 20-44(15)	NCHRP Project 24-40	Consultant Support for implementation of Design Hydrology for Stream Restoration and Channel Stability at Stream Crossings	\$99,990
NCHRP Project 20-44(12)	NCHRP Project 08-92	Dissemination of NCHRP Report 814 Data to Support Transportation Agency Business Needs: A Self-Assessment Guide	\$220,000
NCHRP Project 20-44TS		Travel support	\$10,000
		2018 Total	\$1,234,911
2019			
NCHRP Project 20-44(16)	NCHRP Project 20-30/IDEA 195	Development of an IDEAL cracking test for asphalt mix design, quality control and quality assurance	\$119,645
NCHRP Project 20-44(18)	NCHRP Project 01-55	Validation of the PFC Performance-Based Mix Design Method	\$85,000
NCHRP Project 03-121	NCHRP Project 03-121	Incorporating Freight, Transit, and Incident Response Stakeholders into Integrated Corridor Management (ICM)	\$250,000
NCHRP Project 20-44(19)	NCHRP Project 09-61 et al	Short- and Long-Term Binder Aging Methods to Accurately Reflect Aging in Asphalt Mixtures	\$119,866
NCHRP Project 20-44(20)	NCHRP Project 20-59(55)	Transportation System Resilience: CEO Primer and Outreach	\$149,000

Implementation project number	Original project number	Title	Funds
NCHRP Project 20-44(21)		Synthesis of State Peer Exchanges and RPPM	\$44,785
NCHRP Project 20-44(22)	NCHRP Project 19-14	Right Sizing Transportation Investments	\$384,260
NCHRP Project 20-44(17)	NCHRP Project 20-68A, Domestic Scan 17-01	Implementing the Results of NCHRP Project 20-68A, Domestic Scan 17-01: Successful Approaches for the Use of Unmanned Aerial Systems by Surface Transportation Agencies	\$173,500
NCHRP Project 20-44(23)	NCHRP Project 15-61	Applying Climate Change Information to Hydrologic and Hydraulic Design of Transportation Infrastructure	\$250,000
NCHRP Project 20-44(24)	NCHRP Project 09-58	Effects of Recycling Agents on Asphalt Mixtures with High RAS and RAP Binder Ratios	\$150,000
NCHRP Project 03-128	NCHRP Project 03-128	Business Intelligence Techniques for Transportation Agency Decision Making	\$35,998
NCHRP Project 20-44(25)	NCHRP Project 09-60	Implementing NCHRP Project 09-60 on Addressing Impacts of Changes in Asphalt Binder Formulation and Manufacture on Pavement Performance through Changes in Asphalt Binder Specifications	\$49,900
NCHRP Project 20-44(26)	NCHRP Project 14-37	Implementing Guide Specifications for the Construction of Chip Seals and Micro surfacing	\$200,000
		2019 Total	\$2,011,954
2020			
NCHRP Project 20-44(27)	NCHRP Project 20-07, Task 406	Implementation of NCHRP 20-07, Task 406 Development of a Framework for Balanced Mix Design	\$195,000
NCHRP Project 20-44(28)	NCHRP Project	Development of a tech transfer plan for AASHTO RAC Region 3	\$160,000
NCHRP Project 20-44(29)	NCHRP Project 25-49	Development of a training for NCHRP 25-49 Development of a Highway Construction Noise Prediction Model	\$15,904

Implementation project number	Original project number	Title	Funds
NCHRP Project 20-44(30)	NCHRP Project 08-105	Measuring the Effectiveness of Public Involvement in Transportation Planning and Project Delivery	\$200,000
NCHRP Project 20-44(31)	NCHRP Project 20-107	Effective Construction Project Staffing Strategies for Transportation Agencies	\$200,000
NCHRP Project 20-44(32)	NCHRP Project 08-94	Guidelines for Selecting Travel Forecasting Methods and Techniques	\$375,878
NCHRP Project 20-44(33)	NCHRP Project 20-119	Evaluating the suitability of roadway corridors for use by monarch butterflies	\$162,800
NCHRP Project 20-44(34)	NCHRP Project 20-111J	Successful Practices for State Transportation Research Office's Complying with 2 CFR 200	\$190,000
NCHRP Project 20-44(35)	NCHRP Project 07-25	Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges (A.I.I.)	\$250,000
NCHRP Project 20-44(36)	NCHRP Project 20-83(03)A	Long-Range Strategic Issues Affecting Preservation, Maintenance, and Renewal of Highway Infrastructure	\$280,000
		2020 Total	\$2,029,582
2021			
NCHRP Project 20-44(37)	NCHRP Project 14-34	Implementation of Performance Measures in Snow and Ice Control Operations	\$225,000
NCHRP Project 20-44(38)	NCHRP Project 08-115	Guidebook for Data and Information Systems for Transportation Asset Management	\$250,000
NCHRP Project 20-44(39)	NCHRP Project 08-116	Guidebook for Managing Data from Emerging Technologies for Transportation	\$365,700
NCHRP Project 20-44(40)	NCHRP Project 20-24(95)A	Ensuring Essential Capability for the Future Transportation Agency	\$300,000
NCHRP Project 20-44(41)	NCHRP Project 20-117	Deploying Transportation Resilience Practices In State DOTs	\$180,000
NCHRP Project 20-44(42)	NCHRP Project 08-104	A Guidebook for Post-Award Contract Administration for Highway Projects Delivered Using Alternative Contracting Methods	\$250,000

Implementation project number	Original project number	Title	Funds
NCHRP Project 20-44(43)	NCHRP Project Domestic Scan 16-02	Leading Landscape Design Practices for Cost-Effective Roadside Water Management	\$150,000
		2021 Total	\$1,720,700
		GRAND TOTAL	\$9,656,037

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
Transportation Research Board
The National Academies of Sciences, Engineering, and Medicine

Continuation Request
Project 20-68A/B/C/D, FY 2007 & Continuing
U. S. Domestic Scan Program

Present Expiration Date: Continuing
Recommended Allocation: \$750,000

1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended

The objective of this project is to plan and manage the execution of domestic technology scans, each addressing a single technical topic. The purpose of each scan and of the program as a whole is to facilitate information sharing and technology exchange among the states and other transportation agencies and identify actionable items of common interest, thereby accelerating the rate of beneficial innovation.

A business plan and pilot demonstration with two scans were funded by FY 2005 and FY 2006 allocations. Subsequent SCOR allocations of \$500,000 each, from FY 2007 through FY 2012, enabled the program's initiation and engagement of a contractor to manage scan logistics and provide a yearly assessment of program performance. The primary contractor was engaged for an initial 3-year term with provision for a second 3- year term subject to availability of funds. That contract became effective 12/27/2007. SCOR allocated an additional \$200,000 of FY 2009 funds to be used particularly for monitoring scan impact and exploring ways to enhance scan effectiveness. The NCHRP project panel used these funds to assess scan impact and explore the mechanisms underlying effective dissemination within and among state transportation agencies. Scan planning and dissemination activities were modified to apply lessons learned from these activities.

A 2nd phase of the program was initiated in 2013. A competitive procurement was awarded with terms similar to the 1st phase of the program. In approving this 2nd phase, SCOR increased the annual allocation to \$600,000 to account for increased costs and increased levels of effort on post-scan information dissemination activities. This second phase is ending with scans initiated in CY2018.

A 3rd phase was initiated in 2019. Current plans entail a management review of scan dissemination activities, to be conducted during the first year of the 3rd phase. From the program's initiation, NCHRP funds have from time to time been supplemented by additional amounts provided by FHWA; other appropriate sponsors would be welcomed. From the project's pilot phase through September 2022, such supplemental sponsorship has totaled approximately \$588,000.

The NCHRP project panel selects scan topics from among numerous proposals received each year in response to AASHTO's solicitation, sometimes combining multiple proposals into a single scan. Individuals who submitted selected proposals are included when possible in the scan teams. Each scan team produces a report and presentations of the team's findings and a specific plan of actions to encourage dissemination of useful ideas and lessons learned by the developers and early adopters of these ideas. Scan-team reports are made available from

NCHRP's project web page. Through September 2021, scans on 51 diverse topics have been scheduled; 44 scan-team reports have been released.

Scan-team members may receive limited support for expenses related to presenting these ideas and lessons to colleagues in other agencies; some scan teams organize post-scan symposia or other activities to encourage broader dissemination of the team's findings. The project panel monitors these dissemination activities and explores new ways to accelerate innovation among transportation agencies. Analysis of dissemination experience indicates that scan information reaches well beyond the scan team.

The panel's request for FY 2023, for \$750 thousand, conforms to the current program plan and will enable the program to continue without interruption in its 3rd phase.

2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended

The onset of the pandemic, and its associated travel restrictions, enabled the Domestic Scan Program to conduct 3 scans annually. Given the large volume of scan topic submissions received in 2021, the Program Panel requests increasing the annual funding to \$750 thousand, that will enable the undertaking of three new scan topics and development of new efforts to accelerate the rate of innovation within and among transportation agencies. The panel anticipates the current request will initiate the 3rd phase of the program, and that subsequent requests for annual funding will support the 3rd 6-year term of effort that commenced with the FY 2021 request.

3. Funds (in thousands)

	FY 2005	FY 2006	FY 2007-8	FY 2009	FY 2010- 17	FY 2018- 21	FY 2022	FY 2023
AASHTO Initial Allocation	250							
Continuation Allocation	-0-	-0-	1,000	700	4,500	2,400	600	
Less Obligation	250	-0-	1,000	510	4,690	2,400	600	
Balance (earmarked)	-0-	-0-	-0-	190	-0-	-0-	-0-	
Reallocation	-0-	-0-	-0-	-0-	-0-	-0-	-0-	
Total Available	-0-	-0-	-0-	-0-	-0-	-0-	-0-	
Recommended Allocation								750

4. Interpretation of AASHTO Problem Statement by Panel

Continuing innovation in the practices of U.S. transportation agencies has brought substantial benefits to the nation. Examples of beneficial innovation range from new materials used in pavements and structures, to new ways of collecting and analyzing information about transportation system users and the environment in which the system operates, to new ways of funding the investments needed to improve public safety and efficiency of travel.

Beneficial innovation occurs in any field when new ideas are disseminated and widely adopted by practitioners. Experience in many fields illustrates that expanding the extent of information exchange among practitioners and accelerating the rate of the exchange facilitate innovation.

Experience also shows that personal contact with new ideas and their application is a particularly valuable means for information exchange. U.S. engineering professionals have visited their colleagues in other countries and returned with information that they have subsequently communicated to their domestic colleagues and seen applied to improving domestic practice. The American Association of State Highway and Transportation Officials (AASHTO), the Federal Highway Administration (FHWA), and others have been active in technology transfers at the international level with their involvement in such activities as NCHRP Project 20-36 on "Highway Research and Technology---International Information Sharing."

These earlier experiences and the NCHRP 20-68 program to date have shown that the "scan" approach is a productive means for encouraging the dissemination of information and innovation. Many program participants and observers have noted that new ideas are emerging in state and local transportation agencies around the United States, and that faster dissemination of many of these ideas could yield benefits similar to those associated with international information exchange. Domestic scans conducted by various FHWA offices as well as through the NCHRP further illustrate the value of a domestic scan program.

A scan program entails four key steps. First, knowledgeable people identify novel practices in their field of interest. Second, these people assess the likelihood that these new ideas might beneficially be applied in other settings. Third, new practices that offer the most promise are selected and field visits are made to observe the practices, identify pertinent development and application issues, and assess appropriate technology transfer opportunities and methods. Finally, the results of the initial steps are documented for use by those who participated and for others to apply.

Effective scan programs both supplement and make use of other mechanisms for information exchange such as publications in trade and professional journals, conferences, and peer-to-peer forums. A scan program focuses on face-to-face discussion of current experience, providing opportunities for a uniquely rich exchange of information that is difficult or impossible to replicate through written materials, telephone conversations, and e-mail correspondence. The informal discussions among the scan participants contribute to the extraction of useful information from the individual participant's observations. Executing an effective scan program requires sound understanding of the topic areas to be considered, insightful selection of topics and new ideas to be observed, careful selection of participants who can provide useful insights from their observations, and thoughtful documentation and dissemination of each scan's results. Managing the domestic scan program additionally requires that resources be conserved by not duplicating the information exchange activities of others.

5. Original AASHTO Problem Statement Number

Problem No. 2005-SP-05, 2008-SP-08

6. Research Assignments to Date

NCHRP Project 20-68, "US Domestic Scan Program (Business Plan)" (completed) NCHRP Project 20-68(01), "US Domestic Scan Program Pilot" (completed, 2 scans) NCHRP Project 20-68A, "US Domestic Scan Program" (contractor engaged for 3-year term, renewed for second 3-year term)

NCHRP Project 20-68A(02), “US Domestic Scan Program” (contractor engaged for 3- year term, renewed for second 3-year term, extended 1 additional year to accommodate changes in NCHRP schedules and completion of assigned scan topics)

NCHRP Project 20-68B(01), “Accelerating the Rate of Innovation Among State DOTs- Tracing Domestic Scan Impacts”

NCHRP Project 20-68B(02), “Accelerating the Rate of Innovation Among State DOTs- Tracing Domestic Scan Impacts”

NCHRP Project 20-68C, “Research on Innovation Networks--Domestic Scans” NCHRP Project 20-68D, “US Domestic Scan Program” (contractor engaged for 3-year term, renewable for second 3-year term)

7. Review Date

09/3/2019, 12/5/2019, 9/16/2020, 1/11/2021, and 12/12/2021

8. List of Completed and Ongoing Domestic Scans

Program Year	Domestic Scan Topic
2021	Scan 21-01 - Lessons of Agency Resilience During Periods of Disruption
	Scan 21-02 - Leading Approaches to Implementing Context-Based Classification of Roadways in Planning and Design
	Scan 21-03 - Successful Approaches to Setting Project Development Budgets
2020	Scan 20-01 - Successful Approaches to Utilizing Bridge Management Systems (BMS) for Strategic Decision Making in Asset Management Plans
	Scan 20-02 - Successful Approaches for Facilitating Truck Parking Accommodation Along Major Freight Corridors
2019	Scan 19-01 - Leading Practices for Detailing Bridge Ends and Approach Pavements to Limit Distress and Deterioration
	Scan 19-02 - Leading Practices in Strategic Workforce Management
2018	Scan 18-01 - Hydrodemolition for Removal of Bridge Decks
	Scan 18-02 - Organizing for Emerging Technologies
2017	Scan 17-01 - Use of Unmanned Aerial Systems
	Scan 17-02 - Additional Modes of Service in Existing ROW
2016	Scan 16-01 - HSM for Planning, Design and Operations
	Scan 16-02 - Landscape Design for Roadside Water Management
2015	Scan 15-01 - Developing and Maintaining Construction Inspection Competence

Program Year	Domestic Scan Topic
	Scan 15-02 - Bridge Scour Risk Management
	Scan 15-03 - Successful Preservation Practices for Steel Bridge Coatings
2014	Scan 14-01 - Leading Management Practices in Determining Funding Levels for Maintenance and Preservation
	Scan 14-02 - Successful Intermodal Corridor Management Practices for Sustainable System Performance
	Scan 14-03 - Successful Approaches for the Development of an Organization-Wide Safety Culture in Transportation Agencies
2013	Scan 13-01 - Leading Management Practices for Developing a Cross-Trained Workforce
	Scan 13-02 - Advances in Civil Integrated Management (CIM)
	Scan 13-03 - Leading Practices in Use of Fiber Reinforced Polymer (FRP) Composites in Transportation Infrastructure
2012	Scan 12-01 - Advances in State DOT Superload Permit Processes and Practices
	Scan 12-02 - Advances in Strategies for Implementing Integrated Corridor Management
	Scan 12-03 - Advances in Safety Program Practices in "Zero-Fatalities" States
	Scan 12-04 - Advances in Transportation Agency Knowledge Management
2011	Scan 11-01 - Leading Practices in Large-Scale Outsourcing and Privatization of Maintenance Functions
	Scan 11-02 - Best Practices Regarding Performance of ABC Connections in Bridges Subjected to Multihazard and Extreme Events
2010	Scan 10-01 - Best Practices for Risk-Based Forecasts of Land Volatility for Corridor Management and Sustainable Communities
	Scan 10-02 - Best Practices for Addressing Access and Parking Needs of Non-Resident Users of Rail and Intermodal Transportation Stations
	Scan 10-03 - Best Practices in Performance Measurement for Highway Maintenance and Preservation
	Scan 10-04 - Best Practices Supporting Traffic Incident Management (TIM) through Integrated Communication Between Traffic Management Centers and Law Enforcement and Effective Performance-Measurement Data Collection
2009	Scan 09-01 - Best Practices in Quality Control and Assurance in Design
	Scan 09-03 - Best Practices in Lane-Departure Avoidance and Traffic Calming
	Scan 09-04 - Leading Practices for Motorcyclist Safety

Program Year	Domestic Scan Topic
	Scan 09-05 - Best Practices for Roadway Tunnel Design, Construction, Maintenance, Inspection, and Operations
2008	Scan 08-01 - Best Practices in Managing STIPS, TIPS, and Metropolitan Transportation Plans in Response to Fiscal Constraints
	Scan 08-02 - Best Practices in Maximizing Traffic Flow on Existing Highway Facilities
	Scan 08-03 - Best Practices in Addressing NPDES and Other Water Quality Issues in Highway System Management
	Scan 08-04 - Best Practices in Work Zone Assessment, Data Collection, and Performance Evaluation
2007	Scan 07-01 - Best Practices in Project Delivery Management
	Scan 07-02 - Best Practices in Accelerated Construction Techniques
	Scan 07-03 - Best Practices in Winter Maintenance
	Scan 07-05 - Best Practices in Bridge Management Decision-Making

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
Transportation Research Board
The National Academies of Sciences, Engineering and Medicine

Continuation Request
Project 20-123, FY 2020 & Continuing
Support for AASHTO Committees and Councils

Present Expiration Date: Continuing
Recommended Allocation: \$775,000

1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended

The AASHTO Special Committee on Research & Innovation created NCHRP 20-123 to provide a flexible and ongoing source of funding for AASHTO committees and councils for advancing and implementing their vision, mission, and strategic goals, including the role that research can play their efforts. The activities funded by this project must be an eligible use of SPR-B research funds.

Five FY 2022 projects totaling \$775,000 have been approved for advancement at the time this continuation request was prepared. A list of projects accompanies this continuation request.

2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended

This continuation request will support, for another year, funding for research-related activities needed by AASHTO committees and councils. Activities envisioned to be eligible for funding include but are not limited to the preparation of research road maps, research scoping studies, peer exchanges, updates of AASHTO specifications and manuals maintained by a committee, and updates to strategic plans.

3. Funds (in thousands)

	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
Initial Allocation	1,500				
Continuation Allocation		475	608	833	
Carried Forward balance	-0-	900	734	667	
Less Obligation	600	641	675	775	
Total Available	900	734	667	725	
Recommended Addition					775

4. Interpretation of AASHTO Problem Statement by Panel

This program is needed to respond to the needs of AASHTO committee and councils to assist them in identifying research needs that are important to member state agencies, as well as other activities to assist committees and councils conduct other eligible activities that are related to research.

5. Original AASHTO Problem Statement Number

This project did not result from the submission of a problem statement; it was created and decided upon by the AASHTO Special Committee on Research and Innovation (now R&I) at their March 2018 meeting.

6. Research Assignment to Date

NCHRP Project 20-123, Support for AASHTO Committee and Councils, multiple tasks.

Accountability Report for NCHRP Project 20-123

Purpose:	NCHRP 20-123 provides AASHTO committees and councils with timely access to funds to support their missions with the assistance of consultants, for activities that SPR-B eligible.
Started:	FY 2019
Funding:	Allocated in FY 2022: \$1,500,000 Requested in FY 2023: \$ 775,000
Problem Solicitation:	Needs are identified by each AASHTO committee or council, and members or AASHTO staff submit a funding request to NCHRP.
Process for Selecting Studies:	Funding requests are considered and approved at periodic meetings of the Project 20-123 panel; meetings are held via conference call as needed in response to receipt of a funding request. The panel includes five members, each drawn from the Councils on Highways and Streets, Active Transportation, and Public Transportation; the Committee on Administration; and the Special Committee on Research and Innovation. The panel also includes liaisons from FHWA, and TRB.
Consultant Selection:	The work will be performed by a contractor and overseen by a panel formed for each task and appointed by NCHRP. The approved panel is responsible for selecting its contractor through competitive procurement.
Studies Requested Last Year:	Four requests for a total of \$775,000 were approved of the five submitted for FY 2022. (See Attachment A.)
Studies Funded Last Year:	No additional funding decisions were made last year.
Studies Completed Last Year:	NCHRP 20-123(02) <i>Research Roadmap</i> for the Council on Active Transportation
Distribution of Findings:	Final deliverables will be provided to the leadership of the requesting committee or council, and will be posted as appropriate on the NCHRP website.
Use of Findings:	The reports are of direct use to members of the requesting committee or council. To the degree that NCHRP problem statements result from these efforts, the NCHRP program should benefit from the submission of thoughtful, well-

written, and prioritized research problem statements. Thereby contributing to NCHRP's ability to address important and meaningful research questions.

Next Year's Studies:

This is unknown at this time. Requests are submitted in an ongoing basis.

Attachment A

**NCHRP Project 20-123
FY 2019-2022 Research Projects**

Task Request #	Title	Requestor	Approved Amount
1	Transportation Asset Management Strategic Planning and Research Roadmap Development	COP	\$220,000.00
2	Synthesis of Recent Active Transportation Related Research and Creation of Research Roadmap for Council on Active	CAT	\$250,000.00
3	Staying Nimble: Organizational Development for the Cutting Edge (develop strategic Plan/action Plan	JTF Admin	\$130,000.00
4	Risk Management Strategic Planning Session & Research Roadmap Development	PBM/Risk	\$225,000.00
5	Support for Review of the Manual on Uniform Traffic Control Devices (MUTCD) Notice of Proposed Amendments (NPA) 50K	CTE	0
6	Merge and Update (2005) Policy on the Accommodation of Utilities Within Freeway ROW & and A Guide for Accommodating Utilities Within Highway ROW	RUOA	\$75,000.00
7	Update proposed Manual for the Maintenance of Roadways and Bridges	COM	\$8,200.00
8	Capturing Knowledge Management (KM) Case Studies	Knowledge Management	0
9	Scoping study for the development of a platform for innovations	Research & Innovation	\$100,000.00
10	Strategic Plan Update, Operating Guidelines Development, and Research Roadmaps	Bridges and Structures	\$200,000.00
11	HVR marketing Eastern Research group	Research and Innovation	\$33,000.00
12	System Mobility and Emerging Technologies (SMET): Strategic Planning Session and Research Roadmap Development	Performance-Based Management	\$225,000.00
13	Transportation Planning Strategic Planning and Research Roadmap Development	Planning	\$250,000.00
14	Scoping study for the development of a platform for AASHTO Committee Surveys	Research and Innovation	\$200,000.00
15	Support for AASHTO Approval of the Transportation Operations Manual	Transportation System Operations	\$250,000.00

16	Roadmap for AASHTO Bridge Railing MASH Updates to Support Future Vehicle Fleet Transformation	Bridges and Structures	\$150,000.00
17	Highway Safety Manual Development and Research Roadmap	Safety	\$150,000.00
18	Development of a New Strategic Plan	Transportation System Operations	\$225,000.00

Part 1.2

RESEARCH PROJECTS

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
Transportation Research Board
The National Academies of Sciences, Engineering, and Medicine

Continuation Request
Project 09-63, FY 2019

A Calibrated and Validated National Performance-Related Specification for Emulsified Asphalt Binder

Completion Date: May 1, 2023
Recommended Allocation: \$500,000

1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended

The objective of NCHRP Project 9-63 is to develop a national performance-related material specification for emulsified asphalt binder for use with chip seals and microsurfacing/slurry seals that (a) is similar in concept and format to AASHTO Standard Specifications M 320, Performance-Graded Asphalt Binder, and M 332, Performance-Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) Test; (b) is calibrated and validated with performance data from field test sections; (c) uses readily available testing equipment (i.e., Superpave test equipment); and (d) reflects varying climatic and traffic conditions..

2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended

Additional laboratory testing beyond the scope and funding of the project is necessary to develop an accurate, valid recovery procedure. The project work plan includes a *Recovery Procedures Evaluation Experiment*. This experiment assessed which emulsion residue recovery procedure produces consistent results and how the recovery procedures might be modified to their reduce variability. The experiment included three recovery procedures—AASHTO T 59, AASHTO R 78, Method B, and ASTM D7944—and two laboratories, Asphalt Institute, and its subcontractor National Center for Asphalt Technology. Analysis of the experimental results indicate that the variability of recovered residue test results between the AI and NCAT labs is unacceptable for the three recovery methods. In addition, there is a consistent statistical bias between the results obtained by the two laboratories.

These results were frankly unexpected. The research team met in March 2021 with the project panel to discuss the problem and develop a path forward as a consistent means of residue recovery is needed to achieve meaningful test results and to avoid agency-contractor conflicts. The panel and research team agreed on the following supplemental experiment:

- Evaluate the recovery procedures.
 - Provide an in-depth review of the ASTM D7944, AASHTO T 59 Section 7, and AASHTO R78 Procedure B in the AI and NCAT labs

- Review equipment and step-by-step procedures between the two laboratories
- Conduct a new laboratory experiment using emulsions with known residue percentages and known base asphalt binder properties.
 - Minimum of 3 samples (unmodified, SBS-modified, and SBR-modified) to be provided by Paragon Technical Services
 - Conduct recovery using AASHTO R 78 Procedure A (EN 13074) as a baseline.
 - Conduct recovery using ASTM D7944, AASHTO T 59 Section 7, and AASHTO R78 Procedure B.
 - Use extended recovery time if needed to get to the known residue content of the emulsion.
 - Conduct high temperature DSR testing following AASHTO T 315 as a measure of variability and bias.
 - Prepare samples without reheating (ambient state).
 - Perform testing on samples after reheating to reach fluid state.
- Validate the revised procedures by having 4 to 6 state DOT laboratories perform recoveries and testing once AI and NCAT determine the appropriate procedures for sampling , handling, and testing.

Conducting this new experiment will require reallocation of funds from the future tasks dealing with development of the performance-graded emulsion specification and limits. In addition, the panel foresees the need to expand the field evaluation and validation of the performance-based specification and the supporting test methods and residue recovery procedure beyond the 16 projects presently funded.

The project panel respectfully requests \$500,000 in FY 2023 NCHRP funds to conduct the additional laboratory and field experiments.

3. Funds (in thousands)

	FY 2019	FY 2023
AASHTO Initial Allocation	500	
Continuation Allocation	-0-	
Less Obligation	<u>500</u>	
Balance (earmarked)	-0-	
Reallocation	<u>-0-</u>	
Total Available	-0-	
Recommended Addition		500

4. Interpretation of AASHTO Problem Statement by Panel

The demand for asphalt emulsions has increased due to the widespread adoption of surface treatments for pavement preservation. Highway agencies and industry are moving toward the development and

implementation of performance specifications for chip seal emulsions and other emulsion-based asphalt surface treatments. The key challenge in the development of these specifications is the identification of appropriate material performance properties, test methods, and acceptance criteria that reliably predict the long-term performance of surface treatments or their potential for failure. Research is needed to develop a national performance-related material specification for emulsified asphalt binder similar to the Superpave asphalt binder specification for use by state departments of transportation (DOTs) and local agencies.

5. Original AASHTO Problem Statement Number

Problem No. 2019-D-21

6. Research Assignments to Date

NCHRP Project 09-63, "A Calibrated and Validated National Performance-Related Specification for Emulsified Asphalt Binder"

7. Review Dates

06/17/2019, 02/25/2020, 03/19/2021

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
Transportation Research Board
The National Academies of Sciences, Engineering, and Medicine

Continuation Request
Project 17-89, FY 2018
Safety Performance of Part-Time Shoulder Use on Freeways

Present Expiration Date: June 30, 2021

Recommended Allocation: \$125,000

1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended

The objective of NCHRP Project 17-89: Safety Performance of Part-Time Shoulder Use on Freeways, was to develop models and other quantitative tools for practitioners to evaluate safety performance of freeways with part-time shoulder use (PTSU) (including Bus on Shoulder (BOS)). The research is complete; it produced models that predict (1) the frequency of fatal-and-injury (FI) crashes and (2) the frequency of property damage only (PDO) crashes. These were applied to assess the overall effect of PTSU on total and severe crash frequency. Models are available for basic freeway segments, entrance speed-change lanes, and exit speed-change lanes. A severity distribution function (SDF) was also developed to predict the distribution of FI crashes among different severity levels. Each model includes variables that describe the traffic demand characteristics, geometric elements, and PTSU operational features.

The panel has reviewed the draft final report, the models, and other deliverables, in anticipation of their possible inclusion in the proposed AASHTO Highway Safety Manual, Second Edition (HSM2), under development in NCHRP Project 17-71A.

2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended

This continuation request will support pilot testing of the PTSU models developed in Project 17-89 by state DOTs that operate such facilities with the goal of determining whether additional resources are needed to support wider-scale implementation through HSM2. The pilot tests will provide material for one or more case studies that will help practitioners use the research products. In addition, review of the pilot states' efforts will help identify any Highway Safety Manual-related needs, such as text to be included with the models, text for other sections of the HSM to explain the relationship to other models, training materials, etc. Subject to the availability of data, the participating DOTs will run the models to:

1. Estimate FI and PDO crash frequencies, compare them to DOT experience, and evaluate whether the models are suitable in their present form for incorporation in HSM2.
2. Evaluate differences in safety performance between right- and left-side PTSU.
3. Conduct a before-after study of freeways where PTSU was implemented during Project 17-89.

The contractor will conduct the following tasks:

Task 1. Review the Project 17-89 research results to:

- a) Identify potential challenges to pilot testing.
- b) Determine the need for state calibration of the models.
- c) Identify two to five agencies with data suitable and sufficient for pilot testing; these may include agencies whose data was used in the model development and those whose data was not.

Task 2. Based on the results of Task 1, provide technical support to the agencies with roadway sections with PTSU to (a) conduct pilot testing of the models, (b) compare the model results to the agencies' experience of FI and PDO crashes on these sections, and (c), if suitable data are available, compare right- and left-side PTSU and before and after PTSU safety performance.

Task 3. Submit a final report that presents the results of the pilot testing and includes (a) one or more case studies of use of the models, (b) a recommendation for the suitability of incorporating the models in HSM2 in their present form, and (c) any additional resources needed to support wider-scale model implementation through HSM2.

Task 4. Present a webinar that discusses the pilot tests, the lessons learnt, and the way forward.

3. Funds (in thousands)

	FY 2018	FY 2023
AASHTO Initial Allocation	400	
Continuation Allocation	-0-	
Less Obligation	<u>400</u>	
Balance (earmarked)	-0-	
Reallocation	-0-	
Total Available	-0-	
Recommended Addition		125

4. Interpretation of AASHTO Problem Statement by Panel

Part-time shoulder use on freeways is an increasingly popular and practical performance-based design strategy for both reducing congestion and improving bus travel time and reliability. There are three types of part-time shoulder use: bus-on-shoulder (BOS), static shoulder use, and dynamic shoulder use. BOS is limited to authorized buses driven by trained drivers. Static shoulder use and dynamic shoulder use allow all or most vehicles to use the shoulder when it is open. Static shoulder use opens the shoulder to traffic on a fixed schedule while dynamic shoulder use opens the shoulder to traffic in response to overall traffic conditions.

Sixteen states have one or more part-time shoulder use facilities in operation on freeways, many of which have opened within the past five to ten years. In 2016 FHWA

published a guide on part-time shoulder use. That publication identified the lack of tools for quantifying the safety of part-time shoulder use as a major research gap. Only two safety studies of part-time shoulder use in the United States were cited, and each was focused on a single facility. Moreover, the current Highway Safety Manual (HSM) freeway models do not explicitly consider the potential safety performance of part-time shoulder use.

Research is needed to help engineers and planners better understand both the safety performance of existing part-time shoulder use operations and the specific operational and design elements that influence (or appear to influence) their safety performance.

5. Original AASHTO Problem Statement Number

Problem No. 2018-G-03

6. Research Assignment to Date

NCHRP Project 17-89: Safety Performance of Part-Time Shoulder Use on Freeways

7. Review Dates

11/29/17; 3/7/18; 11/30/18; 12/19/18; 3/21/19; 10/6/20; 11/23/20; 1/14/21

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
Transportation Research Board
The National Academies of Sciences, Engineering, and Medicine

Continuation Request
NCHRP Project 20-124, FY 2019
Deploying Transportation Security Practices in State DOTs

Present Expiration Date: 07/21/2022

Recommended Allocation: \$99,000

1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended

An inaugural “Emergent Security Concepts” national training class and workshop was held virtually on Monday, November 1, 2021. Materials were workshopped for the Security Implementation Tool, the key deliverable developed through the initial research project. Case studies developed under the initial research project were also presented. A key to successful deployment of transportation security practices is the active engagement by transportation thought leaders as demonstrated through the inaugural national training class and workshop. The Security Implementation Tool presents an integrated self-assessment tool that links to templates and informative video modules.

2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended

A continuation of this project is requested to facilitate additional research culminating in two in-person national training classes and workshops. These offerings build on the interactive “Emergent Security Concepts” national training class and workshop facilitated virtually on Monday, November 1, 2021. The inaugural offering was highly customized to the current security needs identified and dissected by the research team for the project and, ultimately, the state DOTs. Although embedded materials were designed to evolve with the state of security practice, annual iterations of the national training class and workshop present an opportunity for security emphasis and expansion in both content and participation.

This continuation takes into consideration the cancelation of TRB’s Transformative Times in Security conference originally scheduled for November 2 – 5, 2021. The national training class and workshop alignment with the TRB conference allowed the research team to volunteer to support the conference planning team. They worked closely with TRB and industry leaders, understanding the value of the conference and the unfortunate aftermath of the cancelation. Per email traffic on Monday, September 27, 2021, numerous TRB specialty conferences were postponed to 2022 and 2023 due to COVID. TRB does not have room for other conferences to be added in 2022. This continuation creates two national-level opportunities for nationally-convened state-DOT-focused security workshops that will not be available for consideration as TRB conferences until at least 2024.

Awareness. The research is divided into two phases. Phase I gathered practitioner insights through surveys, interviews, and stakeholder engagement sessions. Strategic and

operational level recommendations combine practitioner insights with an academic foundation established in a literature review. Strategically, the research presents two interdependent deployment strategies underpinned by three enabling change management techniques.

Availability. Five security parameters are the outputs from the Security Implementation Tool, a stand-alone tool developed in the initial research to measure and evaluate an ecosystem's security posture. Security parameters align with the National Institute of Standards and Technology (NIST) Cybersecurity Framework Implementation Tiers, encouraging security alongside organizational planning, programming, and budgets.

Alignment. Measurable benchmarks and toolkits guide the advancement of the security parameters. Research-derived toolkits feature an array of assets, courses, and references to advance security capacities. Toolkits align with the Department of Defense (DoD) structures and recommendations for managing and creating an effective risk management program (AASHTO Guide for Enterprise Risk Management, 2016).

Access. Phase II of the research included a series of multi-state activities to familiarize every state DOT and its security partners with security practices and implementation approaches. Regional pilot tests, conference presentations, and multi-state activities culminated in a national training class and workshop hosted virtually on November 1, 2021.

Ability. Delivery type diversification in Phase II implementation activities was broad and advanced to specific levels of security expertise. Offerings are the results of qualitative and quantitative measurements to evaluate a state DOT's needs relative to necessary expertise, equipment, and organizational authority to implement the security strategies.

The research plan for advancing the metrics follows a 24-month timeline. Tasks include designing, developing, and facilitating two "Emergent Security Concepts" national training classes and workshops, one for CY 2022 and one for CY 2023. Objectives for each event are as follows:

- Learn and share security behaviors and management involving multiple disasters, disciplines, and collaborations;
- Create a community to change the paradigm of security transportation thinking; and,
- Gather feedback to advance security-derived research findings from NCHRP 20-124: Deploying Transportation Security Practices in State DOTs.

The continuation effort total budget is \$149,000. The panel had held \$50,000 in reserve for follow-on activities; however, the panel did not anticipate the pandemic causing the in-person events to be turned into virtual events, nor the postponement of a 2021 TRB security-focused conference to (at least) CY 2024.

Total Additional Funds Requested: \$99,000

3. Funds (in thousands)

	FY 2019	FY 2022
AASHTO Initial Allocation	\$750*	
Continuation Allocation	-0-	
Less Obligation	\$699	
Balance (earmarked)	-0-	
Reallocation	-0-	
Total Available	\$51	
Recommended Addition		\$ 99,000

4. Interpretation of AASHTO Problem Statement by Panel

NCHRP Research Report 930: Security 101: A Physical and Cybersecurity Primer for Transportation Agencies was published in 2020. This primer provides updated information about current effective practices associated with the evolving physical and cyber security mission in surface transportation. The main audience for *Security 101* is transportation personnel without a security background whose work requires them to address, perform, or supervise security activities as part of their overall job responsibilities. Although the document is designed for those with minimal or no formal security training or experience, the primer is also a handy reference guide sufficiently detailed to be of use to security professionals.

Translating the “what to do” from the primer to the real world (how to do it) is complex. Infrastructure planning, scoping, and design are essential to “designing-in” security. State departments of transportation (DOTs) vary in how they organize their activities. For example, many state DOTs share the role of security with other state agencies. This may include their State Homeland Security, Highway Patrol, and Offices of Emergency Management. Policies among these entities outline roles and responsibilities in addressing security policies. Some allocate federal security funds. Many state DOTs depend on their Highway Patrol and/or local law enforcement to carry out the investigative and enforcement portion of security needs for their infrastructure. The roles and responsibilities of all parties may be outlined in a document commonly referred to as “Joint Operations Policy.”

Research is needed to develop a strategy and a suite of supporting products and activities for deploying transportation security practices in state DOTs. Annual nationally-convened training and workshop events materially aid in facilitating peer-led implementation.

5. Original AASHTO Problem Statement Number

On file.

6. Research Assignment to Date

NCHRP Project 20-124

7. Review Dates

10/18/2021

8. Project Description

The objective of NCHRP 20-124 is to develop and support the implementation of a comprehensive deployment and change management strategy for deploying transportation security practices in state DOTs.

Final deliverables include (1) an implementation and change management strategy and all supporting lesson plans, scripts, training exercises, and all other didactic and experiential material developed in support of the strategy; (2) a final report summarizing the background research; (3) an updated interim meeting and PowerPoint presentation suitable, upon revision, for posting on the NCHRP project webpage; (4) a stand-alone, 1-page executive summary in a suitable format of text and graphics aimed at senior decision-makers; (5) training and educational materials to achieve technology transfer of security practices; and (6) a summary report on the multi-state activities.

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
Transportation Research Board
The National Academies of Sciences, Engineering, and Medicine

Continuation Request
NCHRP Project 22-29B, FY 2018

Evaluating the Performance of Longitudinal Barriers on Curved, Superelevated Off-Ramps

Current Planned Completion Date: June 30, 2022

Recommended Addition Allocation: \$75,000

1. Anticipated Accomplishment(s) When Current Project Allocation Has Been Expended

NCHRP Project 22-29 was completed in 2016 and addressed a longstanding open question about the efficacy of barriers used on curved, superelevated roadway sections (CSRS). At the outset of the research, there had been virtually no in-depth analyses or crash testing of the impact performance of longitudinal barriers when installed on CSRS. Vehicles impacting barriers in these situations are likely to hit at angles different from the 25-degree angles considered in certification testing. Further, because of the effects of slopes of the road and shoulder in these situations, it was not known whether the vehicle-to-barrier interface was adequate. The project provided useful insights after extensive vehicle dynamics and FE crash simulation analyses of barrier effectiveness for the TL-3 crashworthiness standards. It was found that the effects of curvature and superelevation had an effect for passenger cars and light trucks. For large radius curves, the TL-3 barrier performance differences were not significant, but there was a greater likelihood of inadequate barrier interface as the radius of the curves decreased. Recommendations were developed for agencies to improve their barrier selection, placements, and maintenance practices to enhance safety based upon the findings.

Since the effort was unable to address the needs for shorter radius CSRS, it prompted the initiation of NCHRP Project 22-29B which was aimed at conducting similar analyses with a focus on highway ramps where shorter radii are common. The Phase 1 efforts under Project 22-29B found that there was, in fact, a greater likelihood that barriers would not contain errant vehicles because of greater variations in the impact angle and increase chances of poor vehicle to barrier interface. The project panel noted that there are ramp situations where adjoining (opposite direction) ramps might result in serious crashes where larger vehicle might override the barrier. Vehicle and dynamics analyses considered the common range of highway ramp curves to develop barrier guidance for these situations. It was noted that speed controls are often implemented to reduce the potentials for crashes on “tight” ramps, and that data showed a high propensity for vehicles exceeding the speed limits in these situations. The panel noted that the potential hazards of an override problem for larger vehicles (i.e., trucks) warranted research that considered the effectiveness of TL-4 (single-unit trucks) barriers. This research is beyond the original project scope and addressing it would not allow the

highest-level validation and analysis of the research and the planned crash testing to be undertaken.

2. Anticipated Efforts under the Requested Continuation Allocation

The panel respectfully requests continuation funds to expand the analyses for shorter radius ramps for the TL-4 class of vehicles. Models of these vehicles are available to allow both vehicle dynamics analyses and FE crash simulations for the higher barriers. Added resources are needed to modify the barrier models to reflect TL-4 types and conduct the simulation of truck to barrier impacts. The analyses will consider typical TL-4 barriers across a range of ramp curvature, barrier placement, and road/shoulder slope. These analyses are likely to take longer to execute as more finite elements are involved. The analyses will incrementally look at possible impact conditions and barrier effectiveness. The computer analyses will provide critical insights that will help highway agencies to deploy effective barriers in the most appropriate positions for those situations. The efforts will identify potential problems and assess alternative barrier selection, placement, and maintenance guidance to alleviate problems. This guidance will be compatible with previous guidance and that which is expected from the current effort.

3. Funds (in thousands)

	FY 2011	FY 2018	FY 2023
AASHTO Initial Allocation	600		
Continuation Allocation	-0-	250	
Less Obligation	<u>600</u>	<u>250</u>	
Balance (earmarked)	-0-	-0-	
Reallocation	<u>-0-</u>	<u>-0-</u>	
Total Available	-0-	-0-	
Recommended Addition			75

4. Interpretation of AASHTO Problem Statement by Panel

Longitudinal barriers are roadside safety devices commonly used to prevent errant vehicles from impacting hazards located alongside the traveled way. These barriers have been successfully designed in many different variations ranging from rigid concrete parapets to semi-rigid beam guardrail to relatively flexible wire rope barriers. Historically, the development and testing of longitudinal barriers has been done under the assumption that the barriers are installed in relatively straight sections parallel to the roadway. While the barriers designed under this assumption have performed well, their behavior when installed on curved roadways is largely unknown. However, despite this lack of understanding of their safety performance on curved roadways, longitudinal barriers are commonly installed on superelevated curves to protect errant motorists.

NCHRP Project 22-29, "Performance of Longitudinal Barriers on Curved, Superelevated Roadway Sections," and NCHRP Project 22-29A, "Evaluating the Performance of Longitudinal Barriers on Curved, Superelevated Roadway Sections," demonstrated that

the safety performance of a traffic barrier decreases as its curvature increases. The barriers with the sharpest curvature are found on off-ramps. Although spectacular accidents on off-ramps are occasionally reported in the media, there has been no study of barriers on off-ramps since the early 1980s. In that pioneering study, a series of full-scale tests was conducted of Jersey-shape barriers on a sharply curved off-ramp that also had superelevation and downgrade. While the test vehicles were all smoothly redirected in 40 mph impacts, the results indicated that the barriers were near their performance limits. Today, vehicles often travel at speeds substantially greater than 40 mph on off-ramps, and clear guidance is needed on selecting and designing traffic barriers for curved off-ramps.

Based on these considerations, research is needed to quantify the performance of longitudinal barriers on curved, superelevated off-ramps and provide guidelines for their safe application.

5. Original AASHTO Problem Statement Number

Problem No. 2011-G-29

6. Research Assignments to Date

NCHRP Project 22-29, "Performance of Longitudinal Barriers on Curved, Superelevated Roadway Sections"

NCHRP Project 22-29A, "Evaluating the Performance of Longitudinal Barriers on Curved Superelevated Roadway Sections"

NCHRP Project 22-29B, "Evaluating the Performance of Longitudinal Barriers on Curved, Superelevated Off-Ramps"

7. Review Dates (for Project 22-29B only)

September 27, 2018; April 11, 2019; July 2, 2020, November 8, 2021

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
Transportation Research Board
The National Academies of Sciences, Engineering and Medicine

Continuation Request
Project 22-37, FY 2019

Development of a MASH Barrier to Shield Pedestrians, Bicyclists, and Other Vulnerable Users from Motor Vehicles

Present Expiration Date: July 29, 2022 (pending approval of a contract modification from original end date of January 2, 2022)

Recommended Allocation: \$145,000

1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended

NCHRP Project 23-37, “Development of a MASH Barrier to Shield Pedestrians, Bicyclists, and Other Vulnerable Users from Motor Vehicles” developed a non-proprietary barrier for use in separating pedestrians, bicyclists, and other vulnerable users—including wheelchair users and people with visual impairments who use canes—from motor vehicles. Simulation models and full-scale crash tests have been conducted and the barrier has met the requirements of MASH Test Level 3 (high speed). The barrier will be appropriate for a variety of contexts, such as where right-of-way constraints reduce lateral offset between a roadway and a shared use path.

Some funds (\$50,000) from the original allocation were reserved for an additional full-scale crash test had that been necessary. With the successful completion of two full-scale crash tests, a contract modification has been requested to add those funds from the original allocation to the existing contract and to modify the original scope to include development of a transition to connect the new barrier to a typical guardrail installation. This additional scope includes developing design details and conducting computer simulations to evaluate the performance of the transition.

However, until the transitions are also evaluated in full-scale crash tests, many state DOTs will be unable to implement the new system. Additional research is needed to conduct full-scale crash tests of the transition to MASH Test Level 3. This will provide state DOTs with a complete and usable system to address safety for all users along the growing number of multi-use paths.

2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended

Timely allocation of the requested additional funds will enable the use of an already-constructed barrier for testing and the release of complete, implementable designs for use by state DOTs. These activities are not possible under the current funding level for this project:

1. Develop detailed construction specifications for a nonproprietary transition design that is appropriate for connecting the new barrier system to a typical,

nonproprietary guardrail. The design should be informed by the results of computer simulations to evaluate its performance.

2. Modify the currently constructed test barrier to add the transition and a MASH-test compliant segment of typical guardrail.
3. Conduct full-scale crash test of the transition to MASH TL3 standards.
4. Provide complete design details of the transition along with simulation results, and crash test results in the NCHRP research report and in a format readily in a format that can be used by a state DOT to demonstrate MASH compliance.

Note: The requested funds will not be used to investigate, analyze, simulate, or test any proprietary products. The guardrail system developed under Project 22-37 is considered generic (non-proprietary), and no proprietary products will be used, evaluated or incorporated into the transition system. The transition design that will be developed, evaluated, and tested under this project will be a generic, non-proprietary system.

3. Funds (in thousands)

	FY 2019	FY 2023
AASHTO Initial Allocation	500	
Continuation Allocation	-0-	
Less Obligation	<u>500</u>	
Balance (earmarked)	-0-	
Reallocation	-0-	
Total Available	-0-	
Recommended Addition		145

4. Interpretation of AASHTO Problem Statement by Panel

As the number of pedestrians, bicyclists and users of other active transportation modes continues to grow in the U.S., state departments of transportation (DOTs) are seeking to improve how these users are accommodated on or adjacent to our nation's roadways. One option is to install a barrier that separates lanes for motorized vehicles from paths for vulnerable users.

Traditionally barriers are designed for a specific need such as shielding motorists from a steep slope or a fixed object in the clear zone. The selection of a barrier is driven by roadway design speed, traffic volume, and clear zones, along with considerations such as the accommodation of access points, climate conditions, and aesthetics. However, the use of barriers to separate pedestrians and bicycles from motor vehicles requires the consideration of additional factors to address safety for all users. For example, a typical guardrail is designed to redirect motor vehicles, but may not be tall enough to protect pedestrians by preventing inadvertent encroachment into the roadway. Guardrail designs may have bolts or other features that can snag a vulnerable user. Additionally, when struck by a motor vehicle, a barrier may deflect into the path of a vulnerable user.

Previously published guidance includes some information on barrier designs to separate vulnerable users from motor vehicle traffic; however, design specifics are incomplete and may not address the most common design contexts where a new barrier or modification to an existing barrier is needed for positive protection.

Research is needed to develop a barrier with design and performance characteristics that address safety for vulnerable users and for motorists while satisfying the proposed Public Right-of-Way Accessibility Guidelines (PROWAG) and the American Association of State Highway Transportation Officials (AASHTO) Manual for Assessing Safety Hardware (MASH) criteria. To ensure a design is appropriate for commonly encountered design contexts and challenges, it must be informed by a review of current practice that identifies gaps between current practice and crashworthy barrier solutions.

5. Original AASHTO Problem Statement Number

Problem No. 2019-C-11

6. Research Assignment to Date

NCHRP Project 22-37, Development of a MASH Barrier to Shield Pedestrians, Bicyclists, and Other Vulnerable Users from Motor Vehicles

7. Review Dates

October 29 & 30, 2018; February 20, 2020; September 20, 2021.

Part II

NEW PROBLEMS

FY 2023 CANDIDATES FOR FUNDING AS NEW PROBLEMS

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2023-A-01	Communications and Training Manual for Active Transportation (\$100,000 – 18 months)	AASHTO Cmte on Active Transportation	A-01/1
2023-A-02	Enterprise Data Warehouse Implementation Guide (\$350,000 - 18 months)	AASHTO Cmte on Data Management and Analytic	A-02/1
2023-A-03	Future Equity Impacts of Existing Fuel Taxes (\$450,000 - 18 months)	AASHTO Cmte on Funding and Finance	A-03/1
2023-A-04	New Mobility and the User Fee Concept (\$450,000 - 18 months)	AASHTO Cmte on Funding and Finance	A-04/1
2023-A-05	Knowledge Strategies to support the Research Lifecycle and Application of Research Results (\$400,000 – 24 months)	AASHTO Cmte on Knowledge Management	A-05/1
2023-A-06	Lessons learned from two decades of knowledge management (\$175,000 - \$250,000 - 18 months)	AASHTO Cmte on Knowledge Management	A-06/1
2023-A-07	Assessing Financial Risk at the Program and Enterprise Levels (\$400,000-\$500,000 - 24 months)	AASHTO Cmte on Performance Based Management	A-07/1
2023-A-08	Development of the AASHTO Highway Asset Risk & Resilience Manual: Phase 1 (\$3,500,000 - 3 years)	AASHTO Cmte on Performance Based Management	A-08/1
2023-A-09	Incorporating Risk Management into Maintenance Practice (\$450,000 – 18-24 months)	AASHTO Cmte on Performance Based Management	A-09/1
2023-A-10	Innovative Practices for Technology Implementation at Rural, Small, and Mid-Sized Transit Agencies (\$250,000 -18 months)	AASHTO Cmte on Public Transp.	A-10/1
2023-A-11	Guidance in Planning for Managed Retreat as an Extreme Weather and Climate Adaptation Strategy (\$500,000 - 24 months)	AASHTO Cmte on Transportation System Security and Resilience	A-11/1
2023-A-12	Creating a Guidebook Addressing Equity in Payments for Transit and Congestion Charging (\$500,000 - 24 months)	California	A-12/1

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2023-A-14	Optimizing Investment in TSM&O to Reflect an Evolving Mobility Paradigm (\$250,000-\$400,000 - 24 months)	Florida	A-14/1
2023-A-15	Managing Privacy Issues When Using and Storing Connected Vehicle Data (\$400,000 - 24 months)	North Carolina	A-15/1
2023-A-16	Technology Assistance for Small & Rural Transit Agencies (\$200,000 - 18 months)	Texas	A-16/1
2023-A-17	Assessing Big Data Privacy and Utility Trade-offs for Transportation Agencies (\$400,000 - 12 months)	Virginia	A-17/1
2023-B-01	Guidelines for Use of the FEMA's National Risk Index in State Highway Transportation Planning (\$350,000 - 18 months)	AASHTO Special Cmte on Freight	B-01/1
2023-B-02	New Environment Planning – An Identification and Examination of the Inter-relationship Between Evolving Changes for Commercial Vehicles related to Fuel Type (i.e. electric and hydrogen), Technology (i.e. autonomous), and Operational Issues (i.e. human factors); and the Corresponding Impact on future Freight and Transportation Planning Issues, Infrastructure and Operation Needs for Public Transportation Corridors, and overarching Public Policy Implications (\$400,000 - 18 months)	AASHTO Special Cmte on Freight	B-02/1
2023-B-03	Defining Appropriate Design and Accommodation Thresholds for Active Transportation in a Context-Driven Approach (\$550,000 - 24 months)	AASHTO Cmte on Active Transportation	B-03/1
2023-B-04	Institutional Integration of Active Transportation (\$600,000 - 24 months)	AASHTO Cmte on Active Transportation	B-04/1
2023-B-05	Integrating Active Transportation Data into Transportation Decision-Making (\$550,000 - 24 months)	AASHTO Cmte on Active Transportation	B-05/1
2023-B-06	Racial and Economic Disparities in Pedestrian and Bicyclist Safety (\$750,000 - 36 months)	AASHTO Cmte on Active Transportation	B-06/1
2023-B-07	Methods to Improve Representation, Diversity, and Inclusion in Personal Travel Data (\$350,000 - 18 months)	AASHTO Cmte on Data Management and Analytic	B-07/1

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2023-B-13	Institutionalizing Safe Systems and Safety Culture in the Transportation Planning Process (\$400,000 - 12 months)	AASHTO Cmte on Planning	B-13/1
2023-B-14	Benefit Analysis of Private Health Sector Investments in Public/Human Transportation (\$400,000 -18 months)	AASHTO Cmte on Public Transp.	B-14/1
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2023-B-16	Addressing Traditionally Marginalized and Underrepresented Groups in Cultural Resource Management (\$250,000 - 24 months)	AASHTO COE Committee on Environment and Sustainability	B-16/1
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2023-B-21	Framework for Analyzing and Mitigating Highway-related Noise and Vibration Impacts on Terrestrial Wildlife (\$375,000 - 30 months)	AASHTO COE Committee on Environment and Sustainability	B-21/1
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2023-C-06	Impact of Flooding and Inundation on the Resiliency of Pavements (\$650,000 - 24 months)	AASHTO COMP Committee on Pavements	C-06/1
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2023-D-09	Guidance for Including Right-Of-Way and Utilities in Value Engineering Studies \$400,000 - 24 months)	AASHTO ROW, Utilities and Outdoor Advertising Control	D-09/1
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2023-G-01	Development of an Updated Warranting System for Roadway Lighting (\$350,000 -18-24 months)	Delaware, AASHTO Tech Cmte on Roadway Lighting	G-01/1
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2023-G-05	Integrated Strategies for Managing High Travel Speeds (\$500,000 - 24 months)	AASHTO Cmte on Safety	G-05/1
2023-G-06	Intersection Crash Prediction Models for Future Editions of the HSM (\$750,000 – 30 months)	AASHTO Cmte on Safety	G-06/1
2023-G-07	Method for Evaluation of a Mixed-Project Safety Program (\$400,000 – 24 months)	AASHTO Cmte on Safety	G-07/1
2023-G-08	Pedestrian Crosswalk Spacing and Placement Guidance to Improve Safety (\$450,000 - 500,000 - 24-36)	AASHTO Cmte on Safety and Delaware	G-08/1
2023-G-09	Practical Approaches to Quantifying Safe System Concepts (\$450,000 – 24 months)	AASHTO Cmte on Safety	G-09/1
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2023-G-13	Transportation Operations Manual Best Practices Guide (\$350,000 -18 months)	AASHTO Cmte on Transp System and Operations	G-13/1
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Problem No	Title	Submitter	Page
2023-G-17	Exit Speed Warning Sign Placement (\$75,000 - 6+5 months)	Delaware, NCUTCD	G-17/1
2023-G-18	LED Applications on Traffic Control Devices (\$500,000 – 30 months)	Delaware, NCUTCD	G-18/1
2023-G-19	Improved Method to Link Crash, Emergency Medical Service, and Trauma Registry Data to Expand Safety Data Analyses and Safety Program Development (\$400,000 - 24 months)	Washington	G-19/1
2023-G-20	Best Practices for Roundabout and Alternative Intersection/Interchange Lighting (\$500,000 - 24 months)	Delaware and Joint Technical Committee on Roadway Lighting	G-20/1
2023-G-21	Effective flash patterns using LED-Enhanced Chevron Sign Systems (\$45,000 - 240 hours)	Delaware	G-21/1
2023-G-22	Pedestrian Signing - Determination of the “best” pedestrian regulatory crossing sign at intersections (MUTCD sections 2B.11, B.12, 2B.53 and 2C.50) (\$200,000 - TBD time)	Delaware NCUTCD	G-22/1
2023-G-23	Investigate the use of Meteorological Satellite products for Operational Highway Visibility Notification (\$548,000 – 30 months)	FHWA	G-23/1
2023-G-24	Using Advanced Technologies to Reduce Commercial Motor Vehicle Crashes in Work Zones (\$500,000 – 24 months)	FHWA	G-24/1
2023-G-25	A Study of Spatio-temporal Traffic Patterns in Metropolitan Atlanta Using Google Maps (\$896,250 – 3 years)	Georgia	G-25/1
2023-G-26	Capabilities, Requirements, Planning, and Preparing to Virtually Operate Traffic Management Systems (TMS) (\$600,000 - 36. months)	AASHTO Cmte on Transp System and Operations, Georgia,	G-26/1
2023-G-27	Evaluation of Trespassing Detection and Warning Systems in the Vicinity of Highway-Rail Grade Crossings (\$450,000 - 30 months)	Indiana - Council on Rail Transp.	G-27/1
2023-G-28	Toward AI-Enabled Decision Support Systems for TSMO Applications (\$450,000 – 36 months)	Louisiana	G-28/1
2023-G-29	Drivers of Change and Their Impacts on Traffic Monitoring Program Management (\$325,000 – 18 months)	North Carolina	G-29/1

Problem No	Title	Submitter	Page
2023-G-30	Communicating Travel Time Reliability: Analytic and Visualization Methods (\$300,000 - 18 months)	Ohio	G-30/1
2023-G-31	Incorporating a methodology for planning and operational analysis of freeway facilities with ramp meeting strategy (\$500,000 - 36 months)	Oregon	G-31/1
2023-G-32	Signal Timing Manual: Development of the Third Edition (\$750,000 – 36 months)	Utah	G-32/1
2023-G-33	Economic Evaluations of Roadside Driving Under the Influence of Drugs (DUID) Programs (\$500,000 – 24 months)	Washington	G-33/1

Research Field A

ADMINISTRATION

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-A-01

Problem Title

Communications and Training Manual for Active Transportation

Background Information and Need For Research

The transportation sector has a great need for clear, accurate, and more consistent communications related to “active transportation.” which includes but is not limited to walking and biking. Varying interpretations create difficulty for key transportation stakeholders in understanding, planning, and designing and maintaining systems that promote active transportation. It incorporates a number of complex and important issues, such as equity, accessibility, data, planning, design, operations, and safety. As described by the Council on Active Transportation’s recently completed “Research Roadmap” there are many benefits associated with active modes; however, many research gaps related to active transportation also need to be addressed.

Literature Search Summary

Although there is not a universal definition of “active transportation”, the CDC describes it as self-propelled, human-powered transportation (CDC, 2019). This may include self-propelled, mostly human-powered travel including walking, biking, rolling (e.g., via scooter, wheelchair, and stroller), hiking, and running. Varying interpretations make it challenging for transportation to plan adequately.

Research Objective

The objectives of this study are to (1) develop a manual and associated training materials focused on communications to improve clarity, accuracy, consistency, and use of communications related to active transportation; (2) help the Council successfully implement its Research Roadmap and advance their the identified priorities; and (3) provide tools and resources for Council members, the broader state DOT community, and other interested entities to help advance their own active transportation priorities.

Urgency And Potential Benefits

Encouraging the design of safe routes and connectivity, creates increased active transportation which will help reduce health impacts and less reliance on cars.

Implementation Considerations

The work entails development of a tool, manual, and associated training materials focused on communications to advance active transportation.

1. An overview of the value of active transportation, which would draw on the research review provided in the Roadmap and be written in clear, everyday language;

2. An overview of how active modes are and are not considered in broader transportation communications efforts and the implications of inadvertent deprioritization, inadequate consideration, or omissions and inaccuracies;
3. Identification of the varying definitions of active transportation, where they are in use or required, and where federal and state definitions may differ;
4. An analysis of and template for messaging or strategies likely to be most effective for communicating with various stakeholder groups, including elected officials, transportation engineers and planners, and the general public; and
5. A “toolkit” to help users of the manual better communicate the value of active transportation as they seek out additional research, funding, projects, programs, etc., to include a package of resources, templates, and training materials to support effective dissemination and implementation of the manual and its underlying principles.

Recommended Research Funding and Research Period

18 months \$100,000

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Phillip Burgoyne-Allen
pballen@ashto.org

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

N/A

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Phillip Burgoyne-Allen
pballen@ashto.org

NCHRP Review of A-01

Reviewed By:

Ann M. Hartell
ahartell@nas.edu

Comments:

The proposed research will develop communications pieces and that can be widely adopted and used by state departments of transportation for use within their agencies and with external stakeholders. The variation in how state DOTs address active transportation in their organizational structures, processes, and programs may pose a

challenge to the widespread adoption and use of a communications toolkit created at the national level for use by individual states.

The development of communications materials for a single, specific audience type would require a budget in the range of \$250,000. To include work to assess the effectiveness of the messages by testing them with a sample from that audience, the budget should be further increased by \$150,000 for each category of audience and an additional 8 to 12 months to the period of performance. Development of a toolkit to address multiple audiences would likely require additional funding and time.

Review Date:

12/15/2021

FHWA Evaluation of A-01

Reviewed By:

Darren Buck/HEP

Comments:

We see benefit in the research proposal. This resource could potentially help transportation practitioners to communicate the value of investing and maintaining active transportation facilities to elected and appointed officials in their communities. The proposal should be expanded to highlight how Complete Streets and Networks implementation can help create active transportation opportunities. The author references the CDC's active transportation definition but should also acknowledge USDOT's content on this subject <https://www.transportation.gov/mission/health/active-transportation> which provides additional information on the benefits of active transportation. Further, a glossary of standardized terms in the research would be beneficial, beyond providing a standardize definition of "active transportation." More information is also needed on how the toolkit would be used in practice. The research objective should clearly describe if the desired outcome is to produce a standalone research document to supplement active transportation training materials or if the toolkit is the training tool.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for A-01

Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: N/A

Comments:

This research is a low to medium priority for the committee.

Submitter Response for 2023-A-01Comments:

- This toolkit would assist the state DOTs with strategic messaging and framing.
- The Council appreciates comments from FHWA and NCHRP and recommends that the comments be considered for inclusion in the project scope by the project panel.
- This project could also be funded through NCHRP 20-123.

Contact Info:

Bud McDonald
bmcdonald@ashto.org

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-A-02

Problem Title

Enterprise Data Warehouse Implementation Guide

Background Information and Need For Research

As part of a robust data governance strategy, agencies must decide how to best manage storage, access, and dissemination of data products and services both for internal use/reuse and external distribution within its data architecture. An important piece of a modern data architecture is an enterprise data warehouse, which, conceptually, will provide a way to reduce data redundancy, improve data consistency, and enable data usage for better decisions. Effective implementation of a data warehouse is complex, especially when an entity has highly diverse data sets and technology infrastructure. Thus, DOTs will benefit greatly from guidance on how to best architect and implement an enterprise data warehouse strategy that will meet diverse business needs while remaining performant, however, the industry lacks a guidebook on how to develop and implement a comprehensive data warehouse for a DOT.

The guidance should cover the complete set of functional requirements such as, but not limited to, federation (aggregating from multiple sources), data extract-transform-load (ETL) and extract-load-transform (ELT), storage, naming convention, structure (model), roles and responsibilities, web services, data publishing processes, access by third-party applications, and records management. Additionally, any conventions, models, and structure promoted by the guideline will need to support and align with standard frameworks used in transportation such as Industry Foundation Classes (IFC) to the greatest extent practical.

Literature Search Summary

The value of data warehouses for transportation has been in discussion since 1997 and the practice has continued to be developed and refined for specific business needs. However, the guidance has thus far been piecemeal, there is no whole guidebook on how to develop and implement a comprehensive data warehouse for a DOT.

In late 1990s to early 2000s development of data warehouses in DOTs included one focused on supporting a single business unit for a programming and scheduling data mart that included recommended approaches and another with a broader scope of transportation data and an “analytical toolkit” that included a discussion of business requirements and the resultant design approach.

During the more recent past, literature on data warehousing in the transportation realm has included design options for electric mobility, basic design needs for a maritime data

warehouse , a regional data warehouse to support a real-time incident detection system, and a state-focused data warehouse designed for analyzing traffic safety improvements/advancements using eight integrated data sources related to health/medical, traffic incidents, driving records, court records, and census data, etc. Notably, none of the these reports reference detailed guidelines that could be leveraged by a DOT to develop and implement a comprehensive data warehouse for the entirety of an agency's data.

One recent research report evaluated open data portals for the “quality of data, ease of use, and availability of metadata” across many transportation agencies and found wide variations that highlighted the need for DOTs to improve data management and access to a more standardized and accessible benchmark for “ubiquitous audience”. The report highlighted the best evaluated portal and its qualities but did not provide a guide for replicating the portal.

Finally, a NCHRP report on the effect of digitization on DOTs, which included a DOT survey, published in 2020 highlighted the need for new research or synthesis on “best practices of enterprise data warehouse management”.

Research Objective

This research is intended to develop a guidebook on data warehouse implementation to support efficient use, sharing, and reporting of data and address transportation agency business needs. The deployable product from this research is a best practice guide for departments of transportation (DOT) to use in guiding the development and implementation of an enterprise data warehousing strategy that encompasses data in structured (tabular), semi- or un-structured (non-tabular), and geospatial file formats (includes geometry).

This study should broadly consider the needs of the state DOTs and provide guidance to assess data warehouse opportunities across the business needs within an organization and the strategies used to develop, implement, and integrate the use of data warehouses. It is expected that the guidance will address data in structured (tabular), semi- or un-structured (non-tabular), and geospatial formats.

The product should provide guidance on:

- Strategies to assess current data warehouse capabilities and opportunities.
- A glossary of terms that provides definitions of terms and operating procedures keeping in mind diverse operational contexts in different state DOTs.
- Identification of essential data warehouse capabilities (input, access, cybersecurity/permission management, privacy, data quality, etc.)
- The data management strategies and technology needed to provide capabilities for the development and implementation of data warehouses.
- Factors critical for the adoption of data warehouses by agencies and the business functions the warehouse supports. This is anticipated to include surveys or interviews with state DOT Chief Data Officers or equivalent, as well as business domain experts for defining reporting and analytical requirements.

Urgency and Potential Benefits

Data resources have been developed by independent business areas to meet their needs that has often resulted in data silos and challenges in data access for analysis and/or effective and timely decision making. Business practices have evolved to become more interdisciplinary which is increasing the need to access data across business units. Data warehousing provides a cost-effective strategy to align and access cross-organization data resources. Data warehouses support efficient analysis and reporting by providing a single and stable source of integrated data that is commonly needed by decision makers. With limited resources for data management, data warehouses provide a cost-effective means to support the multifaceted needs of our state DOTs.

Benefits of data warehousing includes:

- Daily decision making is positively impacted by improving data quality and increasing accessibility and security through using inventory best practices.
- Improve organizational productivity through improved interoperability of data and automation of common analysis and reporting activities.
- Value is realized through time and cost savings to agencies by providing guidance on enterprise data warehouse strategies that can be quickly applied to improve the current state of data, rather than duplicating efforts with multiple or unknown outcomes.
- Sharing data across business units and agencies will be timelier and more efficient through adopting common standards.
- Build and maintain a historic record of agency data that is separate from operational data stores that are highly dynamic.
- Improve efficiency of design and implementation of collaborative efforts such as the AASHTOWare product portfolio.
- Enable development of common performance metrics

Implementation Considerations

Each state DOT needs to manage its information systems within their state requirements. This guidance will provide useful information for agency policy and procedure to support their strategies for data warehouse development and management.

To support implementation, research activities and products will be shared through:

- The AASHTO Committee on Data Management & Analytics meetings, forums, webinars, and website
- The TRB Standing Committee on Statewide/National Transportation Data and Information Systems
- The TRB Standing Committee on Information Systems and Technology
- AASHTO GIS-T symposium, ITE conference, and USDOT meetings and webinars
- Outreach to other AASHTO committees that would benefit from the guide

Recommended Research Funding And Research Period

Recommended Funding: \$350,000

Research Period: 18 months

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Buffy Conrad, Enterprise Data Governance Manager, Maryland State Highway Administration, BConrad@mdot.maryland.gov, 410-545-8405

Leni Oman, Knowledge Strategist, WSDOT, omanl@wsdot.wa.gov, 260-705-7974
Michael Pipp, Chief Data Officer, Montana Dept. of Transportation, mipipp@Mt.gov, 406-444-6060

Jack Dartman, Supervisor/Architect, Montana Dept. of Transportation, jdartman@mt.gov, 406-444-7937

Chad Baker, Geospatial Data Officer, Caltrans, chad.baker@dot.ca.gov, 916-247-1625

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

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Jack Dartman, Supervisor/Architect, Montana Dept. of Transportation, jdartman@mt.gov, 406-444-7937

Chad Baker, Geospatial Data Officer, Caltrans, chad.baker@dot.ca.gov, 916-247-1625

Denis Whitney-Dahlke, Strategic Data Program Manager, Oregon Department of Transportation, Denise.D.WHITNEY-DAHLKE@odot.state.or.us, 971-719-6274

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Chad Baker, Geospatial Data Officer, Caltrans, on behalf of the AASHTO Committee on Data Management and Analytics, chad.baker@dot.ca.gov, 916-247-1625

NCHRP Review of A-02Reviewed By:

Sid Mohan
smohan@nas.edu

Comments:

This is an important topic, and will complement completed and soon to be completed NCHRP research on data. However, the scope may be too broad and complex to fit the proposed budget and time frame. Understanding and documenting current data warehousing practices across the states will require a significant amount of time and budget on its own. The best practices guide, as proposed, would require even more engagement with states, AASHTO committees, and other stakeholders for it to be truly useful to a broad spectrum of potential users. Would recommend an increase in budget and time to \$450,000 and 24 months to fulfill the current scope.

Review Date:

12/13/2021

FHWA Evaluation of A-02

Reviewed By: N/A

Comments: N/A

AASHTO Committee Evaluation for A-02

Submitted By:

Chad Baker

Research Subcommittee Chair

Data Management and Analytics

Priority #: 1

Comments:

I can see great benefits in providing states this guidance. Efforts in La. make use of the GIS architecture for warehousing data. The challenge has been getting siloed data systems to come forward and embrace the 'one source' mentality. Integrating data systems like those in the AASHTOWare catalog could advance these efforts.

Submitted By:

King Gee

AASHTO staff

Knowledge Management

Priority #: 5

Comments:

The work conducted by transportation agencies is increasingly multidisciplinary, increasing the need to use data across programs within a state DOT. Data warehouses provide a way to efficiently access data from across the organization by developing

reporting tools for common/repetitive needs. This research would provide useful guidance to develop data warehouse practices and improve access to core agency knowledge and information assets. This research would provide useful guidance to develop data warehouse practices and improve access to core agency knowledge and information assets.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-A-03

Problem Title

Future Equity Impacts of Existing Fuel Taxes

Background Information and Need For Research

The current fuel tax mechanism for funding transportation will likely remain in place for years to come, despite some movement toward future implementation of a mileage-based fee. As a fixed per-gallon fee, the federal fuel tax represents a larger share of income the less a payer makes. This research will explore how this disparity may widen as the vehicle fleet becomes increasingly fuel-efficient and alternative fuel vehicle ownership increases, including electric vehicles. This research will benefit state departments of transportation (DOTs) who depend on fuel tax revenue forecasting to allocate resources and make spending decisions. This problem statement relates to AASHTO's strategic goal of advancing equity in transportation.

Literature Search Summary

This research will build upon existing literature on public opinion on federal tax options to support transportation such as "What Do Americans Think About Federal Tax Options to Support Transportation?" (Mineta Transportation Institute, 2021), case studies on state legislation to increase transportation revenue, and research on the equity impacts of alternative funding mechanisms. What differentiates this proposed research is the objective of examining the long-term equity impacts of the current fuel tax mechanism as vehicle types and classes evolve.

Research Objective

The objective of this research is to quantify the long-term user equity impacts of our current fuel tax mechanism in order to aid state departments of transportation in revenue forecasting.

Research tasks and activities could include:

- 1) A detailed economic analysis of vehicle manufacturing and purchasing trends of new and used vehicles over the next several decades and the resulting equity impacts.
- 2) Obstacles for low-income users to access plug-in vehicle infrastructure, such as broadband, charging stations, and banking limitations, and lack of a used electric vehicle market.
- 3) Exploration of vehicle use trends for low-income users.
- 4) Development of a revenue forecasting methodology that incorporates these elements.

Urgency And Potential Benefits

Improvements in vehicle fuel efficiency are developing at a rapid pace. In addition, manufacturers are expanding production of electric vehicle models (including the upcoming Hummer EV and Ford all-electric F-series pickup). In addition, states have set ambitious goals for new electric vehicle ownership. Meanwhile, lower income drivers tend to replace their vehicles less frequently and will continue driving less fuel-efficient vehicles. The equity disparity around what proportion of an individual's income contributes to fuel costs will continue to grow under the current fuel tax structure.

Implementation Considerations

Funding and revenue departments at state DOTs are the audience for this research. They can apply the research to their long-range revenue forecasting.

The AASHTO Committee on Funding and Finance can serve as a venue to support implementation.

Recommended Research Funding and Research Period

Recommended Funding: \$450,000

Research Period: 18 months

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Linda Hull

Utah Department of Transportation

lhull@utah.gov

801-965-4000

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Members of the AASHTO Committee on Funding and Finance

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Susan Howard

AASHTO Program Director for Transportation Finance (on behalf of the AASHTO Committee on Funding and Finance)

showard@ashto.org

202-624-3698

NCHRP Review of A-03

Reviewed By:

Camille Crichton-Summers

ccrichton-summers@nas.edu

Comments:

Despite a significant amount of prior scholarly research related to fuel tax revenue, the topic continues to garner interest particularly given the introduction of advanced technologies and the renewed emphasis on equity considerations. The budget appears reasonable but the research take additional time.

Review Date:

12/17/2021

FHWA Evaluation of A-03
Reviewed By:

Ben Hawkinson/HPTS, Thor Dodson/HPTS, Patrick DeCorla-Souza/HCFB

Comments:

Ben Hawkinson, Thor Dodson - The stated research objective to quantify equity impacts in order to aid revenue forecasting are in fact two different objectives; one does not necessarily contribute to the other. We recommend removing the equity portion from the proposal since we know what will occur; as it says: "The equity disparity around what proportion of an individual's income contributes to fuel costs will continue to grow under the current fuel tax structure." Focus rather on future fuel tax receipts for State revenue forecasting. The funding level should be about \$300,000. FHWA has Highway Revenue Forecasting Model, as well.

Patrick DeCorla-Souza - In conjunction with studies on VMT fees, the equity issues with the current fuel tax system has already been explored. The author should cite this research. Secondly, it is not clear how the objectives of this research can be achieved if we do not know what VMT fee amounts will be charged to EVs. The equity impact will depend on what EVs are charged. Thus the analysis will depend on state policies going forward. Perhaps the research could consider developing a model for use in understanding the equity impacts of alternative VMT fee policies.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for A-03
Submitted By:

Susan Howard
AASHTO staff
Committee on Funding and Finance

Priority #: 1

Comments: N/A

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-A-04

Problem Title

New Mobility and the User Fee Concept

Background Information and Need For Research

New mobility services offer the potential for innovative revenue collection methods. Whether through dedicated fees or an increased reliance on sales taxes, e-commerce, drone, and other automated delivery services, transportation network companies, car sharing, and other new mobility and micromobility options offer the potential for alternative transportation user fees. States will need to explore increased contributions from these sectors because of the additional strain they put on the transportation system through congestion, travel time delays, and vehicle size and weight. This research will benefit state departments of transportation (DOTs) examining new approaches to generate revenue from sales taxes and other user fees based on new mobility options. This research will directly support the AASHTO Committee on Funding and Finance's goal of advancing educational and technical assistance initiatives on current and emerging transportation funding, finance, and financial management research topics.

Literature Search Summary

This research will build upon existing case studies on state sales tax initiatives and other fees to support transportation. What differentiates this proposed research is the objective of a comprehensive examination how new fees and structures support the user fee model that underpins our nation's transportation funding structure.

Research Objective

The objective of this research is to examine the manner in which revenue can be collected from the new mobility sector and support the user fee model.

Research tasks and activities could include:

- 1) Roadmap for state DOTs on implementing fees on new mobility and the new economy.
- 2) A detailed examination of the potential for mobility user fees beyond what is currently in place.
- 3) A forecast of new mobility and micromobility use and potential revenue collections.

Urgency And Potential Benefits

E-commerce delivery, transportation network companies, car sharing, and other new mobility and micromobility options are already changing the landscape of transportation in states and communities. As state DOTs are strive to address additional strains on the transportation network and look more holistically at transportation usage fees, this research will support an understanding of how new models for user fees can address long-term investment needs.

Implementation Considerations

Funding and revenue departments at state DOTs are the audience for this research. They can apply the research to their efforts to address revenue challenges.

The AASHTO Committee on Funding and Finance can serve as a venue to support implementation.

Recommended Research Funding and Research Period

Recommended Funding: \$450,000

Research Period: 18 months

PROBLEM STATEMENT AUTHOR(S): For each author, provide their name, affiliation, email address and phone.

Linda Hull

Utah Department of Transportation

lhull@utah.gov

801-965-4000

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Members of the AASHTO Committee on Funding and Finance

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Susan Howard

AASHTO Program Director for Transportation Finance (on behalf of the AASHTO Committee on Funding and Finance)

showard@ashto.org

202-624-3698

NCHRP Review of A-04

Reviewed By:

Trey Joseph Wadsworth

twadsworth@nas.edu

Comments:

The proposed research could be valuable to DOTs and other transportation agencies looking to understand revenue opportunities and implications with emerging transportation technologies. However, there is a risk that this research could veer too closely to policy recommendations and would have to be carefully guided to avoid that. The suggested timeline seems reasonable.

Review Date:

12/13/2021

FHWA Evaluation of A-04

Reviewed By:

Thor Dodson/HPTS, Ben Hawkinson/HPTS, Patrick DeCorla-Souza/HCFB

Comments:

Thor Dodson, Ben Hawkins - We are unsure of the need for this research. Drones and "other automated delivery services" don't use surface infrastructure, and the other examples (car sharing/TNCs) already pay a fuel tax. Looking at user fees for micro-mobility options would be helpful. Could look at how new modes benefit from and make use of the system to develop a reasonable user fee. Should the new modes be taxed/subsidized based on the externalities they increase/reduce? For instance, drones would have substantial impacts on air space use, noise, privacy, and potential collisions with buildings, powerlines, etc. Is the study looking to see how much they should charge new modes or how they should charge new modes? For the research objective of supporting the user fee model the methodology of the Highway Cost Allocation Study may be useful. We suggest including a look at what, if anything, foreign countries are doing.

Patrick DeCorla-Souza - There is some literature on fees charged to TNC trips in several big cities that could be cited.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for A-04

Submitted By:

Kyla Elzinga
AASHTO staff
AASHTO Committee on Planning

Priority #: 8

Comments: N/A

Submitted By:
Susan Howard
AASHTO staff
Committee on Funding and Finance

Priority #: 2

Comments: N/A

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-A-05

Problem Title

Knowledge Strategies to support the Research Lifecycle and Application of Research Results

Background Information and Need For Research

The transportation practice is constantly evolving. Research is conducted to help understand and apply new concepts or modifications to existing practices. But adoption and implementation of research results and innovation can seem slow, and the potential benefits may not be fully realized. It can be difficult to trace a transportation research concept from idea to use, some challenges include:

- problem statement authors may not know if the project is funded
- titles change making it harder for people to follow the progress of a project
- for one or two years, there is little communication about the projects underway
- champions may change jobs or retire and awareness of the project fades
- there are limited venues for marketing products
- there are multiple repositories of information about research but no single portal
- the volume of information available is daunting to digest

As a result, problem statements are pitched for topics that have recently been funded, studied, or have projects underway and research results may be untapped.

The transportation research community has invested a significant amount of effort to support implementation of research results. The efforts have included practices to incorporate implementation expectations in problem statements, contracts, and reports; studies on how to communicate research results and practices to document the value of research; and surveys to capture the use of research products. But adoption of research findings is still slow, and some are concerned that the value of research isn't commensurate with the investment in research. This impacts the transportation sector as a whole.

The slow adoption of applied research findings in the implementation phase is not unique to the transportation sector. The National Institute of Health has established the National Center for Advancing Translation Science to advance what is called knowledge translation as a practice that "transforms the translational process so that new treatments and cures for disease can be delivered to patients faster". The National Institute for Health describes knowledge translation science as "focused on streamlining the process of moving ("translating") ... findings into ... practice". Developed out of necessity due to a human health science environment closely intertwined with rigorous FDA oversight and approval processes, the practice of knowledge translation maps the

lifecycle from research idea to implementation and evaluation of the products, through adoption in real world communities.

An example of the knowledge translation lifecycle is provided in Figure 1. The Canadian Institutes of Health Research (CIHR) identified six opportunities within the research cycle at which the interactions, communications, and partnerships that help facilitate knowledge transfer might occur. The six opportunities are listed below. This is only one example of a knowledge translation cycle model. The product of this research request should be built to reflect typical context and patterns found in the transportation sector.

KT1: Defining research questions and methodologies

KT2: Conducting research (as in the case of participatory research)

KT3: Publishing research findings in plain language and accessible formats

KT4: Placing research findings in the context of other knowledge and sociocultural norms

KT5: Making decisions and taking action informed by research findings

KT6: Influencing subsequent rounds of research based on the impacts of knowledge use

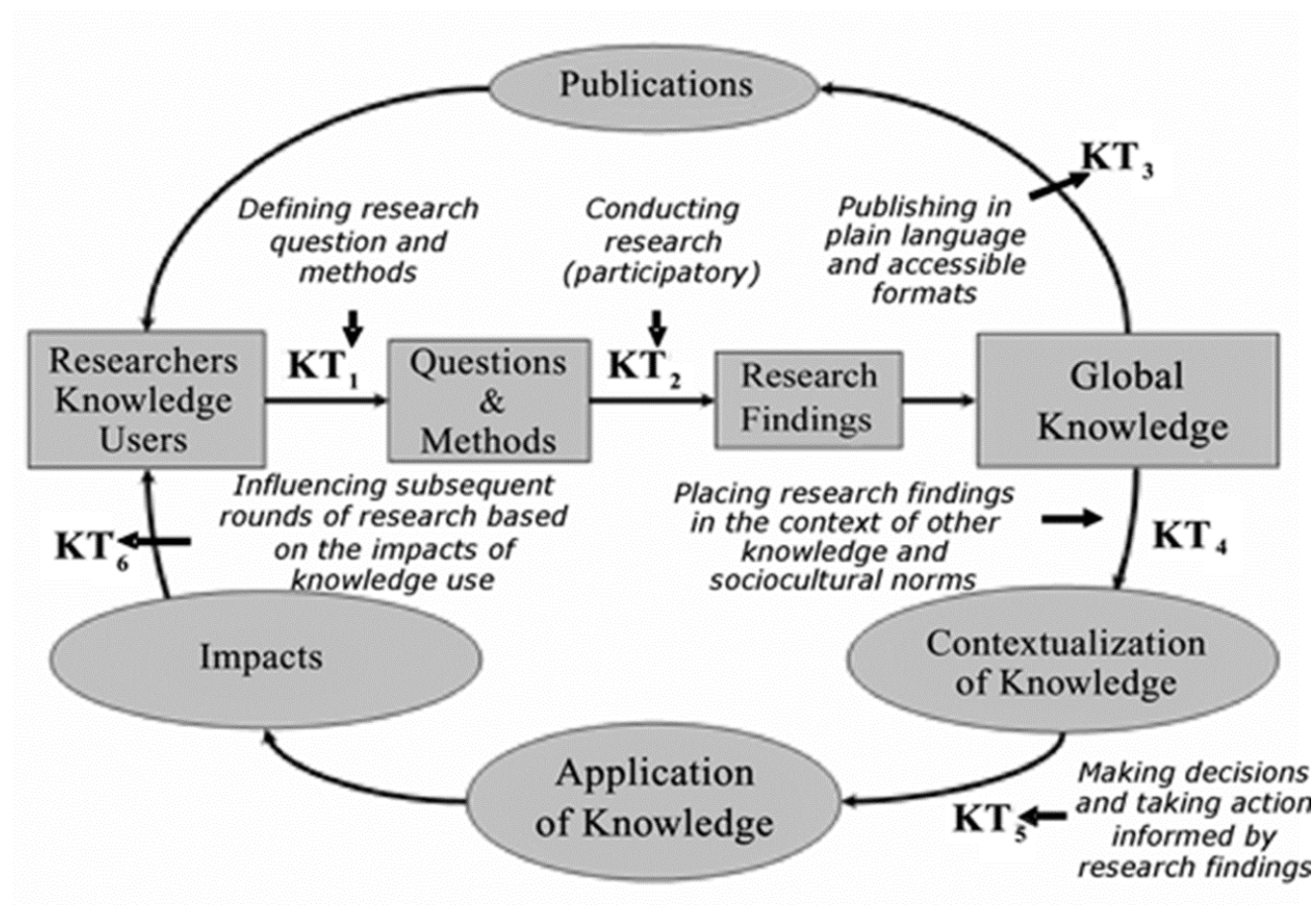


Figure 1. The CIHR 2005 Model and six opportunities for Knowledge Translation (KT)

Knowledge translation emphasizes the engagement with stakeholders that are closely involved in the target implementation community in order to achieve effective adoption of research. Knowledge translation also expands the traditional research lifecycle to include feedback to researchers at each stage of the process, and particularly from community adoption. This continual feedback helps researchers and developers improve projects, services, explanations, and adaptations for current and future work. An effective knowledge translation cycle helps foster nimble organizations that can respond more quickly to disruptions in practice, use of emerging technology and practice, and changing policy.

This research will examine the concepts of the knowledge translation lifecycle, compare it to the transportation and transportation research life cycles, consider how current practices in transportation align with knowledge translation practices and identify common gaps and opportunities that could streamline and enhance the adoption of research and emergent practice in the field. The research will focus on theoretical and applied transportation research that is generated in any stage or function of the transportation life cycle (e.g., policy setting, planning, programming, design, budget development, etc.) and how we can use that to increase the speed of research adoption.

Literature Search Summary

There is a fair amount of literature in TRID about communicating the value of research, the value of research, research implementation, moving research to practice, and evaluating, measuring the value of research. However, these reports lack an analysis of the lifecycle of research ideation to use and information on how to engage and sustain connections with the communities intended to use the results of research and innovation. This research is intended to investigate the lifecycle and strategies to improve the adoption, timeliness, and value of research, innovation, and new practice. It is a reasonable approach in the context of the transportation life cycle.

Research Objective

The objective of this research is to:

- Provide a guide that includes:
- The definition of knowledge translation, identification of sectors that are currently leveraging knowledge translation methods, and a summary of the current uses of knowledge translation and variations in application.
- Explanation of the knowledge translation practices, including participants, activities, and resources needed at each stage of the knowledge translation life cycle.
- A review of current state DOT practices to integrate research and new practice. This includes identifying methods used (e.g., waterfall, agile, win-win spiral, or other project management approaches) and stakeholder engagement patterns by technical discipline (e.g., roadway safety, materials research, planning research, traffic research...).
- A comparison of current methods with the knowledge translation lifecycle to identify leverage points and improvement opportunities.

- Actions to strengthen knowledge translation practices within the transportation life cycle and technical disciplines.
- Major tasks likely included are:
- Literature review of knowledge translation that includes peer-reviewed and gray literature from within and outside the transportation practice and a review of transportation research and innovation implementation and adoption practices.
- Interviews and/or surveys of state DOTs about research and innovation implementation and adoption practices. This may include state DOT research managers, change management practitioners, and subject matter experts that help communicate and implement research practice.
- Review of current feedback pipelines in the transportation life cycle, and an exploration of researcher acceptance and adoption of feedback.
- Inventory of types of outcomes and outputs that might be generated throughout the KT life cycle to raise awareness and demonstrate value.
- Interim reports that summarize the findings from literature, surveys, interviews, analysis of state DOT practice with knowledge translation practices, and draft guidance.
- Development of a tutorial on knowledge translation life cycle and its stages for the transportation research community.
- A final guide, knowledge translation lifecycle map, tutorial, and outreach materials.

Urgency and Potential Benefits

State DOTs are in a period of significant transformation increasing the need to be nimble. But integration of research and innovation can be very slow. Research investments and new practices are scrutinized for the status of implementation and return on investment, and the delay in integration causes concern. This project is urgently needed to help state DOTs understand the activities required to speed delivery of research findings and new practices. This project will increase the value and adoption of transportation research and innovation to stakeholders.

Implementation Considerations

Primary recipients of the results are the AASHTO Committee on Knowledge Management, AASHTO Research Advisory Committee, TRB Standing Committee on Information and Knowledge Management, and TRB Standing Committee on Research, Innovation, and Implementation Management. It is anticipated that the research results will identify current strengths and weaknesses in the research/knowledge translation lifecycle and potential improvements.

This research will also be useful to other AASHTO and TRB Committees actively using research in this practice such as roadway safety, pavements, bridges and structures, and operations. To facilitate awareness and use of these research results, outreach efforts should include the research coordinators for AASHTO committees and the TRB Committee Research Coordinators and Committee Communication Coordinators.

Outreach materials for this project should include:

- A handout about the project and project objectives at the beginning of the project to help raise awareness.
- As much as practicable, engagement, such as a community of practice, with the primary recipients and other interested people throughout the project to maintain awareness and provide input to the researchers.
- Final products including the research report, webinars, and a short actionable strategy that guides users through steps to support knowledge translation.

Recommended Research Funding and Research Period

Research Funding: \$400,000 (\$300,000 for the research objectives, \$100,000 for outreach)

Research Period: 24 months

Problem Statement AUTHOR(s): For each author, provide their name, affiliation, email address and phone.

Leni Oman, Washington State DOT, 360-705-7974

Dr. Denise Bedford, Georgetown University, 301-787-5257,
db233@georgetown.edu

Matt Miller, Texas Transportation Institute, 512-407-1157, mmiller@tamu.edu

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Matt Miller, Texas Transportation Institute, 512-407-1157, mmiller@tamu.edu,
Representative of the of the AASHTO RAC Coordination and Collaboration Task Force

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Leni Oman, Washington State DOT on behalf of the AASHTO Committee on
Knowledge Management
360-480-5437
omanl@wsdot.wa.gov

NCHRP Review of A-05

Reviewed By:

David M. Jared
djared@nas.edu

Comments:

An NCHRP synthesis might be conducted first to determine if sufficient resources on knowledge translation are available to apply to a transportation context. If so, the synthesis could provide a foundation for an NCHRP project to develop guidelines on the

knowledge translation life cycle and its stages for the transportation research community.

Review Date:
12/9/2021

FHWA Evaluation of A-05

Reviewed By:
Jeff Zaharewicz, HIT

Comments:

This is a good problem statement that addresses a clear challenge.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for A-05

Submitted By:
Bud McDonald
AASHTO staff
Agency Administration Managing Committee

Priority #: N/A

Comments:

Support.

Submitted By:
Bud McDonald
AASHTO staff
Committee on Civil Rights

Priority #: N/A

Comments:

Support.

Submitted By:
Chad Baker
Research Subcommittee Chair
Data Management and Analytics

Priority #: 13

Comments: N/A

Submitted By:

King Gee
AASHTO staff
Knowledge Management

Priority #: 1

Comments:

State DOTs are constantly evolving but the practice to adopt research results and other innovations can be slow. This project investigates the life cycle from ideation to implementation. It will augment research implementation and tech transfer products by incorporating more of the 'human factors' that can prepare for and facilitate adoption of new practices. The product of this research request should be built to reflect typical context and patterns found in the transportation sector. Defining research questions and methodologies. Conducting research (as in the case of participatory research). Publishing research findings in plain language and accessible formats. Placing research findings in the context of other knowledge and sociocultural norms. Making decisions and taking action informed by research findings. Influencing subsequent rounds of research based on the impacts of knowledge use.

Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: N/A

Comments:

This seems like an issue that is slowing the progress of advancing research results. It might be part of a broader topic on how to get the message out out new research results, how to make the research more practical, and how to complete research quicker. This might be related to A-13. This research is a low to medium priority.

Submitter Response for 2023-A-05

From:

[email: omanl@wsdot.wa.gov]

Comments:

We appreciate the feedback on the problem statement and opportunity to reply to comments.

Our review identified a substantial body of work on this topic. WorldCat (the world's largest library catalog) lists close to 18,000 items on knowledge translation. Scholarly databases include a number of documents on knowledge translation: EBSCO Host has 3,073 results. Web of Science has 6,360 results. ProQuest had 16,448 results. This practice has been used extensively in health care and education to improve the application of research and innovation and improve outcomes. A review of transportation literature identifies about 200 documents, some addressing the health care transportation interface. These provide a good resource for a literature review to begin this research project. There are also relevant materials in the transportation sector that address elements of knowledge translation that will help examine the gaps in the transportation sector's current knowledge translation capabilities.

The transportation sector has been seeking to increase the speed of research implementation for several years with only focused improvements. Knowledge translation provides a new perspective on this to consider the human and organizational aspects of implementation along the development lifecycle. This project, if funded, provides the opportunity to examine the lifecycle from idea to implementation to identify weaknesses and opportunities for intervention to improve adoption.

Contact Info:

Leni Oman, omanl@wsdot.wa.gov, 360-480-5437

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-A-06

Problem Title

Lessons learned from two decades of knowledge management

Background Information and Need For Research

Knowledge management is rooted in the work of management thought leaders such as Peter Drucker and W.E. Deming. In 1968, Drucker identified knowledge as the central capital of the economy. By 1990, knowledge management as a practice began to emerge simultaneously with the technology boom. Since then, knowledge management has continued to evolve in support of business practices and the need to address complex, multidisciplinary, and multi-organization knowledge flows.

The transportation sector began to take note in the 1990s. In 1998, the Federal Highway Administration initiated a Knowledge Sharing Initiative to examine the use of communities of practice. State departments of transportation began to explore knowledge management in early 2000s such as a study of knowledge management technologies by Kansas DOT and the creation of a Knowledge Management Division at Virginia DOT. Since then, several state DOTs and USDOT Administrations have implemented knowledge management activities including AK, CA GA, KS, KY, MD, ME, MN, PA, TX, UT, VA, VT, WA, WI, FAA, FHWA, FTA, and Volpe. Research projects on knowledge management have been conducted by ACRP, TCRP, and NCHRP and several journal articles and papers have been written addressing knowledge management in various disciplines.

Despite the number of activities and substantial body of information on the use of knowledge management in transportation, awareness of the practice remains limited. This research project proposes to follow up with the organizations that conducted initiatives and studies to learn about the value of the practices on their work and document lessons learned. This information will help state DOT's develop actionable strategies for deploying knowledge management.

Literature Search Summary

A literature search of knowledge management in the transportation sector identified over 400 publications including research reports, journal articles, and news articles. Fifteen state DOTs 15 state DOTs were represented in the literature. Papers also addressed knowledge management in support of pavement management, transit, airports, marine transportation, railroads, and traffic operations. There is a wealth of information to use as a foundation for this study.

Research Objective

This study seeks to extract lessons learned for the early knowledge management activities conducted in the transportation sector. It is anticipated that this project will:

1. Conduct a literature review to identify types of work conducted, the organizations that implemented them, and subject/discipline in which knowledge management was implemented.
2. Follow up with the organizations involved to learn whether the knowledge management practice has persisted and gather lessons learned from implementation.
3. Review the feedback, summarize factors that contributed to the success or demise of the practice, extract lessons learned, and prepare case studies that illustrate common themes derived from the review.
4. Prepare a report and outreach materials.

Urgency and Potential Benefits

State DOTs are losing institutional knowledge due to retirements and employee churning. Many state agencies are trying to quickly develop knowledge management practices but have limited resources for the effort. Reading the large body of information requires more time than staffing levels permit. This project will provide state DOTs an efficient way to use the work that has been done and to develop actionable strategies with a higher probability of success.

Implementation Considerations

The products of this work will be useful for all disciplines within the transportation sector. It is anticipated that the AASHTO Committee on Knowledge Management, the TRB Standing Committee on Information and Knowledge Management, state DOT leads will help champion the products and within their organization and with other committees and disciplines. In addition, it is expected that the technical disciplines represented in the literature will be interested in the findings and the AASHTO Committee on Knowledge Management will help facilitate this outreach.

Recommended Research Funding And Research Period

\$250,000 - \$175,000 for research, \$75,000 for outreach and implementation support.
18 months

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Leni Oman, Knowledge Strategist, Washington State Department of Transportation,
omanl@wsdot.wa.gov, 360-705-7974

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Representatives from the AASHTO Committee on Knowledge Management, TRB Standing Committee on Information and Knowledge Management

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Leni Oman, Knowledge Strategist, Washington State Department of Transportation,
omanl@wsdot.wa.gov, 360-705-7974 on behalf of the AASHTO Committee on
Knowledge Management

NCHRP Review of A-06

Reviewed By:
David M. Jared
djared@nas.edu

Comments:

While this research might be worthwhile to conduct at some point, it overlaps considerably with four pending NCHRP projects: NCHRP 23-14, which is aimed at identifying KM research gaps and how to address them; and 23-17, 23-18, and 23-21, which investigate, respectively, the business value of KM, incorporation of KM into business practices, and how to strategically foster KM with agencies. All four of these 23- series projects include reviews of past experiences, including successes and roadblocks. A holistic study might be better deferred and build on the outcomes of these pending projects.

Review Date:
12/9/2021

FHWA Evaluation of A-06

Reviewed By:
Carin Michel, HIT

Comments:

This is a good problem statement that addresses a clear challenge.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for A-06

Submitted By:
Bud McDonald
AASHTO staff
Agency Administration Managing Committee

Priority #: N/A

Comments:

Support.

Submitted By:

Bud McDonald
AASHTO staff
Committee on Civil Rights

Priority #: N/A

Comments:

Support.

Submitted By:

Chad Baker
Research Subcommittee Chair
Data Management and Analytics

Priority #: N/A

Comments:

Should/could this be submitted as a synthesis topic instead?

Submitted By:

King Gee
AASHTO staff
Knowledge Management

Priority #: 2

Comments:

While knowledge management (KM) seems new to the transportation sector, transportation innovators have been researching KM for at least two decades. This research will investigate how previous research has been implemented, results achieved, and lessons learned that can help advance the KM practice. KM research after action review.

Submitter Response for 2023-A-06From:

[email: omanl@wsdot.wa.gov]

Comments:

Thank you for your review and comments on our problem statement and the opportunity to reply.

The AASHTO Committee on Knowledge Management appreciates the research resources that have been provided to help develop the application of knowledge management (KM) in the transportation sector. Our problem statements are modeled on those used by other business areas such as performance management, highway safety, and asset management in order to provide:

- understanding and developing knowledge management (20-68A scan 12-04 Report, NCHRP Report 813, NCHRP 23-18, NCHRP 23-14),
- techniques for implementation (NCHRP 23-02,20-24 (131), NCHRP 20-24 (141), NCHRP 23-27, NCHRP 23-21)
- methods to measure the value of knowledge management (NCHRP 23-17)

The current proposal is different. It examines the knowledge management interests within multiple transportation business practices. Specifically, it will collect information on whether previous research findings have been implemented and the value derived from this work. This examination will provide insight for deployment of future KM research findings. This information will be useful for all the studies mentioned above but it is also a standalone activity that will inform a KM implementation strategy, quell the concern that KM is new or unnecessary, and help align the interests of KM practitioners with the interests of transportation business functions.

Though one reviewer notes that current projects include review of past experiences, the CRP research reports cited in our literature search have not consistently appear in the literature summaries of previous or active CRP projects on KM. This in itself may be an interesting case study for knowledge translation.

Contact Info:

Leni Oman, omanl@wsdot.wa.gov, 360-480-5437

Review Date:

February 3, 2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-A-07

Problem Title

Assessing Financial Risk at the Program and Enterprise Levels

Background Information and Need For Research

Financial risks can threaten the strategic objectives of transportation agencies - e.g., the safe and reliable and efficient movement of people and goods. For example, the Highway Trust Fund is tied to taxes on gas and diesel. However, the recent COVID-19 pandemic greatly reduced American consumption, thus dramatically reducing revenues. State DOTs have seen their budgets slashed by 30% or more, forcing delays in some projects. Furthermore, external mandates can impose both risks and opportunities. A well-funded mandate could mean state DOTs have additional funding for enhancing resilience, while an unfunded mandate could force a DOT to choose between maintenance and projects. The objective of this project is to help transportation leaders with decision-making tools for allocating limited resources when subjected to unpredictable financial conditions.

Literature Search Summary

This research need was recommended and prioritized through multiple stakeholder engagements during the 20-123 project. No related literature was found that incorporated financial risk at the enterprise and program levels. In addition, the recent COVID-19 pandemic highlighted the consequences of income and financial instability in transportation agencies.

The importance of incorporating risk at the enterprise and program levels has been recognized, and AASHTO published a guide summarizing how DOTs can establish and benefit from an enterprise risk management (ERM) program (AASHTO Guide for Enterprise Risk Management, 2016). This guide divides risk into four levels: enterprise, program, project, and activity. Risks to the enterprise are identified as the risks that affect the organization and its strategic objectives; while risk to the program includes risks that are “common to group of projects that achieve strategic goals” or those that “could affect the performance of major programs such as safety, pavements, bridges, maintenance, information technology, local programs, project delivery, finance, and human resources”. The guide provides an overview on what enterprise risk management is, highlights the benefits, and also includes information of how to identify, assess and manage those risks. However, further guidance and methodologies on how to assess and manage financial risks at the enterprise and program levels are still needed.

Research Objective

The purpose of the proposed research project is to provide state DOTs with the necessary tools to assess and manage financial risk at the enterprise and program levels.

The specific research tasks to accomplish the main objective include:

- Task 1 – Conduct an in-depth literature review of all studies related to assessment and management of financial risks in transportation agencies, especially at the enterprise and program levels, including national and international examples as available.
- Task 2 – Conduct a gap assessment of the state of practice to determine what is still needed to incorporate financial risk at the enterprise and program levels.
- Task 3 – Develop a methodology for identifying and quantifying financial risks at the enterprise and program levels.
- Task 4 – Develop metrics and performance indicators for evaluating effectiveness of financial risk countermeasures.
- Task 5 – Develop decision-making tools for resource allocation under conditions of financial uncertainty.
- Task 6 – Develop methodology and guidance on consideration of program and potentially project-level financial risk within the enterprise.
- Task 7 – Pilot test the developed processes with multiple state DOTs and revised methodology as needed.
- Task 8 – Develop an implementation guide to help state DOTs to incorporate these processes into existing agency programs and projects.

Urgency and Potential Benefits

The recent COVID-19 pandemic greatly reduced American consumption, thus dramatically reducing revenues. State DOTs have seen their budgets slashed by 30% or more, forcing delays in some projects and reductions in workforce. A well-funded mandate could mean state DOTs have additional funding for enhancing resilience, while an unfunded mandate could force a DOT to choose between maintenance and projects. Not having the necessary funding for certain programs or projects may have a short or long term negative impacts on agency mission (e.g., lack of funding to continue or improve safety programs).

This project aims to provide transportation leaders with the necessary decision-making tools for allocating resources when subjected to unpredictable financial conditions in order to reduce risks and increase the return on investment (ROI).

Implementation Considerations

In order to implement financial risk assessments at the enterprise level, senior executives and policy makers need to take the lead and champion these initiatives. Similarly, program managers need to take the major role on encouraging the implementation of financial risk assessments into program level. It is key that senior executives, policy makers and program managers need to have a communication plan to communicate with peers on their areas in order to assess the

financial risks to multiple programs and/or projects that may affect each other. In addition, providing staff training on the subject of financial risk, especially at the enterprise and program levels, is a key factor on successful implementation. Training material (including guidance, workshops, peer exchanges, etc.) to help implementation champions should be developed and used to create awareness and facilitate assessments.

Recommended Research Funding and Research Period

The estimated total funds needed to accomplish the research objectives are roughly \$400,000-\$500,000. Any initial activities designed to facilitate the communication and implementation of key research products would roughly be \$50,000.

The timeframe to complete the research for this project is estimated to be 18-24 months of work. In addition, the amount of time needed to engage in communication and implementation activities is roughly 12 months.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

This problem statement was developed under NCHRP 20-123(4) Development of a Risk Management Strategic Plan and a Research Roadmap. The primary authors on the consultant team included:

- Mara Campbell, Jacobs, mara.campbell@jacobs.com, (573) 353-0253
- Joe Zissman, Cambridge Systematics, jzissman@camsys.com
- Maria Pena, AEM, maria.pena@aemcorp.com,

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Please contact Matt Hardy, AASHTO Program Director for Planning and Performance Management, for a list of recommended panel members representing the AASHTO Committee on Performance-Based Management.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Matthew Hardy

202-624-3625

mhardy@ashto.org

Affiliation: AASHTO staff on behalf of the AASHTO Committee on Performance-Based Management, Tim Henkel, Chair.

NCHRP Review of A-07

Reviewed By:

Leslie C. Harwood
LHarwood@nas.edu

Comments:

This project would address a pressing need for state DOTs. The objective of this problem statement is clear and a budget of \$500,000 is appropriate to perform this work. The estimated \$50,000 for initial implementation seems to be included in the \$4-500,000 estimate and I believe if funded at \$500,000, this project could successfully include those activities. There is some overlap between this project and A-08; I suggest that if A-08 is funded, that this project not be funded and instead it be included in the A-08 portfolio of projects.

Review Date:

12/17/2021

FHWA Evaluation of A-07
Reviewed By:

Stephen Gaj, HISM-30

Comments:

Many States have identified financial risks as one of their priorities in their asset management plans. FHWA has addressed this issue to some degree in their handbooks pertaining to risks and financial planning ; however, work is needed in how States can better apply this information as they develop their TAMPs and their investment strategies. This is an important project in advancing the management of infrastructure.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for A-07
Submitted By:

Matthew Hardy
AASHTO staff
AASHTO Committee on Performance-Based Management

Priority #: 5Comments: N/A

Submitted By:

Susan Howard

AASHTO staff
Committee on Funding and Finance

Priority #: N/A

Comments:

Given the uncertainty of future federal funding, dwindling motor fuels tax base, uncontrolled inflation, and lack of political will, this research could be useful to help prepare state DOT's to manage program and project level risk. Preference for focus at program/project level instead of more broadly at the enterprise level.

Submitted By:

Chad Baker
Research Subcommittee Chair
Data Management and Analytics

Priority #: 9

Comments: N/A

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-A-08

Problem Title

Development of the AASHTO Highway Asset Risk & Resilience Manual: Phase 1

Background Information and Need For Research

Background

The US experienced 308 weather and climate related disasters since 1980 exceeding \$2.085 trillion in physical losses and the loss of 14,492 lives. Between 1980-2020 the average number of billion-dollar events per year was 7.1, that number ballooned to 16.2 billion-dollar events per year on average between 2016-2020 (adjusted for Consumer Price Index). The most billion-dollar weather and climate related disasters occurred in 2020, with 22 billion-dollar events totaling \$246.7 billion in losses and 553 deaths. As of September 2021, the current year is looking to break the record set in 2020 having experienced 18 billion-dollar events to date (Billion-Dollar Weather and Climate Disasters: Overview | National Centers for Environmental Information (NCEI) (noaa.gov)). In addition, the recently published TRB Consensus Study on Resilience Metrics notes that 6 of the world's 10 most costly natural disasters in 2020 occurred in the United States (TRB Resilience Metrics Consensus Study, 2021). With this level of impact on the nation's infrastructure, transportation agencies need consistent methods to support decision making to address stressors such as extreme weather and climate change in planning, design, maintenance, and operations.

The TRB Resilience Metrics Consensus Study 2021 calls for the establishment of standard methods of analysis to support benefit-cost assessment to allow agencies to understand the “buy-down” of risk from capital and maintenance investments. In addition, the study calls on Congress to consider requiring that all federal funding candidate projects that involve long-lived assets requirement undergo well defined resilience assessments that account for changing risks of natural hazards and environmental conditions stemming from climate change. The proposed project will allow AASHTO and TRB to develop industry adopted standard methods of quantitative analysis in lieu of federally developed methods.

Proposed Program of Projects

A concerted level of commitment is needed to develop a single manual to serve as the “go-to” for quantitative analysis of financial risk to agency assets and the traveling public from extreme weather and climate change. Like the Highway Capacity Manual and the Highway Safety Manual, a single resource is needed to ensure consistent methods of analysis between projects and agencies, and to ensure adoption of robust quantitative methods to support benefit-cost analysis and decision making. A single manual will allow state, MPO, federal agencies to compare project investments on a level playing

field – same models, same assumptions, same thresholds of performance. A single manual will also support the instruction of how to address extreme weather and climate change in planning and engineering curriculum at Universities ensuring future Transportation Professionals are equipped with the skills needed to support the adoption of such methods into practice. Finally, a single manual will allow the incorporation of extreme weather and climate change considerations in Professional Engineering examinations to further institutionalize these concepts in future design and decision making.

This program will establish a series of individual research projects to support the development of an AASHTO Highway Asset Risk & Resilience Manual born out of NCHRP 23-09, Scoping Study to Develop the Basis for a Highway Standard to Conduct an All-Hazards Risk and Resilience Analysis and NCHRP 20-123(04) Development of a Risk Management Strategic Plan and Research Roadmap. Similar to other NCHRP research programs such as NCHRP 20-102, Impacts of Connected Vehicles and Automated Vehicles on State and Local Transportation Agencies, this is a long-term research program that will result in an industry “standard” for all-hazards risk and resilience analysis for use in design, maintenance, and planning decision-making. In addition, the program of projects will address required data sources and work to field test the Highway Asset Risk & Resilience Manual with a range of agencies as described in the following three phased approach and in the draft Research Roadmap (see last page of this document):

- Phase 1: Development of AASHTO Highway Asset Risk and Resilience Manual . An anticipated 3-year phase consisting of multiple projects and costing approximately \$3,500,000. Year 1 estimated to cost \$1,500,000 with years 2 and 3 estimated at \$1,000,000 each. There would be multiple projects under this phase including four projects identified through NCHRP 23-09:
 - o Establish quantitative assessment methodology for top priority threats and assets (e.g., culverts and flooding)
 - o Develop historical data capture process quantitative analysis methods
 - o Develop quantitative resilience assessment methodology
 - o Establish performance metrics and thresholds for resilience and risk tolerance; provide guidance on reducing risk and improving resilience
- Phase 2: Implementation of Highway Risk and Resilience Manual. A 2-year, \$2,000,000 program that would implement/apply the Highway Risk and Resilience Manual to 8-10 transportation agencies. A few potential projects in Phase II are outlined here:
 - o Create internal and external agency communication and collaboration practices to incorporate Highway Risk and Resilience Manual in decision making
 - o Develop capacity building plan to identify institutional and educational needs to incorporate Highway Risk and Resilience Manual into practice
 - o Pilot test Highway Risk and Resilience Manual
 - o Identify institutional organizational and procedural (IOP) changes and implementation strategies for the successful adoption of Highway Risk and Resilience Manual

- Phase 3: Development of Tools and Resources to Support the Highway Risk and Resilience Manual. A 2-year \$1,500,000 effort to create automated, geospatial models that transportation agencies could use to implement the Highway Risk and Resilience Manual across networks or the transportation system.
 - o Develop stand alone, open source computer script that can work within a GIS environment to automate Highway Risk and Resilience Manual calculations across multiple assets and threats in a geo-spatial setting
 - o Develop spreadsheet-based tools to automate Highway Risk and Resilience Manual calculations across multiple assets and threats in a spreadsheet application
 - o Selecting Performance Metrics for Evaluating Effectiveness of Risk Mitigation
 - o Incorporating Risk Management into Maintenance Practice
 - o Developing New Performance Metrics for Risk Management
 - o Assessing the Impact of Common Risks on Federal Reporting Metrics

Literature Search Summary

Several studies on the topic of risk and resilience have been conducted through the NCHRP Process as well as FHWA and a few state DOTs. Below is a short list of some of the more relevant NCHRP projects that speak to quantitative methods of analysis for threats to asset condition and performance as well as those that worked to provide guidance on how to incorporate such analyses into decision making processes:

- NCHRP 23-09 Scoping Study to Develop the Basis for a Highway Standard to Conduct an All-Hazards Risk and Resilience Analysis
- NCHRP 20-123(04) Development of a Risk Management Strategic Plan and Research Roadmap
- NCHRP 08-113 Integrating Effective Transportation Performance, Risk, and Asset Management Practices
- NCHRP 23-08 A Guide for Incorporating Maintenance Costs into a Transportation Asset Management Plan
- NCHRP 08-36 Task 146 Incorporating Resilience Considerations in Transportation Planning, TSMO and Asset Management
- NCHRP 20-127 – Business Case and Communication Strategies for State DOT Resilience Efforts
- FHWA – Integrating Resilience into the Planning Process
- Colorado DOT - Risk and Resilience Analysis Procedure A Manual for Calculating Risk to CDOT Assets from Flooding, Rockfall, and Fire Debris Flow

Research Objective

Transportation owners and operators are responsible for the transportation system and the delivery of a range of services and functions through the management of that system. There are inherent risks involved with the management of these systems, notwithstanding aging infrastructure, and fiscally constrained resources. Many agencies are moving toward performance-based resource allocation while simultaneously recognizing risks that may undermine their strategic goals. As these risks affect every component of a highway system to a greater or lesser extent, accurately accounting for

and addressing these risks within a highway agency's enterprise-wide management program is the goal which currently lacks analysis tools.

Investing in risk and resilience strategies and enhanced recovery to reduce or eliminate the impact of external events is also paramount to ensure a thriving, viable transportation system.

Risk management requires the identification and assessment of potential threats and hazards, asset vulnerabilities from applicable threats, an evaluation of potential mitigation actions to reduce risk, a clear and easy to implement process to prioritize mitigation activities, and investment that aligns with agency strategic and performance goals. Asset management and more recently performance management, has been an ongoing focus of many research efforts. However, guidance for analytical risk assessment methods to support risk-based asset management processes is lagging. Risk assessment processes, methods, and tools are needed to integrate risk management into asset and performance management systems. In addition, an understanding of the relationship between risks and system resilience is lacking.

Basics needed:

- Adopted definitions
- Standard framework for quantitative risk based on expected financial losses to agency and traveling public
- Establishment of performance metrics for risk and resilience
- Suggested risk tolerance and resilience performance targets that agencies can customize
- Methods to incorporate climate projections into decision making
- Methods to analyze both deterministic and probabilistic input data (500-yr flood versus climate scenarios)

Future research can expand threats analyzed; assets analyzed; climate projections; life cycle cost; remaining life consideration of assets; environmental impacts, etc.

Urgency and Potential Benefits

Agencies are working to incorporate risk and resilience assessments from climate and extreme weather into their decision-making processes including design and maintenance within their overall asset management programs. However, the industry lacks a consistent, adopted method to support quantitative trade off analysis including benefit-cost assessments. As the recent TRB Resilience Metrics Consensus Study noted – the industry also lacks metrics to understand what acceptable risk is or how to measure resilience of highway systems. Without these methods or metrics, limited research dollars may be expended developing multiple methods without industry consensus as to what the target performance of system resilience should be.

The benefits of an industry adopted quantitative method of assessment of risk to highway assets and overall system resilience is the ability to understand and justify investments to maintain overall system operations and performance to withstand or

rebound from climate related events when they occur. This type of proactive approach demonstrates the industry's commitment to reducing losses to public infrastructure and the traveling public from climate related threats.

Implementation Considerations

This project proposal consists of a series of projects and phases that will result in the development of the AASHTO Highway Asset Risk and Resilience Manual and supporting case studies and software tools. The program needs a long-term financial commitment from the NCHRP program, AASHTO and USDOT in order for this to be a success. The Committee on Performance-Based Management realizes that this proposal is not a typical NCHRP project request and is ready to discuss the details of this critical program with the NCHRP staff and members of the AASHTO Research and Innovation Committee.

Recommended Research Funding and Research Period

This problem statement is asking for funding for Phase 1 of a three phase project. Total funding for all three phases is estimated at \$7 million with a duration of five to seven years. Please see last page of this document for the research roadmap.

- Funding Request: Phase 1 at \$3.5 million
- Duration: Phase 1 at 3 years

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

This problem statement was developed through the NCHRP 23-09 project: Scoping Study to Develop the Basis for a Highway Standard to Conduct an All-Hazards Risk and Resilience Analysis.

The problem statement is supported by the following AASHTO committee:

- Committee on Performance-Based Management
- Subcommittee on Risk Management
- Committee on Transportation System Security and Resilience

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Please contact Matt Hardy, AASHTO Program Director for Planning and Performance Management, for a list of recommended panel members representing the AASHTO Committee on Performance-Based Management and Transportation System Security and Resilience.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Matthew Hardy
202-624-3625
mhardy@ashto.org

Affiliation: AASHTO staff on behalf of the AASHTO Committee on Performance-Based Management, Tim Henkel, Chair.

Highway Risk & Resilience Manual:
Research Roadmap: Development and Adoption – 3 Phased Approach

Development		Implement		Tools & Data		C&C	
1a. Establish Quantitative Assessment Methodology Top Priority Threats and Assets 1b. Develop Historical Data Capture Process 1c. Develop Quantitative Resilience Methodology 1d. Establish Performance Metrics and Thresholds for Resilience and Risk Tolerance	AASHTO Highway Asset Risk & Resilience Manual (INTERIM)	AASHTO Highway Asset Risk & Resilience Case Studies	AASHTO Highway Asset Risk & Resilience Manual (FINAL)	2a. Communication and collaboration practices to include Highway Resilience Manual in decision making 2b. Capacity building plan - institutional and educational needs to move Highway Resilience Manual into practice 2c. Pilot test Highway Resilience Manual 2d. Identify IOP changes and strategies for adoption of Highway Resilience Manual	3a. Develop Stand-Alone Open-Source Geospatial Computer Script 3b. Develop Spreadsheet Based Tools 3c. Metrics for Applications – Federal Reporting; Maintenance; Effectiveness of Resilience Investments	AASHTO Highway Asset Risk & Resilience Software	4. Highway Risk & Resilience Manual Oversight Group

NCHRP Review of A-08

Reviewed By:

Leslie C. Harwood
LHarwood@nas.edu

Comments:

There is documented need for this manual as proposed by the TRB Resilience Metrics Consensus Study. This is a well-scoped program including multiple projects which would feed into the development of the proposed manual. The proposed program is scoped in phases over 7 years, (Phase 1: \$3.5 million over 3 years, Phase 2: \$2 million over 2 years, Phase 3: \$1.5 million over 2 years). This is a significant undertaking, as the problem statement authors acknowledge. Typically, the individual research projects that contribute content to a manual are completed before assembly of the manual occurs. A governance structure that supports the efforts of individual NCHRP panels should be considered, with sustained participation by AASHTO and FHWA to last over 5-7 years. Development of software tools should be contingent on hosting and maintenance by AASHTO before development work commences, and the host should be involved in development. All of this effort is appropriate for NCHRP, but there are significant institutional and operational details to be worked out. More definition of the individual projects is needed to determine the appropriate level of funding per project and therefore for the overall effort. The extent to which individual/component research projects can occur in tandem will impact the speed at which a manual can be produced. This will all likely take longer than suggested.

Review Date:

12/17/2021

FHWA Evaluation of A-08

Reviewed By:

Stephen Gaj, HISM-30

Comments:

This is an important topic and needs to build from FHWA's Asset Management for Resilience to Climate Change and Extreme Weather Handbook. Review Date: December 17, 2021

AASHTO Committee Evaluation for A-08

Submitted By:

Matthew Hardy

AASHTO staff

AASHTO Committee on Performance-Based Management

Priority #: 1Comments: N/A

Submitted By:

Kyla Elzinga

AASHTO staff

AASHTO Committee on Planning

Priority #: 4Comments: N/A

Submitted By:

Bud McDonald

AASHTO staff

Council on Active Transportation

Priority #: N/AComments:

Recommend incorporating active transportation facilities and impacts, including importance of those facilities for evacuation in the event of an emergency. Relevant research: <https://www.sciencedirect.com/science/article/abs/pii/S0968090X15004106#>

Submitted By:

Chad Baker

Research Subcommittee Chair

Data Management and Analytics

Priority #: 7Comments: N/A

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-A-09

Problem Title

Incorporating Risk Management into Maintenance Practice

Background Information and Need For Research

FHWA Directive 5520 encourages state DOTs to develop risk-based, cost effective strategies to minimize the impacts of climate change. Environmental stressors, such as extreme heat and extreme cold, and changes in the frequency and magnitude of extreme events, is changing the lifecycle of transportation assets; i.e, reducing service life, shortening replacement cycles, and increasing maintenance costs. Maintenance personnel offer valuable insight as to the costs associated with achieving performance goals. At the same time, maintenance personnel will require guidance as to how to incorporate risk models into maintenance, inspection, replacement, and repair cycles so that scheduled and routine maintenance continue to mitigate the risk from asset deterioration.

Literature Search Summary

This research differs from the existing body of research found in a review of relevant literature due to its focus on the integration of risk management with existing processes. During the review, there was no body of work that mentions incorporating risk management into the existing maintenance practices. In addition, transportation practitioners during multiple stakeholder engagements during the development of the NCHRP 20-123 project initiated the conversation and advocated for the need of this potential research topic.

Research Objective

The purpose of the proposed research project is to develop a framework and guidance to help state DOTs on how to integrate and manage risk into maintenance practice. The specific research tasks to accomplish the main objective include:

- Task 1 – Conduct an in-depth literature review of all studies related to risk assessment and its incorporation in maintenance practices not only in the transportation sectors but also in other sectors (e.g., water sector, etc.)
- Task 2 – Conduct a gap assessment of the state of practice to determine what is still needed to incorporate risk assessment in maintenance practices
- Task 3 – Develop methodologies to incorporate existing risk assessment methodologies into maintenance practices.
- Task 4 – Develop methodologies for determining how to adjust maintenance cycles and changes in maintenance costs under non-stationary conditions.

- Task 5 – Develop guidance to help state DOTs to implement risk assessments into maintenance practice.

Urgency and Potential Benefits

From the literature review, there does not seem to be any previous or ongoing research focusing on this topic. This indicates a gap in the area and urgency for research to fill it. From this research, a gap assessment in leadership, coordination, and workforce capabilities and a guidance or framework on how to integrate risk into maintenance practice will be developed.

This project will help state DOTs to make informed decisions to allocate funding to maintenance practices on assets that might have higher risks than others based on potential threats/hazards.

Implementation Considerations

In order to implement risk management into maintenance practice, state DOTs will be responsible for using the research results and engaging the necessary staff. State DOTs can implement the research within their own organization through the flexible framework and utilize the guidance document produced from the project. They would need to conduct a risk assessment for their ongoing maintenance practices and implement updated maintenance practices.

What existing venues or processes could be used to support implementation?

It is key that senior executives, policy makers and program managers need to have a communication plan to communicate with peers in order to effectively integrate risk management. Additional products and activities like training workshops to increase the integration of risk management into maintenance practices, as well as peer exchanges and informative presentations can help state DOTs positively impact their organization.

Recommended Research Funding and Research Period

The estimated total funds needed to accomplish the research objectives are roughly \$400,000-\$500,000. Any initial activities designed to facilitate the communication and implementation of key research products would roughly be \$50,000.

The timeframe to complete the research for this project is estimated to be 18-24 months of work. In addition, the amount of time needed to engage in communication and implementation activities is roughly 12 months.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

This problem statement was developed under NCHRP 20-123(4) Development of a Risk Management Strategic Plan and a Research Roadmap. The primary authors on the consultant team included:

- Mara Campbell, Jacobs, mara.campbell@jacobs.com, (573) 353-0253

- Joe Zissman, Cambridge Systematics, jzissman@camsys.com
- Maria Pena, AEM, maria.pena@aemcorp.com,

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Please contact Matt Hardy, AASHTO Program Director for Planning and Performance Management, for a list of recommended panel members representing the AASHTO Committee on Performance-Based Management.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Matthew Hardy

202-624-3625

mhardy@ashto.org

Affiliation: AASHTO staff on behalf of the AASHTO Committee on Performance-Based Management, Tim Henkel, Chair.

NCHRP Review of A-09

Reviewed By:

Leslie C. Harwood

LHarwood@nas.edu

Comments:

This is a well-scoped project and a \$500,000 budget to conduct the work including initial implementation activities seems appropriate. There is some overlap between this project and the larger problem statement A-08 (See Phase 3 of A-08). I suggest that if A-08 is funded, that this project not be funded as it is included in that portfolio of projects.

Review Date:

12/17/2021

FHWA Evaluation of A-09

Reviewed By:

Morgan Kessler/HRDI

Comments:

This is a good topic. Expansion of this topic into the digital twins discussion may be good, as well, from an asset management perspective.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for A-09

Submitted By:
Matthew Hardy
AASHTO staff
AASHTO Committee on Performance-Based Management

Priority #: 3

Comments: N/A

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-A-10

Problem Title

Innovative Practices for Technology Implementation at Rural, Small, and Mid-Sized Transit Agencies

Background Information and Need For Research

The past decade has seen a proliferation of advanced technology used in delivering public transportation services, such as mobility-on-demand mobile applications, real-time bus arrival information, driver-assist/autonomous vehicle functions, and security-related surveillance software. Each of these technologies addresses the real needs of public transportation providers, such as providing increased safety and security or reducing harmful vehicle emissions. However, with each new technology implementation, public transportation agencies face multiple challenges, such as integrating new systems into legacy technology platforms, staff training to fully utilize new technology capabilities, and the ongoing maintenance of the full technology infrastructure at the agency. Additionally, each new technology implementation increases the complexity of the technology ecosystem, adding to the risk that there will be a cascading systemic failure from one piece of technology to another (famously described in the 1984 book *Normal Accidents: Living with High-Risk Technologies* by Charles Perrow).

While agencies of all sizes have challenges related to technology, rural, small, and mid-sized agencies are particularly constrained by smaller staffs, limited access to technical skills in the workforce, and funding capacity for technology implementation, utilization, and maintenance. Many of these agencies work in close collaboration with state Departments of Transportation (DOTs) which typically administer, at a minimum, Federal Section 5311 funding for non-urbanized transportation and the state Rural Technical Assistance Programs. However, not all state DOTs have the on-the-ground operational expertise to support these smaller agencies as they explore new and innovative technologies.

On the one hand, the lack of technical capacity at smaller transit operators can result in underinvestment in technology. On the opposite end of the spectrum, these agencies can become overinvested in technology that they struggle to fully utilize or that actually hurt operations due to system failures or incompatibilities. There is a need to understand how rural, small, and mid-sized agencies can “right size” the suite of technology to meet operational needs and organizational capacity. This need directly relates to Goal 4: Identify and promote research and develop educational resources to support public transportation providers of the AASHTO Council on Public

Transportation's Strategic Plan, which states, "Explore emerging technologies and develop an understanding of its implications on the future of public transportation."

Literature Search Summary

There is a research gap in the review of the opportunities, limitations, and challenges faced by rural, small, and mid-sized operators implementing new transit technologies. TCRP Report 76: Guidebook for Selecting Appropriate Technology Systems for Small Urban and Rural Public Transportation Operators was published in 2002 and provides the most recent such assessment. While this report is a thorough and useful resource, it has two limitations that this proposed study would remedy:

Advancements in technology: TCRP Report 76 is nearly two decades old, and as such it was published prior to three major advancements in technology impacting public transportation: Smart phones, battery-electric buses, and driver-assist technology. The incorporation of these new technologies layered on top of other legacy systems, in addition to the ever deepening well of technical expertise needed to operate and maintain those systems, is a key research area this study would address.

Survey of operators: TCRP Report 76 did not include a survey of transit operators and their experiences with various technologies. This is a key research need because the technology ecosystem in use can have systemic or cascading operational impacts when there are failures. Understanding the real-world experiences of these operators is essential to assessing how to "right size" technology applications to a transit agency's operational context.

There are more recent studies on specific transit technologies, including a 2020 technology survey of operators in rural and small urban areas. While these studies are useful guides to the capabilities and market penetration of specific technologies, they do not take a systemic approach of critically analyzing the impact of layer upon layer of technology and the challenges posed by implementing, utilizing, and maintaining these systems at smaller agencies. This research proposal would shed insight into how state DOTs and rural, small, and mid-sized transit agencies can fit their suite of technologies to meet the needs and capabilities of their operations.

Research Objective

The objective of this research is to develop a report for public transportation officials at state DOTs and rural, small, and mid-sized transit agencies that acts as a guidebook facilitating a clear-eyed assessment of transit technologies as well as the resources needed to manage the full systemic impact of implementing them. The research will include a review of best practices related to specific technologies, a state DOT and operators survey, interviews with technology vendors, and follow-up transit operator interviews to better understand the practitioners' perspectives. A key objective will be the concept of "right sizing" the suite of technologies to avoid situations where overly complicated or expensive systems are meeting relatively simple needs at smaller agencies.

Urgency and Potential Benefits

The final product will primarily consist of a written report summarizing the findings from the operator and state DOT survey and interviews, interviews with vendors, and review of relevant transit technologies, and will provide a framework for making decisions on appropriate technology implementations. The audience for this report will be operators of public transportation at rural, small, and mid-sized agencies, as well as the state DOTs which provide funding and technical assistance to them.

State DOTs in particular have a stake in the successful execution of this research project. For example, a cursory look through the Massachusetts Department of Transportation 2021 Capital Investment Plan (CIP) listed nearly \$5.5 million in technology upgrades, acquisitions, and maintenance for the state's 15 rural, small, and mid-sized operators, much of which is supported by state funding. The decision-making framework proposed by this project would provide guidance to state DOT officials seeking to make the most effective investments possible with limited funding. It would also be a training tool for technical assistance provided by the state DOT to smaller transit operators.

This research responds to the need among smaller transit operators and the state DOTs that support them to understand the challenges and risks of investing in new technologies, and how the full suite of technologies can create cumulative maintenance issues that strain the capacity of these agencies. This research will provide an invaluable resource to these transit operators and their funding partners as they explore new and innovative methods to improve operating logistics and the customer experience.

Implementation Considerations

Multiple officials at state DOTs could make use of the findings from this research project. State Rural Transportation Assistance Program (RTAP) managers would be well positioned to incorporate the key lessons from this project into training materials. Additionally, state officials involved with the allocation of state and federal funding for new technology would also benefit from this research, such as Federal Section 5311 program managers. More broadly, all public transportation professionals involved in the technology acquisition and maintenance process can use this research as a reference guide for making informed, effective decisions.

Distribution of the report to state DOTs and rural, small, and mid-sized transit agencies would be achieved through multiple channels. The new resource would be presented at national and/or regional conferences, such as the Transportation Research Board Annual Meeting, the American Public Transit Association Expo, the Community Transportation Association of America Expo, and/or the National American Planning Association Conference. The findings can also be disseminated through the National Rural Technical Assistance Program, which maintains ongoing technical assistance to rural transit agencies across the country. Webinars could also be conducted in partnership with national organizations such as the Eno Foundation, TransitCenter, or AASHTO, at the discretion of the NCHRP panel.

Recommended Research Funding and Research Period

Recommended Funding:

\$250,000. This includes one professional staff for the proposed research period, with the remainder envisioned for development of training or knowledge materials, and delivery of the knowledge transfer.

Research Period:

18 months

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

David Harris

Immediate Past Chair, AASHTO's Multi-State Transit Technical Assistance Program (MTAP); Member, AASHTO Council on Public Transportation

Division Director, Transit and Rail Division

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Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

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Person Submitting The Problem Statement: Name, affiliation, email address and phone.

AASHTO's Council on Public Transportation

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NCHRP Review of A-10

Reviewed By:
 Jennifer L. Weeks
 jlweeks@nas.edu

Comments:

This need was well articulated during the development of the recently released *NCHRP Research Roadmap for Rural Transportation* and reinforced with projects such as the ongoing *NCHRP 08-127, Emerging Issues: Effects of New Disruptive Technologies on the Performance of State DOTs*. This applied research will help smaller transit agencies reach their potential for public service using technologies available to them. Lastly, the research could help agencies to create a more equitable transportation system by expanding quality of service and access to transportation for those who have limited access to automobiles or for those who prefer to take alternative modes when they are available to them. However, this research may not be eligible for NCHRP funds because the research as proposed is primarily for the benefit of transit operators.

The project has a limited budget and contract time, but it seems appropriate.

Review Date:
 12/6/2021

FHWA Evaluation of A-10

Reviewed By:
 N/A

Comments:

We do not see this as an eligible activity.

Review Date:
 December 17, 2021

AASHTO Committee Evaluation for A-10

Submitted By:

Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/AComments:

Include risk of lawsuits from lack of maintenance or failure to comply with ADA on active transportation facilities including sidewalks, shared-use paths, bike lanes with pavement condition issues. Example: O'Neill v. City of Port Orchard, Supreme Court of Washington, 2017; opinion at <https://casetext.com/case/oneill-v-city-of-port-orchard-2>, discussion of ruling at <https://wabikes.org/index.php/2016/07/06/traffic-court-says-cities-must-maintain-streets-bicyclists/>

Submitter Response for 2023-A-10Comments:

Thanks for taking the time to read and review this most warranted research proposal that is designed to help state DOTs and their transit agency subrecipients (rural, small and mid-sized agencies) best implement innovative practices as it relates to technology.

Enclosed is a Word document with the complete response to the FHWA and NCHRP reviewer comments on A-10 - Innovative Practices for Technology Implementation at Rural, Small, and Mid-Sized Transit Agencies.

Contact Info:

See below.

Review Date:

Monday, February 7, 2022

RICHARD B. PRICE

Associate Program Manager, Transit Policy and Technical Assistance
American Association of State Highway and Transportation Officials (AASHTO)
555 12th Street NW Suite 1000
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Problem Statement 2023-A-10 - Innovative Practices for Technology Implementation at Rural, Small, and Mid-Sized Transit Agencies	
Reviewer's Comments	Response to Reviewer's Comments
FHWA Evaluation of A-10 Reviewed By:	Response to FHWA Evaluation –

Comments: We do not see this as an eligible activity. Review Date: December 17, 2021	Thanks for taking the time to read and review this most warranted research proposal that is designed to help state DOTs and their transit agency subrecipients (rural, small and mid-sized agencies) best implement innovative practices as it relates to technology. To obtain funding through the National Cooperative Highway Research Program, research proposal authors MUST submit proposal that are designed to effect the portfolio of work of state departments of transportation, including bridges, materials, traffic and safety, and also public transit. This research proposal will assist state DOTs with its public transit portfolio. Here is how: State departments of transportation oversee and award federal and state funding to rural, small and mid-sized transit sub-recipient agencies. In many cases, state DOTs help manage these transit agencies and oversee these technology projects, as well as manage their own transit systems looking to implement technology projects. Many of our rural, small and mid-sized transit sub-recipient agencies are interested in technology projects and have become major recipients of funds for the acquisition and implementation of these types of projects. As a result, state DOTs are asked for assistance with overseeing and in cases managing these projects on behalf of transit sub-recipient agencies. This research primarily benefits the transit offices/divisions/departments of the 52 state departments of transportation, including the District of Columbia and Puerto Rico, all of which are members of AASHTO's Council on Public Transportation. This research is vital to state DOT transit to help staff determine

	successful innovative technology practices that will expend scarce transit resources (federal and state) most effectively and provide both state DOT and transit sub-recipient agencies with proven paths forward for implementation. Please know that this problem statement ranked #1 in priority for members of AASHTO's Council on Public Transportation and Multi-State Transit Technical Assistance Program. Thanks again for your comments on this research proposal.
NCHRP Review of A-10 Reviewed By: Jennifer L. Weeks, jlweeks@nas.edu Comments: This need was well articulated during the development of the recently released NCHRP Research Roadmap for Rural Transportation and reinforced with projects such as the ongoing NCHRP 08-127, Emerging Issues: Effects of New Disruptive Technologies on the Performance of State DOTs. This applied research will help smaller transit agencies reach their potential for public service using technologies available to them. Lastly, the research could help agencies to create a more equitable transportation system by expanding quality of service and access to transportation for those who have limited access to automobiles or for those who prefer to take alternative modes when they are available to them. However, this research may not be eligible for NCHRP funds because the research as proposed is primarily for the benefit of transit operators. The project has a limited budget and contract time, but it seems appropriate.	Response to NCHRP Reviewer comments - – Thanks for taking the time to read and review this most warranted research proposal that is designed to help state DOTs and their transit agency subrecipients (rural, small and mid-sized agencies) best implement innovative practices as it relates to technology. To obtain funding through the National Cooperative Highway Research Program, research proposal authors MUST submit proposal that are designed to effect the portfolio of work of state departments of transportation, including bridges, materials, traffic and safety, and also public transit. This research proposal will assist state DOTs with its public transit portfolio. Here is how: State departments of transportation oversee and award federal and state funding to rural, small and mid-sized transit sub-recipient agencies. In cases, state DOTs help manage these transit agencies. Our rural, small and mid-sized transit sub-recipient agencies are interested in technology projects and recently they are becoming major recipients of funds for the acquisition and implementation of these types of projects. As a result, state DOTs are asked for

	assistance with overseeing and in cases managing these projects on behalf of transit sub-recipient agencies. This research primarily benefits the transit offices/divisions/departments of the 52 state departments of transportation, including the District of Columbia and Puerto Rico, all of which are members of AASHTO's Council on Public Transportation. This research is vital to state DOT transit to help staff determine successful innovative technology practices that will expend scarce transit resources (federal and state) most effectively and provide both state DOT and transit sub-recipient agencies with proven paths forward for implementation. Please know that this problem statement ranked #1 in priority for members of AASHTO's Council on Public Transportation and Multi-State Transit Technical Assistance Program. Thanks again for your comments on this research proposal.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-A-11

Problem Title

Guidance in Planning for Managed Retreat as an Extreme Weather and Climate Adaptation Strategy

Background Information and Need For Research

Climate change impacts increasingly affect transportation systems in the U.S. Transportation agencies across the country already face substantial impacts from extreme weather and other climate events, with future projections suggesting that this trend will continue, and possibly magnify. Impacts to transportation infrastructure from such events can be direct and rapid (e.g., flooding, wind, wildfires) or indirect and slow (e.g., sea level rise, land erosion, subsidence, pavement degradation). These impacts can also cause immediate or longer-term changes in the way people use local infrastructure and where they choose to permanently locate or relocate. When, where and how permanent retreat or abandonment should occur also requires a thorough understanding of the interconnectivity of transportation with other critical infrastructure systems (e.g., energy, communication, public health, housing, water, etc.).

State and local governments often have short-term economic incentives to allow development in known high risk areas, requiring often huge and ongoing investment from transportation agencies to repeatedly repair or maintain such assets. Such development can also exacerbate risks in neighboring areas if they displace natural protections such as wetlands or greenspace. State DOTs will ultimately have significant financial and operational responsibility with respect to these assets as their exposures increase. Moreover, the entrenchment of expensive and long-lived transportation infrastructure in areas that are increasingly exposed to extreme weather and other climate events are challenging, making it seemingly impossible to “move” these major structures out of harm’s way. Moving or abandoning supporting infrastructures, and how to relocate to new contexts, may be as challenging and expensive as migrating the transportation infrastructure itself.

Managed retreat needs to be a strategy available to transportation planners, but the understanding of implementation frameworks is only beginning to be considered. Managed retreat is not merely “relocating,” infrastructure, it includes evaluation of alternative routes, structures, contexts, and other considerations to more efficiently use transportation funding while preserving critical access to people, freight, and emergency services. It also requires a complex understanding of place attachment, the community in which the transportation system exists, the interconnectedness of the infrastructure at issue with other systems and people, and whether laws and regulations authorize a state DOT to make managed retreat decisions.

There is a need for research that develops information about managed retreat strategies in a way that supports state DOT decision-making regarding transportation systems. A successful managed retreat plan can decrease risk to the entire system, save valuable resources that may be better allocated elsewhere, and protect lives and livelihoods. Moreover, embedded in these decisions are social justice issues to consider (e.g., economically disadvantaged people are unable to migrate and are left “stuck” and their standard of living becomes reduced even further). However, state DOT’s often do not have the experience, tools, or frameworks needed to approach these issues in a way that leads to successful outcomes.

This research project will develop a framework and guidance for state DOTs to explore and implement managed retreat actions. There is no “once size fits all” approach, but a framework and guidance could provide substantial support as state DOTs begin to determine the best approach to specific, ongoing extreme weather and climate risks in a particular area. Included within this approach is guidance for how to determine and measure transportation performance thresholds at which retreat strategies should be implemented, one that allows for sequenced and phased planning and budgeting of retreat over long time scales.

Literature Search Summary

Managed retreat is a nascent field, but with growing recognition. While a literature search of the Transport Research International Documentation (TRID) database revealed only a handful of studies related to the topic, this issue is taking hold in various locations and involving multiple modes: 1) in November 2020, the State of California approved moving a stretch of Highway 1 inland, a planning effort that took over a decade; 2) Illinois has deployed expanded floodplains, relocated communities and removed flood-prone transportation infrastructure; 3) two cities in Canada are evaluating retreat options for a portion of a rail line that is now increasingly vulnerable to weather-induced events. Moreover, there are a growing number of media reports suggesting that managed retreat is a needed and, in some cases, the best adaptation strategy. Importantly, there is a dearth of available frameworks or guidance documents to assist state DOTs with how such a strategy should begin to be considered, much less implemented.

Research Objective

The research will develop a practice-ready managed retreat framework and guidance targeted to state DOT’s, enabling an informed approach to discussions and to facilitate decision-making. The final product will draw from experiences and outcomes across the U.S. and abroad, written from the perspective of managed retreat as a viable resilience strategy that can have positive, long-term benefits.

Tasks include the following:

1. Collect and synthesize managed retreat case studies from the U.S. and abroad, including a review of state laws and regulations in selected states that impact DOTs managed retreat decision-making.
2. Identify patterns of specific challenges and potential solutions likely to be relevant to state DOTs.
3. Identify relevant research regarding human decision-making in managed retreat considerations.
4. Convene an expert working group to synthesize the research, case studies, and pattern identification, and develop a framework and guidance document that can apply nationally.
5. Pilot test the framework with a select group of state DOTs in areas experiencing managed retreat needs.
6. Incorporate pilot test results and revise final framework and guidance.
7. Prepare guidance document that will include a practice-ready framework.

Urgency and Potential Benefits

All state DOTs regularly face the impacts of extreme weather and other climate events, but those events are worsening in some areas, a trend that is expected to continue. Transportation and supporting infrastructure are often expensive and long-lived, and the practice of designing, building, and maintaining based only on current or past extreme weather and climate exposure does not adequately protect those substantial investments by state DOTs. Indeed, investments being made now should long outlast the expected changes in extreme weather and climate. Incorporating managed retreat into the toolbox could more efficiently use and direct limited transportation resources. Failing to include this option may result in the need for even larger ongoing investments to protect infrastructure impacted by extreme weather and climate change, infrastructure that may not have been built in a particular place or a particular way had managed retreat been a considered strategy.

Implementation Considerations

The research product would be implemented by senior managers and operations staff within state DOTs. As noted, pilot testing within selected DOTs is appropriate, and training workshops and presentations can be held in person or in a synchronous format on-line. Potentially interested AASHTO Committees and Councils include: Committee on Transportation System Security and Resilience; Committee on Environment and Sustainability; Subcommittee on Air Quality, Climate Change & Energy; Committee on Maintenance; Committee on Planning; and Committee on Performance Based Management.

Recommended Research Funding and Research Period

Research Funding: \$ 500,000

Research Period: 24 months

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Tim Sexton, Minnesota DOT, Chair, CTSSR Subcommittee on Research,
timothy.sexton@state.mn.us
Mark Abkowitz, Chair, TRB Committee on Extreme Weather and Climate Change
Adaptation, mark.abkowitz@vanderbilt.edu

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Members from the CTSSR Committee Transportation System Security and Resilience
Members and Friends of the TRB Committee on Extreme Weather and Climate Change
Adaptation

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Tim Sexton, (651) 366-3622, timothy.sexton@state.mn.us
Affiliation: Minnesota DOT, AASHTO Committee on Transportation System Security and Resilience

NCHRP Review of A-11

Reviewed By:

Leslie C. Harwood
LHarwood@nas.edu

Comments:

The project objective is clear and the \$500,000 budget and 24 month timeline seem appropriate for this research. I agree with the FHWA commenter that this problem may have a disproportionate impact on economically vulnerable and/or underrepresented populations and this research needs statement should include reference to this problem. If funded, it is suggested that consideration of these populations be included explicitly in the scope of work.

Review Date:

12/17/2021

FHWA Evaluation of A-11

Reviewed By:

Surlya Motsinger, Becky Lupes - HEPN-30

Comments:

This as an important topic for additional research.? A FHWA/TRB/AASHTO conference held in late 2019 included multiple sessions on this topic which were well attended and

the interest level from State DOTs was high. While we think that the statement is well thought-out and written, the statement background information and research need section could be strengthened by acknowledging a need to consider in managed retreat decision making potential disproportionate impacts on economically vulnerable or underrepresented populations. Review Date: December 17, 2021

Submitter Response for 2023-A-11**From:**

[email: timothy.sexton@state.mn.us;pzelinski@ashto.org]

Comments:

Agree with comments from FHWA and NCHRP that managed retreat may have a disproportionate impact on economically vulnerable and/or underrepresented populations. Consideration of these populations can be explicitly included in the scope of work.

Contact Info:

Tim Sexton, timothy.sexton@state.mn.us

Review Date:

January 3, 2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-A-12

Problem Title

Creating a Guidebook Addressing Equity in Payments for Transit and Congestion Charging

Background Information and Need For Research

Every American must “pay for” transportation and mobility services— whether it’s loading up a contactless payment card such as a Clipper and TAP, grabbing \$2.25 for bus fare, downloading a new app to try out a Transportation Networking Companies, putting a transponder in their vehicle to cover bridge / road tolls, or paying a gas tax when at the pump. Even as more and more Americans are relying on credit or debit cards for many of their transactions (Federal Reserve, 2020), 25% of Americans remain underbanked or unbanked and lacked access to EMV payment methods (CNBC, 2019), substantially increasing the need for convoluted payments systems to anticipate various forms of payment.

Simultaneously to this trend, many state Department of Transportations, are implementing, or beginning to consider Road Charge programs, as a result of the transition from gas-powered vehicles to zero-emission vehicle (ZEV) or electric vehicles, causing a projected decline of gas tax revenue, a significant transportation funding source for the State. This transition often results in the need to have a deeper, first party relationship with the payee / driver, meaning that there will be a significant possible increase in transaction volume handled by state DOTs that are not currently tolling operators.

Currently there is no comprehensive research to indicate what design provides the most effective approach or the most appropriate solution to what type of payments should be used nor how to best make a nationwide, interoperable system across a variety of transit providers and a system that ensures riders are not excluded from being able to access opportunities, recreation and more. As a result, research is needed to address the equity impacts and ability to provide mobility to all users. Research is also needed to ensure that State DOTs, transportation agencies, new mobility providers and others can align to and best provide services to residents.

Literature Search Summary

Existing research examines the various levels of complexity that comes with integrating current transportation providers and payment systems to increase mobility across modes. The research collectively addresses the opportunities that integrated payment systems provide, like increasing access (Tan, 2021), as well as barriers that arise, such as geographical coverage and data security (Butler, 2021). Recent mobility trends

emerged as a transportation solution to complement transit while reducing carbon emissions by encouraging non-vehicle trips. However, as these systems often require smartphones, access to a debit, credit or mobile banking and occasionally a license, many transit riders find it difficult to utilize these forms of transportation if they do not possess one or more of the requirements (Shaheen, 2016). Further, current discounts offered by transit agencies vary from jurisdiction to jurisdiction and include complex instructions for users. Creating a single system mobility wallet that enables everyone to participate in multiple modes of transportation, regardless of banking status or income level, not only helps to increase access but also allows the seamless application of discounts and credits in a more effective and equitable way. Consistent equity measures across transportation are crucial to incorporate the range of mobility needs. For example, not only are lower income individuals less likely to own cars and more likely to take transit, but those also that do have a vehicle still have unreliable access to a household vehicle (Blumenberg, n.d.).

This research will build upon the existing research offering shared standards and actionable steps to create and implement payment solutions for an interoperable system across transportation providers increasing transportation access for all in the process.

Research Objective

The objectives for this project are to provide Guidelines and Specifications for state Department of Transportations, local transportation agencies, new mobility providers and others to offer the best service for users. The first objective is to determine which payment systems shared standards to align with. These shared standards will not only address the efficiency of transactions, but also prioritize the transit dependent and unbanked improving mobility options for all. Our second objective is to determine the best privacy practices for users, as preliminary research suggests that privacy and data security concerns as potential barriers to Mobility-as-a-Service (MaaS) implementation (Visa, 2020). Our last objective is to quantify how inequitable the current system is and mitigate the inequities that exist. The results of these reviews will then be incorporated into a guidance document.

When the guidelines and specifications are completed, a second task will be to convene a workshop with State DOTs to communicate and implement the guidelines and specifications to establish pilots for an interoperable system within and across state lines.

Urgency and Potential Benefits

Previous research indicates that while interoperable system is appealing to agencies, many have concerns regarding user access, payment systems, data management and costs. Further, coordination between stakeholders can be one of the most difficult tasks at hand. Issuing a guidebook at the state DOT level allows a clear path towards implementation while ensuring equity measures are incorporated. If this research is not conducted, agencies will continue individually, making it more difficult to synchronize between agencies. Additionally, with the variety of systems out there, and offered at steep costs, this research will allow State DOTs and transit/mobility providers to make

better informed decisions on best practices for an interoperable and equitable system. Conducting and implementing this research will directly benefit the first and foremost the users, as well as state DOTs, transit, and transportation agencies by increasing access and ease to transportation systems, increasing ridership, lowering overhead costs, and creating equitable fares.

Implementation Considerations

As part of the State Department of Transportation (DOT), California Integrated Travel Project (Cal-ITP) is in the position to provide actionable guidelines for themselves and other state DOTs. Cal-ITP current role to standardize reporting standards for transit agencies can be used as a model for the implementation of the Payment Shared Standards. To create additional awareness for these guidelines and open-sourced system, we will engage in presentations, peer exchanges and pilot testing to implement the research results. In addition to state DOTs, those responsible for the research results include any National Transit Database reporters, transportation agencies, and Intelligent Transportation System Programs, will all be responsible for using the research results.

Recommended Research Funding and Research Period

The total funding request is for \$500,000. To complete the research objectives, we request \$300,000. For the implementation of the findings, we request \$200,000.

The research period is 24 months in total to complete our research objectives. Of the 24 months, 6 months are dedicated to completing further research. The remaining 18 months are dedicated to convening with other State DOTs to determine pilot programs.

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Hunter Owens, Research Data Manager, California Integrated Mobility, (310) 592-6639

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Priscilla Freduah-Agyemang, MaaS Program Manager, Southern California Association of Governments, agyemang@scag.ca.gov

Ian Wesley, Data Scientist, Washington DOT, WesleyI@wsdot.wa.gov

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Joe Horton, Chief, Office of Safety Innovation and Cooperative Research, California Department of Transportation, 916-955-7841 joe.horton@dot.ca.gov

Reviewed By:
 Jennifer L. Weeks
 jlweeks@nas.edu

Comments:

Most of what is contained in this problem statement is appropriate for NCHRP, but some of the desired outcomes are not clear. While NCHRP cannot make recommendations for which systems or products agencies should use, it is possible to identify the functionality requirements and other criteria for such systems that agencies can incorporate into their decisionmaking. Regarding the implementation phase, what would be piloted? The types of implementation activities described are typical for an NCHRP project, but the research phase of this proposed project cannot produce a recommendation for a specific system(s) to be used. If building a system is envisioned, there is not sufficient time or budget to do that, and a host and ongoing governance and maintenance responsibilities would have to be fully addressed.

This research statement proposes to address the full range of equity implications of making different modes of transportation available to the broad array of customers. Integrated fare payment systems are a convenience for most users and the States and other agencies that use them in that the transactions are immediate and coordinated electronically. The costs of operating cash payment systems and collections are considerable to agencies. Fare evasion is also something that agencies seek to avoid using technology. However, the systems require considerable interorganizational coordination and can be difficult to implement. Although the technical factors of implementing such technology are not the focus of this research, they do affect decision making on whether or how to implement them. Equity is a concern in the application of payment technologies for a number of reasons. Not only is there a bank divide in that many low income people are "unbanked", i.e., do not have a credit card or a bank account, but there is a digital divide in terms of access to the technology required to purchase and use many transportation modes. As personal mobility services expand and create opportunities for shorter trips with fewer costs to agencies and individuals such as parking, gas and even reducing emissions, the ability to access those services is not equal across all population groups. Furthermore, because so many alternative modes are not provided by the public sector but are private companies, research should examine policies and techniques to encourage these companies to invest in and accommodate markets that may appear less lucrative to the service providers. The topic of market availability could be woven into this research or proposed as a separate research project.

There are some transit agencies that have sought to address equity in access to services through fare systems and payment structures. The research should definitely seek out these examples, including any benefits and challenges agencies have experienced in their implementation, and to the extent such information is available, understand whether they are increasing equity in access and use among the traveling population.

Review Date:
12/6/2021

FHWA Evaluation of A-12

Reviewed By:
Bob Sheehan/Murat Omay/JPO - Ben Hawkinson/HPTS

Comments:

Bob Sheehan/Murat Omay - Although it somewhat parallels the Complete Trip Research and Coordination (CTRC) research efforts on a different level, the NCHRP A-12 problem statement appears to be fragmented in its scope. The background statement opens with state DOTs and road usage fee programs, but the body of the statement shifts the entire focus to mobility services and transit. While the development of guidance is consistent with the recommendations from the recently completed Multimodal and Accessible Travel Standards Assessment, a "guideline" might not be the best product from an effectiveness perspective. A framework (or reference architecture) with critical and practical decision-support elements (policy, technology, resource/capability) would make it more effective and deployment-ready for consideration by state DOTs and other transit/transportation agencies. Through the NCHRP stakeholder engagement efforts with public and private-sector decision-makers, practitioners, and implementers, such framework would be developed with support from multiple perspectives, vetted by the industry, and, perhaps, ready for further refinement and demonstration under a larger demonstration program.

Ben Hawkinson - We are unsure what this funding would go toward and do not understand this: "Currently there is no comprehensive research to indicate what design provides the most effective approach or the most appropriate solution to what type of payments should be used nor how to best make a nationwide, interoperable system across a variety of transit providers and a system that ensures riders are not excluded from being able to access opportunities, recreation and more. As a result, research is needed to address the equity impacts and ability to provide mobility to all users. Research is also needed to ensure that State DOTs, transportation agencies, new mobility providers and others can align to and best provide services to residents."

Review Date:
December 17, 2021

Submitter Response for 2023-A-12

From:
Owens, Hunter@DOT <Hunter.Owens@dot.ca.gov>

NCHRP Comments:

NCHRP Review of A-12:

Reviewed By: Jennifer L. Weeks jlweeks@nas.edu

Review Date: 12/6/2021

Response:

We thank the reviewer for their comments. The desired outcome of this proposal is to create the framework for state DOTs and agencies to guide decision-makers in planning and designing payment systems which addresses the equity impacts and opportunities to increase mobility access across all transportation forms to all users regardless of banking status, income level, or access to technology. The framework's primary task would be to aid agencies in their evaluation of the various systems in the marketplace. The framework would emphasize the importance of including elements such as open data standards and interoperable APIs rather than recommending a specific system. To allow for the scope to fit the time frame, the pilot will ideally be conducted after the framework is complete. However, open-loop and transportation mobility wallet pilots, such as Oakland's Universal Basic Mobility Pilot and Monterey-Salinas' contactless payments pilot and others may be evaluated as part of the research phase into payment systems and program types. This framework will aim to address the difficult task of interorganizational coordination by conducting the research and recommendations through a State DOT lens. The problem statement authors recognize that implementation limitations are bound to arise, however, difficulties may be greater without an aligning framework before widespread implementation. As for implementation at the user or customer level, the authors agree that access to technology is a significant factor when creating effective equity measures. As stated previously, part of this research includes examining existing pilots and programs, some of which pilot solutions to overcome the technology barrier by offering access without the use of smartphones to transportation modes provided by both private and public companies.

FHWA Evaluation of A-12:

Review Date: December 17, 2021

Reviewed By: Bob Sheehan/Murat Omay/JPO - Ben Hawkinson/HPTS

Response:

We thank the reviewers for their comments. In the paragraph identified by the second reviewer, it was the authors' intention to highlight the lack of framework indicating what elements in a payment system provide the most effective approach for an interoperable system across transportation modes and providers. As a result, there is a need for complete and intersectional research in order to guide decision-makers in planning and designing payment systems which addresses the equity impacts and opportunities to increase mobility access across all transportation forms to all users regardless of banking status, income level, or access to technology.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-A-13

Problem Title

A guidebook to instruct practitioners on how to identify, assess, and implement emerging technologies

Background Information and Need For Research

Societal and environmental change frequently disrupts the transportation system, often significantly. In response, state DOTs seek out helpful technologies but encounter challenges in (a) identifying and assessing new tools and opportunities in a timely and sufficient way; (b) responding with the proper mix of traditional and emerging approaches; (c) installing policies to enable change management and instituting models for stakeholder and industry practitioner input; (d) encouraging pilots; (e) facilitating pre-release availability; and (f) selecting the right scale and level of effort to promote adoption, proper resourcing, implementation, evaluation, and sustainable programming.

There is a need to detail the ways state DOTs have effectively managed research, adoption, evaluation, and retirement of technologies. For example, what are the tools, processes, and expertise which elicit informed, complete answers to these questions (posed in Transportation Research Circular E-C253, Transformational Technologies in Transportation): What is the ultimate objective? What is the urgency? What is acceptable risk? How much evidence will we need to move forward? What are the barriers? Can we provide credibility, transparency, and balance stakeholder influence? Additional issues may concern workforce readiness to adopt new technologies, measuring success, or others: every DOT has examples. A guide can document these experiences, extract and validate the universal lessons from specific cases, and provide sample tools, e.g., checklists and templates, and other practice points, resources, and aides.

Literature Search Summary

Review of peer reviewed and grey literature suggests that operational tools for R&D are not collected or shared in a systematic way. An agency developing or adopting new technologies may have processes, e.g., for accepting external proposals for pilots, tests, and deployments or for implementing a smart cities program; however, these processes often are not documented for nor exposed to outside audiences. Research on the emerging technologies topic – occurring at TRB and elsewhere - is broad; at the same time, individual projects in the literature may pertain to a specific technology, mode, or process and correspond to diverse needs, uses, or phases of development or implementation. TRB's US Domestic Scan program (NCHRP 20-68A and related projects) facilitate response to emerging technologies within research programs; the proposed research might review how state DOTs leverage the Domestic Scan program

to respond to pressures of disruptive technologies and emerging science and inform the guide with those lessons learned. Similarly, the NCHRP 20-102 series of work covering automated vehicles and mobility-on-demand – such as NCHRP 20-102 (11), peer exchanges, and the aforementioned Transportation Research Circular C-253

“Transformational Technologies in Transportation: Impacts on Traditional Research Processes and Programs” - may apply to other technologies and inform the guidebook. Other prior research includes research roadmaps for emerging areas of innovation or collaboration, as well as guides to new technology adoption using methods such as directed technology transfer or organizational cultural change.

Active and upcoming research, when completed, also may become useful references regarding key topics related to adoption of technologies, e.g., procurement practices (NCHRP 23-19), system mobility (NCHRP 20-123(12)), and leveraging big data and artificial intelligence in analysis (NCHRP 17-100). NCHRP 20-123(09) will identify requirements for a platform for sharing innovations. TRB efforts to instruct the sector on adopting resilience, e.g., NCHRP 117 and NCHRP 20-59(54) & (55), may offer relevant frameworks also. An overarching guide would help maintain a focus on the application of research results and the implementation of recommendations. In this way, the guide could be a universal reference and tool.

Research Objective

The research objective is to improve adoption of emerging technologies by developing a guidebook that would provide direction that will enhance the necessary planning and collaboration for implementing new technology. Research process would include:

- Literature review
- Survey
- Structured interviews
- Catalog and framework development
- Guidebook development
- Workshop to finalize findings before developing a final report.

Focus areas may include the following:

- Analyze innovation and research knowledge transfer activities inclusive of factors such as replicability, extensibility, and alignment to the objectives of user communities
- Catalog effective practices
- Construct a comprehensive use framework enabling transportation agencies to capitalize on research and innovations from within the workforce and across the public and private marketplace
- Detail concrete processes and tools for implementation.

The final deliverable is a guidebook with aides such as checklists and templates, a catalog of innovation and research transfer activities, and documented approaches. For example, the guidebook could include a spreadsheet-based framework for emerging technology implementation in a state DOT.

Urgency and Potential Benefits

Potential benefits of this proposed project include: (1) Key information and lessons learned (from national, diverse sources) in one place to help educate the agency workforce and technical leadership in discerning the true value of potential solutions, selecting methods and technologies, and determining the fit to a given organization. (2) Alternative models for implementation of project findings based on the following: a) agency authorities; b) workforce profile; c) availability of external resources; d) availability of single source or consortium funding; e) full or partial application scenarios; f) priorities of the sponsoring agencies or lines of business; g) and end user needs and objectives. (3) A comprehensive resource synthesizing and presenting the universal aspects of research, innovations, their adoption, enabling policies, and privacy issues arising from data collection, enhanced sensing, and other technologies. (4) Opportunities to deploy research, innovation and technical upgrades with a systems approach, accounting for both workforce impacts and asset life-cycle costs for a better comparison of investments, co-benefits, and/or easier evaluation.

There is an urgent need for concrete examples of: (1) how to achieve replicability and extensibility to improve research and innovation ROI; (2) how to vet, leverage, and share compendia or repositories, across all media, of new and emerging technologies (which may include reference to NCHRP 20-123(09)'s requirements for a platform for sharing innovations); (3) how to take in technology from industry from a public-centered perspective, e.g., without committing to a product or service that unduly restricts sharing and collaboration (4) how to maintain a workforce that can adapt to new technologies as well as maintain cyber-resilience in managing new technologies. Meeting these urgent needs will bring efficiencies and create a culture of innovation, collaboration, and evidence-based decision-making.

Implementation Considerations

The guidebook will be sent to State DOT research managers, followed by a TRB webinar led by the project team. AASHTO's R&I committee also is a potential pathway for disseminating findings to state DOTs and local and statewide partners (contractors, consultants, and academics) typically involved in research, implementation and innovation lifecycles. The project itself would involve workshops which can grow champions and ambassadors, to facilitate later implementation. To ensure sustained use and acceptance of the guide, consideration should be given to having a section of the guide that addresses (1) leveraging consortia for pooled funding of research projects that employ the guide, to encourage shared test beds and knowledge transfer; (2) maintaining recurring reporting on the guide's implementation (e.g., through the state DOT research managers in collaboration with TRB); and (3) producing a fixed schedule of updates (e.g., 5 years) since technologies, expertise, and methods will continue to develop.

Recommended Research Funding and Research Period

The best estimate to fund the research is in the range of \$300,000. The estimate to facilitate implementation is between \$10,000 and \$25,000. The research should be completed within 2 years.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Joe Horton, California Department of Transportation (CALTRANS),

Joe.Horton@dot.ca.gov, 916-955-7841

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Emily Parkany, Vermont Agency of Transportation, emily.parkany@vermont.gov, 802-272-6862

Stephanie Dock, DC Department of Transportation, stephanie.dock@dc.gov, 202-359-6965

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

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Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Stephanie Dock, DC Department of Transportation, stephanie.dock@dc.gov, 202-359-6965

NCHRP Review of A-13

Reviewed By:

David M. Jared

djared@nas.edu

Comments:

Complementary to but more comprehensive than Transportation Research Circular E-C253, "Transformational Technologies in Transportation: Impacts on Traditional Research Processes and Programs." Considering the broad set of resources that might inform the guidebook, the research will likely need to determine the highest priorities for agencies in its initial tasks and structure the guidebook accordingly. Also, a process management plan that systematically revisits emerging technologies is important to ensure the guidebook's future relevancy and utility. The research scope should not duplicate NCHRP Report 750, Volume 3 *Expediting Future Technologies for Enhancing Transportation System Performance*. Finally, "agencies" might be substituted for

"practitioners," since the research seems particularly aimed at state DOTs and possibly other transportation agencies.

Review Date:
12/9/2021

FHWA Evaluation of A-13

Reviewed By: Jeff Zaharewicz/HIT

Comments:

This is a good problem statement that addresses a clear challenge.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for A-13

Submitted By:
Bud McDonald
AASHTO staff
Agency Administration Managing Committee

Priority #: N/A

Comments:

Support with comment: consider incorporating a discussion of how to recognize and address equity implications in adoption of new and disruptive technologies, inclusive of implications for transportation system users who disproportionately bear burdens of system decisions based on race, poverty, and disability.

Submitted By:
Bud McDonald
AASHTO staff
Committee on Civil Rights

Priority #: N/A

Comments:

Support with comment: consider incorporating a discussion of how to recognize and address equity implications in adoption of new and disruptive technologies, inclusive of implications for transportation system users who disproportionately bear burdens of system decisions based on race, poverty, and disability.

Submitted By:

Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A

Comments:

Recommend inclusion of how to recognize and address gaps in modal consideration of technology use, so that systems examine driving, active transportation and transit movements.

Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: N/A

Comments:

This research may be related to A-05 (if the technologies come from research). This is a low to medium priority.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-A-14

Problem Title

Optimizing Investment in TSM&O to Reflect an Evolving Mobility Paradigm

Background Information and Need For Research

TSM&O exists in an environment increasingly defined by third-party technologies and software applications integrated into the automobile fleet. This research will pose the following question: “If and how much longer DOTs should invest in traditional TSM&O infrastructure (e.g., dynamic message signs and closed-circuit television cameras) and its operation, as both could become effectively obsolete?” DOTs will need guidance to redirect/transition their TSM&O-related investments so as to be better suited for advanced technologies when “tipping points” occur. Concurrently, DOTs will need guidance on how best to repurpose existing TSM&O infrastructure (e.g., making fiber optic facilities available to support other public purposes). This research can provide guidance to prepare for and address the future problem that the functionality of TSM&O will face due to the advancement in technology.

Literature Search Summary

There is no current TSM&O research in TRID or RiP that studies the recent practices regarding this evolving mobility paradigm.

Research Objective

This research will provide DOTs with guidance on the following:

- 1) To determine if and when investment in DOT-owned infrastructure and systems used to support TSM&O can be stopped, reduced and/or, re-directed
- 2) To assess how and when third-party technologies and software applications can be integrated into DOT-owned/operated TSM&O systems, concurrent with changes to TSM&O cessation, reduction, or redirection of existing TSM&O support resources
- 3) To identify how TSM&O infrastructure can be repurposed to serve other public needs

Urgency and Potential Benefits

The TSM&O environment is rapidly changing with the evolution of technological solutions. For example, the products and services offered by third-party mobility as a service provider and the increasing interest in mobility by non-traditional participants such as Microsoft can be of tremendous value to DOTs and might prove the current infrastructure obsolete if these products and services can be implemented without DOT infrastructure. Additionally, DOTs may need several years to adjust their TSM&O-

related investment to better align with mobility industry trends and opportunities, which makes the need for this research timely.

Implementation Considerations

The guidance produced through this research may be incorporated into DOT TSM&O-related strategic plans, policies, procedures, and work program planning. The guidance may be reflected in modifications to inter-agency agreements relating to TSM&O operation and maintenance (e.g., co-location agreements associated with traffic management centers).

Recommended Research Funding and Research Period

Funding: TBD; recommend \$250,000 - \$400,000

Research Period: Recommend 24 months

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Mark Plass, P.E.

District 4 (Ft. Lauderdale) Traffic Operations Engineer

Florida Department of Transportation

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954-777-4399

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

TBD

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

J. Darryll Dockstader

Manager, Research Center

Florida Department of Transportation

Darryll.Dockstader@dot.state.fl.us

850-414-4617

NCHRP Review of A-14

Reviewed By:

Trey Joseph Wadsworth

twadsworth@nas.edu

Comments:

The proposed research could be valuable to DOTs and other transportation agencies as emerging technology continues to be incorporated into the transportation system. For

example, if anticipated connected vehicles need vehicle-to-infrastructure (V2I) solutions to be deployed by DOTs. Understanding the relationship between new infrastructure and existing TSM&O infrastructure would be valuable. The research objective should be expanded or clarified to include an assessment of what emerging mobility may seek from public infrastructure and/or any dependencies to achieve envisioned benefits of new mobility. The research timeline seems reasonable, but the budget should be increased to \$500,000.

Review Date:
12/13/2021

FHWA Evaluation of A-14

Reviewed By:
Corbin/HOTM

Comments:

The term "Evolving Mobility Paradigm" does not appear to be meaningfully defined, and not correlated to AASHTO's use of "Emerging Mobility" and their associated Inter-Committee Working Groups (CAV, EV, Air Mobility, Shared Mobility). Implicitly, the proposal seeks to understand and integrate into transportation system management and investment decision-making the increasing array of private sector services. These private sector services seem to encompass both data and information (e.g. TMS software capabilities), and the provision of infrastructure and related infrastructure services (e.g. DMS). This is a profoundly timely topic and set of issues, but the proposed approach may be too vague and isolated. There may be potential to consider aspects of A-14 in further refinement of G-13 (Transportation Ops Manual Best Practices) or G-26 (Virtual Operation of TMS).

Review Date:
December 17, 2021

AASHTO Committee Evaluation for A-14

Submitted By:
Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A

Comments:

Recommend including active transportation, including whether third-party service providers can fill existing gaps concerning pedestrian/bicyclist movements within the

system, and implications for safety and mobility of active transportation users in TSMO technology shift.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-A-15

Problem Title

Managing Privacy Issues When Using and Storing Connected Vehicle Data

Background Information And Need For Research

Connected vehicles have the potential to provide a rich source of data for state and local transportation authorities. The data will be so rich that unethical actors could use it to exploit or violate the privacy of travelers. This research intends to help state and local transportation authorities gain the most benefit from the data while minimizing their liability for traveler privacy.

Connected vehicle data will go much further than the typical counts from point sensors. Information in the basic safety message (BSM), transmitted 10 times per second, can provide count, speed, travel time, vehicle density, vehicle length, status of windshield wipers and lights, perhaps even origin-destination all at high spatial and temporal resolution in real-time. Authorities may even infer very localized road weather conditions from the status of lights, wipers, and brakes, all contained in the BSM. Such data can enable a host of new applications, operational capabilities, and provide new insights for transportation authorities.

Even though the security certificates and broadcast identifiers are supposed to change frequently to make it harder to track specific vehicles, it won't take much to correlate such data with individuals as the GPS coordinates are not encrypted and are transmitted in the clear. Therefore, there is a risk to individual privacy where this data is collected and stored. To avoid litigation and other problems, entities that intend to collect, store, and use connected and automated vehicle data need to proactively prepare to secure this kind of data. Threats include hackers stealing, altering, or destroying data; insiders abusing it; mistakes causing inadvertent exposure; and inadequate anonymization that leads to privacy violation. Agencies cannot retroactively install protections against such threats. The threat environment is too sophisticated so developers and data users must consider data security and privacy from the beginning.

Another hurdle for government agencies is public opposition to governments collecting information despite an ironic not well-informed consent to private companies collecting personal cellphone data. Public concern for privacy, hence pressure on legislators, is growing though and will increase the costs of mishandling data that has an impact on individual privacy in the future.

Areas to consider must include, encryption, anonymization, data retention policies, access control, sharing policies and possibly more.

Research questions to address include:

1. How to handle the scale of data from millions of vehicles ten times a second? Should data be aggregated at the point of collection? Should one collect samples or all raw data?
2. What processing should occur at collection, at the edge, in the cloud, if any of these are in the data architecture and how can the data be protected at each point and the communications between them?
3. Do the applications using the data matter to how the data must be collected, transferred, processed, and stored? Or are any protections independent of data use?
4. How does scale affect the ability to protect the data versus the utility of the information? Is it necessary to collect it all? At what point does scale make it too hard to protect?

Literature Search Summary

Paige M. Boshell, "The Power of Place: Geolocation Tracking and Privacy," Business Law Today, American Bar Association, March 25, 2019,
<https://businesslawtoday.org/2019/03/power-place-geolocation-tracking-privacy/>

A comprehensive treatise on the exploitation of personal location data, market forces, and current state of Federal and State regulation.

U.S. Senate Committee on Commerce, Science, and Transportation, "Protecting Consumer Privacy," Hearing, September 29, 2021,
<https://www.commerce.senate.gov/2021/9/protecting-consumer-privacy>

The latest in a long history of Congressional activity trying to deal with privacy.

Bill Chappell, "Uber Pays \$148 Million Over Yearlong Cover-Up Of Data Breach," NPR, September 27, 2018, <https://www.npr.org/2018/09/27/652119109/uber-pays-148-million-over-year-long-cover-up-of-data-breach>

One example of the cost of a transportation-related data breach and its subsequent mishandling.

Sydney Shepard, "The Average Cost of a Data Breach," Security Today, Jul 17, 2018, <https://securitytoday.com/articles/2018/07/17/the-average-cost-of-a-data-breach.aspx>

Cybertalk.org, "Ransomware attacks on the transportation industry, 2021," July 28, 2021, <https://www.cybertalk.org/2021/07/28/ransomware-attacks-on-the-transportation-industry-2021/>

The transportation industry witnessed a 186% increase in weekly ransomware attacks. Those kinds of attacks include threats to release data with privacy repercussions.

Gina Tonn et al., “Cyber Risk and Insurance for Transportation Infrastructure,” Wharton School, University of Pennsylvania, Risk Management and Decision Processes Center, Working Paper # 2018-02, March 2018, https://riskcenter.wharton.upenn.edu/wp-content/uploads/2018/03/WP201802_Cyber-Security-Transportation-Sector.pdf

Malicious data breaches make up 27.1% of all incidents resulting in an average loss of \$0.33 million. Privacy-related incidents also have a very high occurrence frequency accounting for 22.9% of incidents, with average losses over \$1.5 million, which is more severe than the losses caused by malicious data breaches. Among all the incident types, unintentional disclosure of data has the most destructive impacts on victim companies with an average loss of \$3.17 million.

Research Objective

The objectives of this research are to:

- a) Identify the risks to transportation authorities of collecting data that can lead to privacy violations.
- b) Identify processes, techniques, methods, design requirements, activities, and policies to prevent and mitigate potential privacy violations.
- c) Create a guidance document for transportation authorities to help them address the privacy issue proactively.

Urgency and Potential Benefits

Connected vehicle data can supplant existing traffic data collection efforts, sparing agencies much of the cost of data collection and maintenance. Because the data will have so much higher resolution and cover all roads, not just a few sample points, it will enable a host of new services and capabilities as noted above, from operations and planning to policy. Such widespread impact is as difficult to quantify as the potential of the internet was thirty years ago, other than to say it will be significant. However, there are some obvious potential benefits. One is to displace some of the \$50 to \$100 million per year spent on traffic counting programs. Another is the ability to more precisely predict where transportation agencies will see the most growth, which can help with prioritizing funding.

There is an opportunity cost to not being able to capitalize on data available from almost every vehicle. But privacy violations cost the public trust as well money. Data security specialists estimate that companies in the U.S. lose an average of almost \$8 million per incident due to security breaches and that cost is increasing almost five percent a year. Transportation agencies can less afford these risks.

This need was first identified by the TRB Traffic Monitoring Committee ACP70 in 2016. Although there have been advancements in this area since then, the need still exists and is even more prevalent with advanced technology and the development of new data sources from vendors, for example, using video recognition with AI and machine learning technologies.

Being able to leverage high-quality traffic count data from continuous counting equipment is paramount for traffic volume count programs and allows agencies to improve facilities and safety based on traffic volume data that shows demand and user facility needs.

Those benefiting from this research include state, county, MPO, and city traffic program managers; signal operating agencies; and the public at large (due to resource saving and increased safety and mobility due to improved data and decision-making).

Implementation Considerations

- Consider legislation to ensure that the practices outlined as a part of this research are adequately implemented
- Standards are under development for a pedestrian safety message (PSM), which would perform the same function for vulnerable road users like pedestrians and cyclists that the BSM does for vehicles. Because these handheld devices would also transmit location information agencies could collect this data over the air as well. Would the handheld transmitter simply be a smartphone or instead a device similar to what is in vehicles? Would the policies and procedures for securing vehicle-based data apply directly to pedestrian devices or would implementation of collection, aggregation, and anonymization need to be adjusted for them?

Recommended Research Funding and Research Period

\$400,000 over 24 months

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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- Chris Vaughan, North Carolina State University, (919) 515-8036, clvaugh@ncsu.edu
- Lawrence A. Klein, Klein & Associates, (714) 356-2275, larry@laklein.com

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

None at this time.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Kent L. Taylor, North Carolina Department of Transportation, (919) 345-9829 mobile, klTaylor@ncdot.gov

NCHRP Review of A-15

Reviewed By:

Leslie C. Harwood
LHarwood@nas.edu

Comments:

Concerns over personally identifying information and data usage continue to be an issue at the forefront of the discussion of connected and automated technologies. The proposed research will create guidance for state DOTs concerning privacy issues of the data obtained from these technologies. The budget and timeline are appropriate for this proposed project. However, it should be considered that technologies are ever-changing in this space and the outcomes of this project may need to be updated in the near future. In addition, legislation is listed under the implementation section of this needs statement and is not something that NCHRP can work on. I also agree with the commenter from FHWA that the objective needs to specify that this project is looking at these issues in the context of public agencies and not with private companies; however, I suggest that this research cover any access which is granted to the data (e.g. via contract with a private organization by a state DOT).

Review Date:

12/17/2021

FHWA Evaluation of A-15Reviewed By:

Chou/HRSO

Comments:

The problem statement outlines two issues regarding connected vehicle data that are of concern to public agencies: 1) the processes, procedures, and systems that will be necessary to collect, aggregate, analyze, and transform huge volumes of high-velocity data into actionable information in a cost efficient manner, and 2) how to protect those data throughout the process from collection to disposition. The problem statement needs some editorial work to clarify that the authors proposed to address concerns with the collection, use, and storage of personal (vehicle) data by State and local DOTs and other public agencies, and not collection by private entities.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for A-15Submitted By:

Chad Baker

Research Subcommittee Chair

Data Management and Analytics

Priority #: 5

Comments:

Merge with A-17?

Submitter Response for 2023-A-15From:

[email: kltaylor@ncdot.gov]

Comments:

The authors agree with reviewer comments on Problem Statement A-15.

We recommend also adding an additional Research Objective between b) and c), to be the new c):

“Identify risks and mitigations in the case that a public agency grants access to a third party.”

Under Implementation Considerations we suggest deleting the bullet point that refers to legislation. We also recommend adding a new bullet point after the bullet point on standards as follows:

- “Data can be freely collected because there is no prohibition on receiving any data transmitted over the air. Interacting with a transmitting system is prohibited (hacking), but not collecting its transmissions. Collecting data from a Smartphone app would likely require opt-in.”

Contact Info:

Kent L. Taylor, North Carolina Department of Transportation, (919) 345-9829 mobile, kltaylor@ncdot.gov

Review Date:

02/07/22

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-A-16

Problem Title

Technology Assistance for Small & Rural Transit Agencies

Background Information and Need For Research

Research recently published in TCRP Synthesis 154 documented small/rural transit agencies' concerns about obtaining, implementing, learning how to use, and maintaining new technologies to improve service effectiveness, efficiency, and customer satisfaction. Small/rural transit agencies are interested in applying such technologies but are likely to have more-limited financial and staffing resources than their large/urban counterparts, which can constrain their ability to acquire, make full use of, and sustain such technologies. There is a need to identify and develop methods and tools that small/rural transit agencies can use to overcome their resource limitations and realize the benefits of technological innovations and investments.

Literature Search Summary

The proposed research follows from research recently published in TCRP Synthesis 154. It is expected that the proposed research could be informed by information in RITA's Transit Training Needs Assessment: Identifying Current and Future Training Needs of the Public Transportation Industry, Final Report, which was published in May 2021.

Research Objective

The proposed research will produce a report that contains guidance and tools to assist small/rural transit agencies in acquiring, implementing, and maintaining new technologies to improve service effectiveness and efficiency. Among other relevant solutions, TCRP Synthesis 154 documented two cases in which development of a technology business plan was reported to be critical to successful integration of new technologies. Thus, the proposed research will develop a "model" technology business plan that small/rural transit agencies can adapt to their needs; the research will also provide guidance for how to carry out such adaptations.

Potential research tasks:

- Development of research plan (Month 1)
- A review of relevant literature and available agency plans and reports of relevance (Month 2)
- Conduct of a survey to identify agencies' approaches to technology investments, resources, relevant costs, needs, and tools (Months 3-4)

- Conduct of focus groups and/or case studies in which agencies' approaches to technology investments, their resources and costs, and their needs and tools are explored and evaluated in detail (Months 5-6)
- Acquisition and evaluation of tools that agencies have developed and/or used to support their technology investments (e.g., technology business plans) (Months 6-7)
- Preparation of an interim report to summarize the above-listed tasks and establish the focus of the next phase of the research (Month 8)
- Panel review of interim report and panel meeting (Month 9)
- Development of tools to address identified needs, including a model technology business plan (Months 10-13)
- Preparation of a draft final report (Month 14)
- Panel review of draft final report and panel meeting (Month 15-17)
- Preparation and submittal of final report (Month 18)

Urgency and Potential Benefits

The proposed research addresses needs expressed by multiple transit agencies in the recently completed TCRP Synthesis 154 research. Helping small/rural transit agencies acquire, implement, and maintain new technologies will help small/rural transit agencies improve service effectiveness and efficiency, thereby getting more value from state funds used to support transit service. The ultimate beneficiaries of the research will be members of the public for whom public transportation provides accessibility and mobility (e.g., those who need public transportation to reach jobs, health care opportunities, education opportunities, and so on).

Implementation Considerations

State DOT divisions that will be responsible for making use of and/or disseminating the research results are most likely to be public transportation programs/divisions. The research will be a value tool in state DOT's toolkits for providing technical assistance to the transit agencies in their states, particularly if state DOT's sponsor informational or training sessions based on the proposed research.

Recommended Research Funding and Research Period

Recommended Funding: \$200,000

Research Period: 18 months (see the task list above for a more-detailed schedule)

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Kelly Blume
Texas A&M Transportation Institute
505 E Huntland Dr, Suite 455
Austin, TX 78752

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Some of the transit agencies and DOT staff that participated in the TCRP Synthesis 154 studies may be willing to participate on the panel for the proposed research.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Kelly Blume
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505 E Huntland Dr, Suite 455
Austin, TX 78752

NCHRP Review of A-16

Reviewed By:

Camille Crichton-Summers
ccrichton-summers@nas.edu

Comments:

This is a nationwide issue where entities that fall within the purview of state DOTs could benefit from the acquisition, implementation, and maintenance of new technologies that could improve service efficiency. These agencies lack sufficient resources to vet, purchase, implement, and maintain new technologies and train staff accordingly. State DOTs are responsible for the dissemination of state planning and research (SPR), Local and Tribal Technical Assistance Programs (LTAP/ TTAP), or other federal funds and/or with a governance role in multimodal transportation systems. Small & Rural Transit organizations are among the recipients. Improving the means by which they provide service benefits multimodal system performance at local and regional levels. The research objectives will aid in mobility and accessibility and should include linkages to multimodal systems and may include equity considerations. The research may not be eligible for NCHRP funds because it is directed at improving transit agency performance. If should several technologies are included in the scope the budget and schedule should be increased.

Review Date:

12/17/2021

FHWA Evaluation of A-16

Reviewed By: N/A

Comments:

We do not see this as an eligible activity.

Review Date:

December 17, 2021

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-A-17

Problem Title

Assessing Big Data Privacy and Utility Trade-offs for Transportation Agencies

Background Information and Need For Research

With the ubiquitous usage of information and communication technologies by transportation system users (like smartphones), sensorization of multi-modal transportation networks, and the emergence of demand responsive services, large amounts of longitudinal data on individual movement and activity patterns have become available to transportation agencies. Such data, commonly known as “big data,” have opened up new opportunities to measure, understand, model, and predict mobility behavior and system usage/performance at a very high resolution for planning, design, and operations.

Various transportation agencies have started using such big data for different projects. However, due to their high level of granularity and widespread availability, big data in transportation have the potential to raise privacy concerns for individual users. To safeguard user privacy, various anonymization, de-identification, and aggregation techniques have been developed over time in order to protect privacy. However, these same techniques may also decrease the utility of the data or render them useless for analyses of interest to transportation agencies. Therefore, it is necessary to recognize both objectives: protecting privacy and maximizing the utility of the data in selecting the methods for privacy protection. By looking through a more specific contextual lens of various transportation analyses, it may be possible to address many of these privacy challenges by applying appropriate techniques and practices, while maintaining high information utility in the data.

Literature Search Summary

The ubiquitous nature of personal information and potential for misuse raise concerns for the protection of individual privacy [1]. A vast array of technical safeguards have been developed to protect personal information ranging from simple aggregation to k-anonymity, differential privacy, and the creation of synthetic sets and generative models. For example, in 1998 Sweeney and Samarati [2] demonstrated the k-anonymization model for protecting privacy when disclosing information through generalization and suppression. Subsequent work including l-diversity [3], t-closeness [4] and (k, e) Anonymity [5] addressed weaknesses in the work, showing that while k-Anonymity was sufficient in certain contexts and use cases, it was not sufficient to provide privacy protection in others. Dwork [6] then proposed “differential privacy” to guarantee privacy protection for individual participants whose addition or removal from a survey does not affect the aggregate outcome. More recently, population synthesis and

deep generative models have evolved to maintain a balance in the trade-off between the guarantee of privacy and the loss of utility, including the development of a generative model for synthesizing privacy-enhanced travel activity diaries for travel model validation by Badu-Marfo et al. [7]. Passing knowledge of the practice of big data analytics for transportation, however, indicates that privacy protection measures and strategies are often “homegrown” solutions not directly derived from or identical to the methods published in the literature. It will therefore be important to review these methods as part of the research as well.

References:

1. National Academies of Sciences, Engineering, and Medicine 2018. Cell Phone Location Data for Travel Behavior Analysis. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25189>.
2. Samarati, P. and L. Sweeney (1998) Protecting privacy when disclosing information: k-anonymity and its enforcement through generalization and suppression, Technical Report, Technical report, SRI International.
3. Machanavajjhala, A., J. Gehrke, D. Kifer and M. Venkatasubramanian (2006) l-diversity: Privacy beyond k-anonymity, paper presented at the Data Engineering, 2006. ICDE'06. Proceedings of the 22nd International Conference on, 24–24.
4. Li, N., T. Li and S. Venkatasubramanian (2007) t-closeness: Privacy beyond k-anonymity and l-diversity, paper presented at the Data Engineering, 2007. ICDE 2007. IEEE 23rd International Conference on, 106–115.
5. Wong, R. C.-W., J. Li, A. W.-C. Fu, and K. Wang (2006) (α , k)-anonymity: an enhanced k-anonymity model for privacy preserving data publishing, paper presented at the Proceedings of the 12th ACM SIGKDD international conference on Knowledge discovery and data mining, 754–759.
6. Dwork, C. (2008) Differential privacy: A survey of results, paper presented at the International Conference on Theory and Applications of Models of Computation, 1–19.
7. Badu-Marfo, Godwin, Bilal Farooq, and Zachary Patterson. "A Differentially Private Multi-Output Deep Generative Networks Approach for Activity Diary Synthesis." arXiv preprint arXiv:2012.14574 (2020).
8. Badu-Marfo, Godwin, Bilal Farooq, and Zachary Patterson. "Perturbation methods for protection of sensitive location data: Smartphone travel survey case study." Transportation Research Record 2673.12 (2019): 244-255.

Research Objective

The objective of this research is to map privacy and information utility issues associated with various types of Big Data either currently used or potentially available for use by transportation agencies and to recommend best practices to address these issues, while maintaining a high level of information utility for specific transportation use cases. Attention will be given to privacy issues that may arise due to the adoption of emerging technologies and services, e.g., connected and automated and mobility as a service. This work would involve the following tasks:

Task 1: Literature search of past studies

A systematic review of the recent transportation literature will be conducted to understand the various uses of big data, identify major use cases, state-of-the-art on privacy challenges, techniques for protecting data, and their effects on privacy of users and utility of the data for transportation agencies. A focus will be on what lessons can be learned from past studies and how they can be generalized into standard operating practices. Attention will be given to whether and how privacy protection measures already vary by use case. Best practices adopted by other industries that also deal with location and personal data will be identified and assessed as well.

Task 2: Survey of state practices and data providers on use cases and data availability
A thorough scan of existing and potential data sources, type of use cases, expectations in terms of utility of big data in various use cases, privacy challenges and mechanisms/tools, priorities for protecting, and best practices deployed by transportation agencies will be conducted. The task will involve systematically interviewing staff from agencies and commercial data providers as well as developing online surveys. Existing as well as upcoming privacy guidelines provided by the U.S. Federal government as well as EU, Canada, and Australia and their relevance to Transportation industry will be documented.

Task 3: Synthesize survey responses to identify privacy concerns and develop potential strategies

This task will involve analyzing the database created in Task 2 to develop a detailed mapping of current and emerging privacy issues and expectations in terms of use of Big Data for existing and emerging use cases by transportation agencies. Based on the literature review completed in Task 1, the research will develop some initial strategies to address the issues pointed out here.

Task 4: Create preliminary recommendations

This task will involve compiling preliminary recommendations on appropriate best practices for privacy preservation, based on the type of Big Data sources available for transportation analysis to agencies. The task will address the relevance of privacy preserving practices to specific use cases and their effects on the utility of transformed data in use cases. It will discuss the spatio-temporal scales used in practice and the potential effects on privacy and utility when adjusting these scales in different use cases.

Urgency and Potential Benefits

The unintended privacy violation of sensitive information of a large number of users has become an increasingly serious concern. Badu-Marfo et al. [8] showed that even if trip ends in GPS data are masked using random perturbation techniques, with enough information, important locations (e.g., place of residence) can be inferred. Many state DOTs are either using, or planning to use, big data that contain individual level information (e.g., location-based services [LBS] data) for different purposes. In this context, it is critical to prepare transportation agencies on how to protect user data privacy, while successfully using the rich information contained in big data for

transportation analysis. The research done here will benefit state and local agencies by developing recommendations that can be embedded into planning practice. It is expected that these recommended best practices, can help transportation agencies build the trust of the public needed to ensure the ability to use such data into the future. Furthermore, it will enable them to safeguard against any financial damage that may occur due to hacking or data leaks.

Implementation Considerations

Any department within a state DOT or MPO (e.g., planning, travel demand modeling, transportation system analysis) using big transportation data will benefit from this research. State DOTs and MPOs can implement the recommendations from this project to set privacy related requirements of using big data. Consultants analyzing user data to serve agency needs will also be able to implement the recommendations of this project.

Recommended Research Funding and Research Period

Budget is expected to be \$400,000. It is estimated that 12 months would be needed to complete the data collection and consultation, and another 12 months are needed to analyze the collected data and develop detailed recommendations.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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Samiul Hasan, Ph.D., Assistant Professor, University of Central Florida (Email: samiul.hasan@ucf.edu, 407-823-2480)

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Zachary Patterson, PhD, Concordia University, Montreal, Canada (zachary.patterson@concordia.ca, 514-848-2424)

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

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Bob Osmond, Virginia DOT, Robert.Osmond@vdot.virginia.gov, 804-201-1400

Jeff Von Brown, Iowa DOT, jeff.vonbrown@iowadot.us,

We have also received support from the following organizations for this problem statement:

Virginia DOT

Kentucky DOT

Michigan DOT

Iowa DOT

Transportation Research Board Urban Transportation Data and Information Systems Committee (AED20)

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Michael Fontaine

Virginia DOT/Virginia Transportation Research Council

Michael.Fontaine@VDOT.Virginia.Gov

434-293-1980

NCHRP Review of A-17

Reviewed By:

Sid Mohan

smohan@nas.edu

Comments:

While this problem statement deals with an important issue, the scope could be tightened to focus primarily on Task 4. Some of the other tasks as envisioned in this problem statement would be better suited for an NCHRP synthesis project. The major value of this problem statement could be in the development of recommendations (as stated in current Task 4) for data privacy at all stages of data lifetimes, right from when it is collected, to when it is processed, to analyzed, to stored, to disseminated etc. These recommendations could also have value for the various external partners (such as contractors) a transportation agency deals with on a day-to-day basis, and who collect, store, share data on behalf of transportation agencies.

Review Date:

12/13/2021

FHWA Evaluation of A-17

Reviewed By:

Tianjia Tang/HPPI

Comments:

The proposed research is needed and is timely. The proposed objective is reasonable and can be achieved. However, the proposed budget (\$400k) appears to be high. Our estimate is that the cost should be no more than \$250k.

Review Date:

December 17, 2021

Submitter Response for 2023-A-17
From:

[email: michael.fontaine@vdot.virginia.gov]

Thanks to the reviewers for their comments

Comments:

By FHWA Evaluation of A-17 Reviewed By: Tianjia Tang/HPPI

Response:

The authors agree with the suggested budget of \$250k.

By: Sid Mohan smohan@nas.edu

Response:

The authors agree with this comment and have revised the tasks to address it. The authors also believe that the revised tasks are consistent with the revised budget. The revised tasks are as follows:

Task 1: Literature search of past studies

A systematic review of the recent transportation literature will be conducted to understand the various uses of big data, identify major use cases, state-of-the-art on privacy challenges, techniques for protecting data, and their effects on privacy of users and utility of the data for transportation agencies. A focus will be on what lessons can be learned from past studies and how they can be generalized into standard operating practices. Attention will be given to whether and how privacy protection measures already vary by use case. Best practices adopted by other industries that also deal with location and personal data will be identified and assessed as well.

Task 2: A comprehensive analysis of potential use cases and privacy preserving techniques

A thorough compilation of existing and potential data sources, type of use cases, expectations in terms of utility of big data in various use cases, privacy challenges and mechanisms/tools, priorities for protecting, and best practices deployed by transportation agencies will be conducted. A variety of relevant use cases will be

considered, e.g., long-term transportation planning, level of service improvement on an urban arterial, and diversity, equity, and inclusion analysis for public transit options. Existing as well as upcoming privacy guidelines provided by the U.S. Federal government as well as EU, Canada, and Australia and their relevance to Transportation industry will be documented. This task will also involve developing a detailed mapping of current and emerging privacy issues and expectations in terms of use of Big Data for existing and emerging use cases by transportation agencies.

Task 3: Create preliminary recommendations

This task will involve compiling preliminary recommendations on appropriate best practices for privacy preservation, based on the type of Big Data sources available for transportation analysis to agencies. The task will address the relevance of privacy preserving practices to specific use cases and their effects on the utility of transformed data in use cases. It will discuss the spatio-temporal scales used in practice and the potential effects on privacy and utility when adjusting these scales in different use cases. Synthetic data generation techniques, e.g., generative adversarial networks, as an alternative to original data sharing will be discussed. The recommendations will address privacy issues at all stage data lifecycle including when it is collected, to when it is processed, analyzed, stored, and shared.

Contact Info:

Michael Fontaine, Michael.Fontaine@VDOT.Virginia.Gov

Review Date:

2/8/22

Research Field B

TRANSPORTATION PLANNING

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-01

Problem Title

Guidelines for Use of the FEMA's National Risk Index in State Highway Transportation Planning

Background Information and Need For Research

The Federal Emergency Management Agency's (FEMA) National Risk Index (NRI) analyzes eighteen natural hazards (e.g., hurricanes, tornadoes, winter weather) and computes natural hazard exposure, frequency, historic loss ratio, expected annual loss, risk scores, and ratings for each hazard in each county and Census tract in the US. The risk methodology includes three components: a natural hazard component (expected annual loss), a consequence enhancing component (social vulnerability), and a consequence reduction component (community resilience).

While the NRI goes beyond the expected annual loss (EAL) statistic, this important quantitative component utilizes hazard-specific innovative methods for developing frequency and historical loss data that is now available to the public. It also contains a consequence factor that considers buildings, population, and agriculture exposure to each of the 18 natural hazards. It is expected that the EAL statistic will be widely relied upon for community preparedness and planning, supply chain vulnerability modeling, and for insurance purposes. It is envisioned that FEMA will continue to revise and improve various hazard methodologies as new data and methods become available.

The NRI web application enables data interactions analyses, reports, and access to downloadable county and Census tract data. This tool was developed to help support natural hazard planning for emergency managers for cities and states and can be used to inform funding decisions at local and federal levels. As State DOTs are continually looking for ways to adapt and incorporate increased natural hazard severity into capital planning, they would benefit from new interpretative guidance.

Although guidance for incorporating natural hazards into transportation planning exists (e.g., NCHRP Report 931: A Guide to Emergency Management at State Transportation Agencies), additional interpretive guidance is needed to help State DOTs consistently, and correctly, apply the NRI information including the annualized frequency, consequence exposure, historic loss, and expected annual loss components and additional factors for social vulnerability and community resilience.

Literature Search Summary

TRB has funded a number of research projects related to this area and these have the potential to inform new guidelines for natural hazard resilience planning. A few selected

studies include the development of all-hazards emergency management and response guidelines (NCHRP 20-116; NCHRP Research Report 931; NCHRP 14-45), pilot testing of climate change design practices (NCHRP 20-44(23); NCHRP 15-80; NCHRP 15-61), a framework for flood event decision making (NCHRP 20-59(53)), and support for state DOT system resilience and all-hazards programs (NCHRP 20-59(56); NCHRP 20-117).

State DOTs and transportation research institutions have also published their own research on local natural hazard resilience improvement projects. These projects are typically isolated and function as individual models for specific areas and hazards. Many projects center on evaluation of natural hazard threats and capital planning projects to mitigate hazard impacts. However, some projects aim to improve response following a hazard event. For example, California has developed a transportation-specific web application in partnership with USGS called ShakeCast which enables rapid emergency response during earthquakes and prioritizes bridges for inspection based on proximity to the epicenter and earthquake magnitude.

Research Objective

To develop guidelines for use of the National Risk Index (NRI) in State highway transportation planning. The guidelines will include practical advice on interpreting the hazard-specific and composite risk score and component values for the purposes of 1) revising existing hazard mitigation plans, emergency response plans, capital investment plans, and strategic plans and 2) improving decision-making and analysis in other common-use case scenarios (e.g., local zoning, insurance). The guidelines will also include contextual advice on how to use NRI data for inclusion in risk assessments and designing risk mitigation strategies to address risk.

Urgency and Potential Benefits

Many State DOTs would immediately benefit from new interpretative guidance on the use of NRI. There is an urgent need to clarify how to compare community scores and what the scores should mean in the context of decision-making around capital investments and insurance. This project would incorporate the most current NRI data and supporting documentation and guidance developed as part of this research could then be released to State DOTs with the most up-to-date information.

Implementation Considerations

It is not anticipated that there would be any barriers in implementation. The guidelines could be readily used by State DOTs after publication.

This research needs statement is supported by:

TRB AT000 Freight Systems Group

AASHTO Special Committee on Freight, Caroline Kieltyka (AASHTO Liaison),
ckieltyka@aashto.org, 202-624-8489

Recommended Research Funding and Research Period

It is estimated that a budget of \$350,000 and 18 months would be needed to complete this research.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Richard Bornhorst, FACTOR, Inc.
 rbornhorst@factorinc.com
 (202) 381.0622

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Tom McQueen, Georgia Department of Transportation, tmcqueen@dot.ga.gov,
 404.631.1785

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

AASHTO Special Committee on Freight
 Caroline Kieltyka (AASHTO Liaison)
 ckieltyka@ashto.org
 202-624-8489

NCHRP Review of B-01Reviewed By:

Trey Joseph Wadsworth
 twadsworth@nas.edu

Comments:

The proposed research could be valuable to DOTs in understanding this tool and how they could apply it to their planning. As suggested in the problem statement, it is a tool available nationally and that might be beneficial for DOTs to use as a consistent resource in their planning efforts. The other benefit is that the NRI has an equity lens with social vulnerability, which would be helpful to DOTs in achieving equitable outcomes if they had guidance on how to best utilize the NRI. The timeline and budget seem reasonable.

Review Date:

12/13/2021

FHWA Evaluation of B-01Reviewed By:

Becky Lupes, Elizabeth Habic - HEPN-30

Comments:

The risk index should not be recommended for highways and there are many other tools that serve this purpose. The research objectives don't seem to be geared toward State DOTs; the research would be better developed in partnership with a DOT and with input from the AASHTO Committee on Transportation System Security and Resilience and the TRB Committee on Extreme Weather and Climate Change Adaptation.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-01

Submitted By:

Caroline Kieltyka

AASHTO staff

Special Committee on Freight

Priority #: 12

Comments: N/A

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-02

Problem Title

New Environment Planning – An Identification and Examination of the Inter-relationship Between Evolving Changes for Commercial Vehicles related to Fuel Type (i.e. electric and hydrogen), Technology (i.e. autonomous), and Operational Issues (i.e. human factors); and the Corresponding Impact on future Freight and Transportation Planning Issues, Infrastructure and Operation Needs for Public Transportation Corridors, and overarching Public Policy Implications

Background Information and Need For Research

The complexity and inter-related long-term impacts associated with a variety of rapidly-changing factors for commercial vehicles including fuel options, technologies, business operational environment, freight flow changes (local, regional, national and international) require a comprehensive examination. A silo approach which deals with a specific subject is no longer appropriate for this evolving environment. The pandemic has accelerated many issues and laid bare structural issues which limit the ability of the existing freight transport industry in the United States to respond to significant disruptions.

The inter-play among new fuel options, vehicle technology and operational issues impact the transportation and freight planning processes. Many trucking firms are interested in switching to alternative fuels but may be hesitant due to the lack of corresponding fueling infrastructure. At the same time, commercial vehicle technologies are undergoing major and ongoing changes. Additionally, the impact of federal hours-of-service enforcement changes in recent years and the challenges in attracting and retaining drivers are leading to implementation of new concepts by the industry and government.

This research will examine the various factors and bring them together in a comprehensive coordinated report which identifies these inter-relationships and the impacts on all aspects of freight planning. A final issue which requires study is the timing of the introduction and adoption of different alternative fuels.

Research-informed public sector transportation agencies can assist by creating balanced, multivariate-based transportation planning concepts and processes which incorporate such issues as fueling station selection, location and emerging fuel type considerations; truck O-D patterns; truck size/weight and type characteristics; and available land use planning options taking into account local development characteristics and trends.

Literature Search Summary

A cursory literature review did not identify any research and/or reports which specifically addresses the issues identified in the problem statement.

Research Objective

The objective of the research is to inform local land use planners as well as regional and state DOT transportation planners of the changing and evolving environment focused on the emerging dynamics between these aspects of changing freight industry operations and needs. The research product should provide a baseline understanding upon which recommended processes can be employed to assist in freight-focused public-sector planner stakeholders at all levels and deliver a guidebook which provides those planners with guidance and recommendations for appropriate processes under different development scenarios.

Urgency and Potential Benefits

The emergence of national and state pronouncements, most related to addressing climate change, is focusing on the use of alternate fuels for commercial vehicles. This is leading to an effort to identify the location, design, and function of local and highway-based fuel stations (travel/truck stops). Private sector freight industry planners continue to identify, recommend and implement the use of new energy sources for commercial vehicles and need strong public sector partnerships to develop and/or re-develop the facilities, utilizing a variety of tools that focus on optimizing their employers' return on investment.

Public agency planners need to understand the processes to assist locating and developing these critical facilities. This understanding will enhance their ability to anticipate and accommodate the developments from a perspective of beneficial impact to the socio-economic-transportation fabric of the community emerge. The impacts can spread beyond the immediate precincts of the fueling station.

As a result of the research, planners will understand the factors employed to identify and select locations for the stations and the direct and indirect impacts on the socio-economic-transportation fabric of the community. The identification of the root factors and the consequential impacts will assist planners in proactively creating programs to proactively and strategically support the location of the stations with a balanced consideration of local land use impacts.

Implementation Considerations and Supporters

The research should lead to the development of a guidebook which outlines the identified locational factors and the impacts. The optimal presentation of this information would be in an interactive guidebook which includes explanatory scenarios. This research will develop a guidebook for agencies to consider as they identify and assist in the development of these locations.

This research needs statement is supported by:

AASHTO Special Committee on Freight, Caroline Kieltyka, ckieltyka@ashto.org, 202-624-8489

Recommended Research Funding and Research Period

This project should be completed within 18 months. Suggested funding is \$400,000.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

- Charles Edwards, Univ. of North Carolina at Chapel Hill, chwedwards@gmail.com, (919) 215-0605
- Sushant Sharma, TTI, s-sharma@tti.tamu.edu, (314) 556-7363
- Tom McQueen, Georgia Department of Transportation tmcqueen@dot.ga.gov, (404) 631-1785

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

- Charles Edwards, Univ. of North Carolina at Chapel Hill, chwedwards@gmail.com, (919) 215-0605
- Sushant Sharma, TTI, s-sharma@tti.tamu.edu, (314) 556-7363
- Tom McQueen, Georgia Department of Transportation tmcqueen@dot.ga.gov, (404) 631-1785

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Caroline Kieltyka
 AASHTO – Program Manager for Freight
 ckieltyka@aaashto.org
 202.624.8489

NCHRP Review of B-02

Reviewed By:

Trey Joseph Wadsworth
 twadsworth@nas.edu

Comments:

The proposed research objective needs clarity. The proposed research may benefit from the conclusion of active research. NCHRP Synthesis 53-08 Strategies and Programs for Electric Vehicle Charging is looking at DOT practices on EV charging for both passenger and freight. Additionally, NCHRP 20-102(22) State and Local Impacts of Automated Freight Transportation Systems is comprehensively looking at the freight system as suggested in the proposed problem statement, but from the technology side, rather than the fuel side. However, the issue may be related and the frameworks suggested by NCHRP 20-102(22) may be beneficial to the proposed research (publication anticipated in 2023). Both of these active research projects might provide a better underpinning for the desired research in the proposed problem statement and help avoid duplication of effort

Review Date:
12/13/2021

FHWA Evaluation of B-02

Reviewed By:
Diane Turchetts, John Davies - HEPN-30

Comments:

This problem statement is timely, particularly given the IIJA grant program to support deployment of EV charging infrastructure and fueling infrastructure for H2, propane and natural gas. However, we are concerned the proposal's broad scope encompasses a large set of complex issues that would need to be addressed for the study to have value for transportation decision-making. If the study is going to address a range of alternative fuel types, this suggests the need to identify the fuel type available, cheapest, and range-appropriate for different hauling distances and geographies. Addressing the electricity aspect of this question alone could be challenging, since there's a question of where specifically there could be sufficient power to support significant demand for charging (potentially including fast charging). We suggest dropping the automation element since it seems severable in many ways from the fuel/energy aspect of the proposal. We also suggest considering whether the fuel/energy element can be narrowed, and suggest being more specific about the transportation decisions that would be informed by this proposal. More detail on fueling station selection (not quite sure what this means), as well as location and land use decisions, is suggested. It would also help if the proposal spoke to the role of public sector vs private sector in deploying charging/fueling infrastructure. Finally, I would note that there has been some related research in this area. See for instance the list of publications by Lew Fulton of UC Davis, who has completed papers on Electrification of Medium- and Heavy-Duty Ground Transportation and Automation, Electrification and Shared Mobility in freight. It would be helpful to know how this research would contribute beyond these published sources. Publication list: https://itspubs.ucdavis.edu/author_detail.php?id=979

Review Date:
December 17, 2021

AASHTO Committee Evaluation for B-02

Submitted By:
Caroline Kieltyka
AASHTO staff
Special Committee on Freight

Priority #: 7

Comments: N/A

Submitter Response for 2023-B-02From:

Caroline Kieltyka, AASHTO

Comments:

We appreciate that the initial review suggestions from NCHRP and/or FHWA staff recognize the clear value of the proposed problem statement to *comprehensively* discuss and alert state and federal policy makers -- and policy implementers -- as to the diversity of freight "change agent" issues discussed and their inter-relationships, as opposed to separately and discretely conducting in-depth research about each of the respective issues. Suggestions to limit the scope of the research has merit given the timeframe of the research and funding level, and considering the rapid and ongoing evolution of the topics discussed and for development of alternatives. If pursued this round, this research problem could create a structure for which these and other issues and topics are addressed vis-à-vis changes in policy at the federal, state, and local levels, assisting to clarify the focus of this proposed problem statement.

As the evaluators point out, the topic is very timely however a lack of certainty concerning the final appropriate version of the IIJA (a.k.a. recent Federal transportation re-authorization bill) and the currently-evolving policy directions of associated funding and individual grant programs could delay clear direction of a clear research methodology -- should the problem statement be selected in this round. It may be feasible to pursue this problem statement in the resurrected NCFRP program or in next year's NCHRP solicitation round, as details on national policy directions become clearer and more firmly support that *comprehensive* investigation of the several, inter-related freight "change agent" topics noted in the proposed problem statement.

Contact Info:

- Caroline Kieltyka, AASHTO [[email: ckieltyka@ashto.org](mailto:ckieltyka@ashto.org)]
- Tom McQueen, Georgia DOT [[email: Tom_McQueen@outlook.com](mailto:Tom_McQueen@outlook.com)]

Review Date:

2/7/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-B-03

Problem Title: Defining Appropriate Design and Accommodation Thresholds for Active Transportation in a Context-Driven Approach

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, for example, some Complete Streets policies specify minimum accommodations for pedestrians and bicycles. However, the minimum accommodations are frequently used 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. Research is needed on the design flexibility and the different levels of accommodation recommended for different context and roadway types.

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 that there was a limited evidence base available to inform changes in standards in the AASHTO Bike Guide.

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 primarily for project selection, rather 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

This research will address design flexibility and the different levels of accommodation recommended for different context and roadway types. The objective of this research is to understand (1) how the use of minimum accommodations may limit active transportation, and (2) what alternative approaches and design flexibilities would result in recommendations for different levels of accommodation for different context and roadway types to better serve all road users. The research aims to understand this in different contexts, with a focus on the design and engineering of roadways and intersections.

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 indicates 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 to what extent agencies do or do not exceed minimums. This research would involve case studies, surveys of practitioners, and other data collection approaches. The research would also identify the reasons for not exceeding minimums.
3. Identification and evaluation of alternative approaches, design flexibilities, and/or ways of presenting guidelines, to better serve all active transportation users in the design of roadways and intersections by recommending different levels of accommodation for different context and roadway types. 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 may not often exceed minimum accommodations. 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.
5. Develop a guidebook that explains the advantages and disadvantages of minimum accommodations and provides step-by-step guidance on alternative approaches and design flexibilities that better serve all active transportation users by recommending different levels of accommodation for different context and roadway types. 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 information regarding the effects of alternative decisions-making techniques. Alternative design approaches may also lead to easier implementation at the local level.

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.

Recommended Research Funding and Research Period

\$550,000

24 months

Problem Statement Author(s)

Jennifer Dill, Portland State University
 Christopher Monsere, Portland State University
 Jeremy Chrzan, Toole Design Group
 AASHTO Council on Active Transportation

Potential Panel Members

N/A

Persons Submitting the Problem Statement

Toks Omishakin, Caltrans Director, and Chair of the Council on Active Transportation

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.
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- 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.
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NCHRP Review of B-03

Reviewed By:

Trey Joseph Wadsworth
twadsworth@nas.edu

Comments:

The proposed research could be valuable to DOTs and other transportation agencies in improving their practices and design approach for active transportation. The objective could be expanded to explore the interaction between freight and active transportation in achieving desired accommodations for all users, especially as access to curb space is in greater demand with the rise of e-commerce and TNCs who need ready access to the curb creating potential conflicts with active transportation users. NCHRP Synthesis 53-17 *Integrating Freight and Active Transportation into Policies, Programs, Plans, and Project Development* will document current DOT practices on this topic and the findings could help with this proposed problem statement. The timeline and budget seem reasonable.

Review Date:

12/13/2021

FHWA Evaluation of B-03

Reviewed By:

Darren Buck/HEPH-10

Comments:

We see some benefit in this research, but it's not a high priority. Understanding the land use and design context for Complete Streets implementation is paramount to ensure that streets are designed with an acceptable (minimum) level of comfort for all users. This effort could also help provide guidance for using the Performance Based Practical Design process for walking and bicycling facilities and designing for appropriate for the contexts. It could also supplement NCHRP 15-72, Identification of AASHTO Context Classification. However, this project has been not identified as a critical research need at this time by the CAT or FHWA bicycle and pedest research outreach processes.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-03
Submitted By:

Patricia Bush
AASHTO staff
Committee on Design

Priority #: N/A

Comments:

Endorsed by Committee on Design.

Submitted By:

Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: 4

Comments: N/A

Submitter Response for 2023-B-03
Comments:

- Please note that Levels of Traffic Stress and Safe System Approaches will be addressed in the research approach.
- Through NCHRP 20-123, a research Roadmap was developed to assist the Council on Active Transportation implement the research components of its 2018 Strategic Plan. To identify and define research priorities, the team reviewed existing and on-going research; conducted a survey of practitioners, including

AASHTO councils and committees, TRB committees, state DOTs, and ITE, APBP, and NACTO members; and conducted a series of practitioner workshops. The Roadmap contains active transportation research that will address the most important needs of state DOTs. The priority level of research identified in the Roadmap 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. Of the 110 research topics identified, this was the #4 priority for CAT.

Contact Info:

Bud McDonald

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Review Date:

2/3/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-B-04

Problem Title: Institutional Integration of Active Transportation

Background

Walking, bicycling, and rolling needs should be considered in nearly all transportation 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, walking, bicycling, and rolling are often not considered or considered only as an afterthought. This points to the need for institutional change.

Literature Search Summary

There is some limited research to explain why active transportation infrastructure, process, practices and processes are (or are not) institutionally adopted. That research identified factors such as political leadership, local advocacy, 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). Carefully documented case studies of successes and failures in institutional 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 institutional policy learning and transfer, as well as 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. A 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 look at state department of transportation institutional structures, policies, programs, processes and practices from top leadership through various disciplines and program phases, including planning, environment, design, construction, operations, maintenance, safety, communications/public outreach, and contracting (hereafter referred to as “agency institutional structure and policies”) and how active transportation can be effectively institutionally integrated. This research will (1) identify and assess the challenges to embedding active transportation throughout agency institutional structure and policies, (2) identify existing strategies to overcome those challenges, and (3) recommend additional strategies to overcome those challenges. The research will focus on internal challenges that can be influenced and changed directly by state departments of transportation

The research will involve collecting transportation agency case studies and additional data through practitioner surveys, focus groups, and/or other appropriate methods. The research will use relevant theory from transportation and other disciplines. The challenges and factors considered in the research will include, but not be limited to:

- organizational structure and scale (including the institutional position of the state bicycle and pedestrian coordinator);
- political and administrative leadership;
- leadership consideration of walking and bicycling as system needs;
- influence by outside organizations;
- staff knowledge, experience, and attitudes;
- existence of context sensitive, complete streets or other policies that balance the needs of all users in project development and delivery;
- active transportation needs and design solutions that are not only based on historic data but also consider future growth and future counts for active transportation users;
- the inclusion of active transportation as a primary purpose for projects;
- policy conflicts between local, state and federal agencies;
- how active transportation benefits are incorporated when calculating a cost benefit ratio for a project;
- consideration of connecting active transportation infrastructure;
- consideration of how bicyclist and pedestrian facilities improve the human environment;
- use and influence of agency performance measures;
- funding processes, levels and structures;
- research or information gaps and the application of outdated or inaccurate information, manuals and data;
- 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
- transportation mode equity and systemic biases.

Project tasks include the following:

1. Review of existing research. The review will cover relevant theories, such as policy transfer, policy learning, and institutional and organizational change and culture, from other disciplines, as well as existing transportation case studies.
2. Develop a research plan. That plan will include case studies and other data collection methods, such as surveys and focus groups.
3. Identify and select case studies based on selection criteria identified in the research plan. The case studies will likely include examples of both success and failure and represent a range of agency, geographic (urban, rural and suburban) and social contexts.
4. Collect case studies, data and information from top leadership through various disciplines and program phases, including planning, environment, design,

construction, operations, maintenance, safety, communications/public outreach, and contracting.

5. Prepare a report that: (a) reviews the existing research; (b) describes this research effort; (c) identifies and prioritizes the challenges to integrating active transportation into agency institutional structure and policies; (d) identifies strategies used to overcome these challenges; and (e) provides clear recommendations of specific step-by-step actions agencies can undertake to institutionalize active transportation top leadership through various disciplines and program phases, including planning, environment, design, construction, operations, maintenance, safety, communications/public outreach, and contracting. The report will identify information gaps and any application of inaccurate information that may impede progress in institutionalizing active transportation.
6. Prepare step-by-step implementation plans for agency leaders and various disciplines and program phases, including planning, environment, design, construction, operations, maintenance, safety, communications/public outreach, and contracting, with specific short-term and long-term action items. This may include a capability maturity framework assessment tool.
7. The plan will also include ideas for 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 challenges and strategies for overcoming those challenges, which public agencies could use to change current practice. The benefit would be greater consideration of active transportation throughout program and project planning, development and delivery policies, leading to greater use of active transportation modes and improved safety and health and reduced emissions. The research would help shift the culture to include active transportation in all of their policies.

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.

Recommended Research Funding and Research Period

\$600,000

24 months

Problem Statement Author(s)

Jennifer Dill, Portland State University

Talia Jacobson, Toole Design Group

AASHTO Council on Active Transportation

Potential Panel Members

N/A

Persons Submitting the Problem Statement

Toks Omishakin, Caltrans Director, and Chair, Council on Active Transportation

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NCHRP Review of B-04

Reviewed By:

Jennifer L. Weeks
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Comments:

The scope will have to be carefully managed given the focus on public policy and funding allocation. The emphasis on policy will require the researcher to apply techniques to be discrete in the analysis of policies enacted and applied by State DOTs. Other elements that should be looked at in terms of how active transportation is integrated into networks on the ground include processes used for program decision making, project prioritization, and selection for implementation. Lastly, the types of funding that are allocated by State DOTs for implementation of active transportation should be examined. In particular, the allocation of federal funding as well as local contributions (or requirements for local contributions) to active transportation would be an interesting thing to study. The budget is adequate but an additional 6 months will be needed.

Examining the application of active transportation to State DOT transportation networks should be looked at within the socio-economic context. What are the differences in application between states in different geographic regions of the United States, rural versus urban and suburban applications, and demographics of those locations. To be impactful, methods and strategies for incorporation of active transportation policies and projects into transportation plans and programs should be the emphasis of this project, building on the lessons learned from the study. Case studies will be very helpful.

The budget is probably about right and maybe a bit lean for this project.

Review Date:

12/10/2021

FHWA Evaluation of B-04

Reviewed By:

Christopher Douwes/HEPH-10

Comments:

This research is necessary to support Complete Streets and Complete Networks initiatives. It is missing the linkage between State DOTs and other State agencies interested in active transportation. State resource agencies develop statewide comprehensive outdoor recreation plans that include trail plans that can be integrated into active transportation networks. State health agencies often support active transportation efforts.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-04

Submitted By:

Bud McDonald

AASHTO staff
Council on Active Transportation

Priority #: 1

Comments: N/A

Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: N/A

Comments:

Could this be combined with B-05? This project has a low to medium priority and will be more important after other active transportation projects are completed.

Submitter Response for 2023-B-04

Comments:

- The Council appreciates comments from FHWA and NCHRP and recommends that the comments be considered for inclusion in the project scope by the project panel.
- Through NCHRP 20-123, a research Roadmap was developed to assist the Council on Active Transportation implement the research components of its 2018 Strategic Plan. To identify and define research priorities, the team reviewed existing and on-going research; conducted a survey of practitioners, including AASHTO councils and committees, TRB committees, state DOTs, and ITE, APBP, and NACTO members; and conducted a series of practitioner workshops. The Roadmap contains active transportation research that will address the most important needs of state DOTs. The priority level of research identified in the Roadmap 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. Of the 110 research topics identified, this was the #1 (tied) priority for CAT.

Contact Info:

Bud McDonald
bmcdonald@ashto.org

Review Date:

2/3/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-B-05

Problem Title: Integrating Active Transportation Data into Transportation Decision-Making

Background

Active transportation data can inform transportation decision-making at various agency levels. However, tools and resources are needed on how to identify what type of data is most useful for guiding such decision-making, how to package and present such data to convey its meaning and limitations, and how to integrate data from different sources and develop data flow systems to get information where it needs to go. Also, 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 other resources. There is also an emerging industry of companies seeking to help agencies manage their transportation data, including active transportation data.

This research proposal will provide tools and resources for data usage-- how to interpret, apply and integrate active transportation data into transportation decision-making and identify what agency processes and skills are needed to effectively apply data.

Literature Search Summary

The need for this research follows the proliferation in recent years of active transportation data as well as understanding the potential of data from new connected technologies, from 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, and inform safety analyses to quantify exposure for interpreting crash data, project prioritization, and multimodal model development. 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), 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 related to and should be coordinated with this research project. NCHRP 07-31 is focused on data availability, sources, storage, maintenance, needs, and gaps. This research proposal will address data usage-- how to apply and integrate data into transportation decision-making, 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 a portion of the proposed research output. TCRP Synthesis 153 was undertaken “to describe how transit agencies manage, store, analyze, and... govern their transit service data.” The impetus for the project was, in part, the growing availability of transit data and the increasing need to plan and coordinate data usage to use the data effectively. This proposed research is a higher level of effort as 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 step-by-step guidance on incorporating data into agency decision-making.

NCHRP Web-Only Document 226: “Data Visualization Methods for Transportation Agencies” offers another model for a data application tool. Although Document 226 is not specific to active transportation and is focused on the end product of data presentation, the report does demonstrate the importance of specialized data skills and effective data presentation. The proposed research would assess more specialized active transportation data needs and data applications beyond visualization

Research Objective

This research will assess interpreting and applying active transportation data to transportation decision-making in various program phases, including planning, finance, environment, design, traffic engineering, construction, operations, maintenance, and safety. The research will document best practices and develop a set of tools and step-by-step instructions to leverage active transportation data to improve decision-making.

Tasks include:

- Task 1. Conduct a literature review on active transportation data-informed decision-making in planning, finance, environment, design, traffic engineering, construction, operations, maintenance, and safety. From the information collected, document how active transportation data could and should inform transportation decision-making in these arenas. Also document effective workforce training approaches and how to address the effects of missing data for facility presence and quality.
- Task 2. Develop initial application matrices outlining which data can be used for which agency decisions in planning, finance, environment, design, traffic engineering, construction, operations, maintenance, and safety. Also, identify processes, skills, training and resources needed for successful data application.
- Task 3. Develop (using the literature review and initial application matrices) and conduct a scan aimed at better understanding how active transportation data is being, or could be, applied to improve agency decision-making in planning, finance, environment, design, traffic engineering, construction, operations, maintenance, and safety; and what data, processes, skills, training and resources are needed for successful data application. The scan will include interviewing agency staff in policy, planning, finance, environment, design, traffic engineering, construction, maintenance, operations, safety and data specialists, as well as collecting information, documentation and case studies in these areas.
- Task 4. Develop and conduct a survey of external active transportation practitioners regarding what data they have, how they use/apply data, and what skills they need to apply such data. Follow-up interviews may be needed.
- Task 5. Prepare a toolkit with step-by-step guidance to successfully integrate active transportation data in transportation decision-making. The toolkit will include:
 - o Updated application matrices, outlining which data may be used for which agency decisions.
 - o Step by step guidance and processes for integrating data into agency decision-making in planning, finance, environment, design, traffic engineering, construction, operations, maintenance, and safety.
 - o Identification of the skills, training and resources needed to achieve successful data application in agency decision-making.
 - o Collection of best practices for data management, analysis, and application in these agency decision-making areas.
- Task 6. Prepare a final report covering findings from the literature review, scan, and survey. Such findings will include:
 - o Priority additional research and resource needs.
 - o Identification of what additional data and information could better inform agency decision-making.
 - o Plans for developing additional needed resources.
 - o How this research could be applied to performance management
 - o .

Urgency and Potential Benefits

Active transportation data-informed policy and decision-making could help transportation agencies deliver priority, safer walking and bicycling networks; improve active transportation modeling; identify safety hazards and hotspots; focus spending and prioritize resources; and improve agency decision-making 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 to agency decision-making. 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 decision-making processes.

The outputs from this research should help transportation agencies understand active transportation data uses and shortcomings, how they should interpret the data, and how the data can inform agency decision-making.

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. This would also help agencies plan for data needs.

Implementation Considerations and Supporters

The results of the research will be used by agencies to assess where and how to better integrate active transportation data into their decision-making, 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 activities.

Further research would monitor emerging data sources and methods, and assess when updates are needed to the materials developed in this project.

Recommended Research Funding and Research Period

\$550,000

24 months

Problem Statement Author(s)

Nathan McNeil, Portland State University

Jessica Schoner, Toole Design Group

AASHTO Council on Active Transportation

Potential Panel Members

N/A

Persons Submitting the Problem Statement

Toks Omishakin, Caltrans Director, and Chair of the Council on Active Transportation

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NCHRP Review of B-05

Reviewed By:

Trey Joseph Wadsworth
twadsworth@nas.edu

Comments:

The proposed research could be valuable to DOTs, however, the objectives are quite broad. The research panel will have to focus on more specific outcomes to make the inquiry manageable, especially since data can be such an expansive topic. While the desire to improve decision-making is important and useful to DOTs, specific areas of

improvement are not identified in the problem statement, which poses a risk that this research could go in many directions, making the outcomes difficult to implement. The timeline and budget seem reasonable if the scope can be focused.

Review Date:
12/13/2021

FHWA Evaluation of B-05

Reviewed By:
Darren Buck/HEPH-10

Comments:

We see benefit in this research. The proposal meets an identified need among active transportation practitioners to integrate walking and bicycling volume data collected into new analyses and processes. A recent TPCB peer exchange centered on this topic. The focus on integrating data into decision-making is particularly timely, with the new authorization bill, the Administration's focus on Complete Streets, and FHWA's Complete Streets plans to focus on State DOT Complete Streets policies and processes.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for B-05

Submitted By:
Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: 2

Comments: N/A

Submitted By:
Chad Baker
Research Subcommittee Chair
Data Management and Analytics

Priority #: 4

Comments:

Data integration from disparate systems is crucially needed for successful advancements of data management technology.

Submitted By:

King Gee
AASHTO staff
Knowledge Management

Priority #: 3

Comments:

It is recommended that B-04 and B-05 be combined into one project. This research will help identify knowledge and information that needs to be shared in support of active transportation, how and when that knowledge will be consumed, and how new knowledge and information will be reinvested. This research proposal will provide tools and resources for data usage-- how to interpret, apply and integrate active transportation data into transportation decision-making and identify what agency processes and skills are needed to effectively apply data.

Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: N/A

Comments:

Can this be combined with B-04, to increase the priority/urgency of both?

Submitter Response for 2023-B-05

Comments:

- The Council appreciates comments from FHWA and NCHRP and recommends that the comments be considered for inclusion in the project scope by the project panel.
- Through NCHRP 20-123, a research Roadmap was developed to assist the Council on Active Transportation implement the research components of its 2018 Strategic Plan. To identify and define research priorities, the team reviewed existing and on-going research; conducted a survey of practitioners, including AASHTO councils and committees, TRB committees, state DOTs, and ITE, APBP, and NACTO members; and conducted a series of practitioner workshops. The Roadmap contains active transportation research that will address the most important needs of state DOTs. The priority level of research

identified in the Roadmap 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. Of the 110 research topics identified, this was the #2 priority for CAT.

Contact Info:

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Review Date:

2/3/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation****FY2023 NCHRP PROBLEM STATEMENT****Problem Number: 2023-B-06****Problem Title:** 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. Although there is limited data on bicycle injury and fatality disparities, 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. An environmental factor to consider is exposure to harmful air pollution. Racial bias, whether explicit or implicit, could also play a role in pedestrian and bicycle safety, impacting decisions regarding whether to or where to walk or bike. 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 strengths, 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 backdrop 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, BTSCRCP 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 BTSCRCP 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) Coordinate with NCHRP 8-150 to comprehensively 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) as well as specific land use/context data. 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.

Recommended Research Funding and Research Period

\$750,000

36 months

Problem Statement Author(s)

Nathan McNeil, Portland State University

Jennifer Dill, Portland State University

Stefanie Brodie, Toole Design Group

AASHTO Council on Active Transportation

Potential Panel Members

N/A

Persons Submitting the Problem Statement

Toks Omishakin, Caltrans Director, and Chair, Council on Active Transportation

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NCHRP Review of B-06

Reviewed By:

Jennifer L. Weeks
jlweeks@nas.edu

Comments:

This is a comprehensive look at this important topic. The budget and time are appropriate given the scope. The project attempts to use data to support the need to understand the socioeconomic implications of bicycle and pedestrian safety. The review of vulnerabilities in the streets is an important safety issue.

Review Date:

12/20/2021

FHWA Evaluation of B-06

Reviewed By:

Darren Buck/HEPH-10

Comments:

We see benefit in this research. It could supplement existing Pedestrian and Bicycle Information Center (PBIC) and National Safe Routes Partnership research on equity and racial disparities in bicycle and pedestrian safety. This effort may also complement research underway by the FHWA Equity in Safety Working Group. The research could help identify exposure data for pedestrians and bicyclists in minority and low income communities and could be strengthened by considering the health impacts effects from the noted pedestrian safety disparities. The research could also assess opportunities to safely engage in active transportation in underserved communities and identify strategies to improve access to essential services.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for B-06

Submitted By:
Bud McDonald
AASHTO staff
Agency Administration Managing Committee

Priority #: N/A

Comments:

Support.

Submitted By:
Bud McDonald
AASHTO staff
Committee on Civil Rights

Priority #: N/A

Comments:

Support.

Submitted By:
Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: 3

Comments: N/A

Submitted By:

Chad Baker
 Research Subcommittee Chair
 Data Management and Analytics

Priority #: 14

Comments:

Merge with B-05?

Submitted By:

Kelly Hardy
 AASHTO staff
 Safety

Priority #: N/A

Comments:

Could this research be included with B-05? Or B-10? This should include a research objective and a task focused on what can be done to improve the safety. Without this step, it does not appear that the research can be applied to make the situation safer, just to better identify the problem.

Submitter Response for 2023-B-06Comments:

- The Council appreciates comments from FHWA and NCHRP and recommends that the comments be considered for inclusion in the project scope by the project panel.
- It is critical to highlight the need to target investments to make up for disparities in infrastructure.
- This research is supported by the Agency Administration Managing Committee and the Committee on Civil Rights.
- Through NCHRP 20-123, a research Roadmap was developed to assist the Council on Active Transportation implement the research components of its 2018 Strategic Plan. To identify and define research priorities, the team reviewed existing and on-going research; conducted a survey of practitioners, including AASHTO councils and committees, TRB committees, state DOTs, and ITE, APBP, and NACTO members; and conducted a series of practitioner workshops. The Roadmap contains active transportation research that will address the most important needs of state DOTs. The priority level of research identified in the Roadmap 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. Of the 110 research topics identified, this was the #3 priority for CAT.

Contact Info:

Bud McDonald

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**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-B-07

Problem Title

Methods to Improve Representation, Diversity, and Inclusion in Personal Travel Data

Background Information and Need For Research

We are a nation searching for mobility solutions but the solutions that are implemented are not always equitable. Data from travel surveys, traffic monitoring devices, multimodal transit systems (passenger data), mobile or cellular data, connected vehicles and other sources, are used to forecast demand, identify the demographics of transit users, inform transportation investments, and craft urban/suburban/rural policies. Because personal travel data are essential to shaping our transportation system, it is critical that the data captures diverse population groups that comprise the U.S. population—such as low-income, different gender and sex, socio-economically disadvantaged, people of color, disabled persons, senior citizens, limited English proficiency, individuals who rely on public transit and rural residents. Their travel behavior must be reflected accurately in future data collection activities because consistently limited coverage of their voices, needs and perspectives has led to inaccurate estimates of their transportation access and behavior, impeded policy changes related to equitable outcomes, and contributed to broader problems of economic, educational, social and health inequities. The USDOT in May 2021 released a Request for Information on Transportation Equity Data, with a list of 25 transportation equity data questions; reviewing the submitted comments, it appears that three broad categories of questions received disappointingly few responses.

- Improving existing data. What current data details travel patterns for people in historically underserved and underrepresented groups (i.e., panel surveys) that may be useful to evaluate transportation equity? How well does the NextGen National Household Travel Survey (NHTS) fulfill this requirement? Can (and how can) transportation-related questions be added to existing panel surveys such as the Panel Survey on Income Dynamics? What metadata is useful in determining that a data collection effort is equitable (e.g., demographic profile of the researchers, method of questionnaire administration, language of questionnaire)? What methods or data would be useful in addressing non-response bias in various types of data collection?
- Biases in data used for sampling or analyses. What approaches should DOT implement to ensure that collected data from individuals from underserved and underrepresented communities are accurately reported? What is the equity impact of the common practice of connecting third-party data, like credit card data, to address data for sampling and analysis? How can we identify and correct biases in data used for balancing and weighting like Census/American Community Survey?

- **Data policy.** How do the ways in which target populations are classified and defined (i.e., classifications of race and ethnicity, household structure, sexual orientation, and socio-economic status) affect how data are collected, tabulated, and analyzed? How should USDOT develop a data collection framework, gather new and existing data, set data standards, and analyze and aggregate it into useful information for policymaking?

This research problem statement focuses on generating insightful and practical guidance that state DOTs and other transportation agencies can use to answer these three categories and to apply the information in a manner that will engender actionable equity policies and sustainable planning decisions.

Literature Search Summary

While there is a strong body of literature on the topic of transportation equity and factors contributing to inequitable outcomes, the literature rarely addresses the issues that stem from the lack of coverage, reliability and accuracy of data used as inputs for policy and planning decisions. Even less has been published on providing practical methods for addressing representation, inclusion, and diversity in travel surveys. There is a stream of research in the survey science discipline about challenges in sampling hard-to-reach populations, but these tend to provide statistical solutions to the problem. While important to do so, it is just as necessary to identify and understand the biases inherent in various data sources in order to address systematic issues and provide practical approaches for counteracting them. Now, new forms of data collection and new data types (e.g., GPS data traces and connected vehicle data) are increasingly being relied upon in investment decision making and priority setting. However, there is a lack of literature addressing the equitable representation of diverse groups in these emerging data sources as well.

Research Objective

The objective of the research is to create a guidebook on methods for improving the representation and inclusion of the diverse population groups that comprise the U.S. population in personal travel data for the purpose of addressing transportation equity. This objective focuses on a wide range of equity aspects including race, income, education, age, car ownership, physical or cognitive impairments, gender and sex, language skills, acculturation, and residence (rural vs. urban), etc. Major tasks are to (1) develop a typology of transportation data types that are used in policy and planning; (2) review literature and interview industry experts to identify issues of representation, diversity and inclusion of these data types; (3) determine practical methods or approaches (i.e., solutions) for mitigating the identified issues for different types or sources of data; (4) determine the challenges inherent in using alternatives to surveys, such as location-based services data and administrative records for being representative; (5) validate these issues and solutions through engaging with affected population groups and organizations representing these groups; and (6) develop a practical guidebook to raise awareness of the issues and to disseminate information on methods that state DOTs, other transportation agencies, and their consultants/contractors can use to implement the identified solutions.

Urgency and Potential Benefits

This problem is important to the majority of state DOTs and other transportation agencies because they are entrusted with maintaining and improving our Nation's transportation system. Equitable and safe access to transportation is a civil right--one that is receiving increasing public attention. However, misguided policies and missed opportunities can reinforce racial, ethnic, geographic, and disability disparities as well as divide or isolate neighborhoods. Most importantly, these disparities undermine the essential goal of ensuring that all Americans have equitable access to safe, affordable, and sensible transportation options, no matter who they are or where they live.

Implementation Considerations

Within a state DOT, the research results will be used by several different types of people from the CEO, to outreach and diversity officers, to research contractors and managers, and to technical users of transportation data. The product of this research will be a guidebook with an easy-to-follow synthesis of key issues and why they are important, as well as a "how-to" on methods for mitigating the issues. It will be written from the perspective of the likely implementers in DOTs, MPOs, and other agencies. Dissemination of the research results and practical guidance can be executed through TRB, AASHTO, ITE publications, webinars, and workshops. The recommendations could also be used by private data providers in order to make their products more attractive to end users.

Recommended Research Funding And Research Period

Research Funding: \$350,000

Research Period: 18 months

PROBLEM STATEMENT AUTHOR(S): For each author, provide their name, affiliation, email address and phone.

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Supporting state DOTs:

Iowa Department of Transportation

Ohio Department of Transportation

Oregon Department of Transportation

AASHTO support:

Committee on Data Management and Analytics (CDMA)

Supporting TRB Committees

AED10 Statewide/National Transportation Data and Information Systems

AED20 Urban Transportation Data and Information Systems

AEP25 Travel Survey Methods

AME10 Equity in Transportation

AME20 Women and Gender in Transportation

AME80 Community Resources and Impacts

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

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Dr. Alec Biehl, Postdoctoral Research Associate at Oak Ridge National Laboratory, American Association of Public Opinion Research, member of DEI committee alecbiehl2019@u.northwestern.edu,.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Peggi Knight, Director, Research and Analytics Bureau, Iowa DOT, Peggi.knight@iowadot.us, 515-239-1530

NCHRP Review of B-07

Reviewed By:

Trey Joseph Wadsworth
twadsworth@nas.edu

Comments:

The proposed research would be timely and valuable to DOTs as they seek to improve equitable outcomes. The research objective is clear, though expansive. The timeline seems reasonable, though the budget may be a little low for the scale of the research project as proposed, especially if any of the listed implementation activities would be desired within the research project. I would suggest \$450,000.

Review Date:

12/14/2021

FHWA Evaluation of B-07

Reviewed By:

Danny Jenkins/HPPI, Lori Porreca/HPIP, Mona Asudegi/HPTS

Comments:

Danny Jenkins - This project would be beneficial to assist with future National Household Travel Survey data collections to possibly improve our ability to reach certain underrepresented populations. The time and budget appear reasonable. Lori Porreca - This project will address some significant issues related to inclusive data, but we didn't see anything related to privacy and access issues in regards to data. As so much travel data is "owned" by the private sector, will this project consider those issues in terms of what data is available?

Mona Asudegi - This project can certainly help NHTS and future data collection efforts in better coverage of population and demands. The gap identified in the problem statement is valid and needs to be addressed in order to resolve underrepresentation of certain groups and demands and, as a result, other modeling outcomes in transportation studies. We would recommend looking into data collection methodologies in other sectors, as well, particularly by the private sector (such as advertisement) for covering all groups of population and considering lessons that can be learned for the transportation sector. Also, while identifying methodologies to cover unrepresented data, we would recommend focusing on approaches that can address future potentials (possibly by regular updates) and not just filling the gap for current missing data.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-07
Submitted By:

Bud McDonald
AASHTO staff
Agency Administration Managing Committee

Priority #: N/A

Comments:

Support.

Submitted By:

Bud McDonald
AASHTO staff
Committee on Civil Rights

Priority #: N/A

Comments:

Support.

Submitted By:

Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A

Comments:

Recommend including active transportation, including access to transit, in the analysis.

Submitted By:

Chad Baker
Research Subcommittee Chair
Data Management and Analytics

Priority #: 3

Comments:

As the expansion and use of connected devices becomes more prevalent, I can appreciate the need to include areas of the population that may not be represented by these advanced technology systems.

Submitter Response for 2023-B-07

From:

[email: Peggi.knight@iowadot.us]

Comments:

1. FHWA Comment: Privacy and access issues in regards to data. As so much travel data is "owned" by the private sector, will this project consider those issues in terms of what data is available?

Response: In the Research Objectives section, major task #4, we were thinking about data owned by the private sector as well as privacy and access issues in the context of "determining the challenges inherent in using alternatives to surveys, such as location-based services data and administrative records for being representative."

But we could edit major task #4 as the following: determine the challenges inherent in using alternatives to surveys, such as location-based services or other private sector data and administrative records for privacy and access issues as well as being representative.

2. FHWA Comment: We would recommend looking into data collection methodologies in other sectors, as well, particularly by the private sector (such as advertisement) for covering all groups of population and considering lessons that can be learned for the transportation sector.

Response: We could add a major task that comes between current #3 and #4: Examine the data collection methodologies in other sectors, particularly the private sector to draw best practices for covering all groups of population and identifying lessons that can be learned for the transportation sector.

3. FHWA Comment: While identifying methodologies to cover unrepresented data, we would recommend focusing on approaches that can address future potentials (possibly by regular updates) and not just filling the gap for current missing data.

Response: We could add a major task that comes between current #4 and #5: Identify "representation" solutions that can be applied to future data collection activities (possibly by regular updates) so that the study does not just focus on addressing diversity and representation issues in current data.

4. NCHRP Comment: The budget may be a little low for the scale of the research project as proposed, especially if any of the listed implementation activities would be desired within the research project. I would suggest \$450,000.

Response: Given the expanded scope represented by the FHWA comments, we believe that the budget should be expanded to \$450,000 or even \$500,000.

Contact Info:

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**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-08

Problem Title

A Guide for Creating Effective Visualizations

Background Information and Need For Research

A visualization can be “effective” in several ways: providing information, informing policy and decision making, and influencing behavior. There is little guidance on how to systematically evaluate a visualization’s effectiveness by either of these measures. This problem affects both transportation professionals and the traveling public – including movers of freight.

Even with clear visualizations providing insight – sophisticated “nuggets of truth” from vast amounts of information and solutions to vexing problems, there may be viewers who do not comprehend or respond. Developing a means to evaluate the effectiveness of visualizations deployed internally and externally would significantly enhance their value. This research addresses this problem by: evaluating the effectiveness of noteworthy practices currently being pioneered by state DOTs that were documented, but not assessed, in previous NCHRP projects; addressing the new tools that have proliferated, such as Tableau, R, Infogram; and ultimately developing an easy-to-use guide to creating effective visualizations.

Literature Search Summary

NCHRP Synthesis 52-16, Visualization of Highway Performance Measures, identified the problem stated above; there is little guidance or widely shared practices on how to evaluate a visualization’s effectiveness using a systematic process. This research will build and expand upon that research, as well as NCHRP 226, Vizguide, NCHRP Project 20-24(93)B(02), Communicating Performance Management, and NCHRP Synthesis 20-05/Topic 52-16 Visualizing of Highway Performance Measures.

Research Objective

The object of this research is to develop an easy-to-use guide for evaluating the effectiveness of transportation visualizations that state DOTs can use to improve communication and decision-making. With this guide, state DOTs will have the tools to hone their message, manage the data overload that occurs in visualizations and impact travel behavior with effective visual data increasing safety, security and mobility.

The suggested tasks for this research are:

- 1) Research the essential components of what makes a visualization effective. Build off NCHRP 226 and 20-24(93)B(02). Evaluate the visualization techniques and practices documented in NCHRP Synthesis 52-16.

- 2) Create a guidebook that clearly communicates how to approach a new visualization and guide its creation.
- 3) Evaluates how to gain feedback on the effectiveness of a visualization in communicating information and influencing behavior, and also facilitates decision making. This could build off practices currently used for public service announcements (PSA).
- 4) Identify or develop noteworthy practices for evaluating the effectiveness of a visualization.
- 5) Create a Guidebook that provides state DOTs with options for evaluating the effectiveness of a visualization.
- 6) Integrate the two elements – creation and evaluation – into a guide that demonstrates the feedback loop of continuous improvement enabled by joining these two functions.
- 7) Establish an online case study website that showcases exceptional and innovative visualizations. This could include a category for the use of emerging data and emerging analytic capacity so state DOTs could maintain currency in innovative practices. The website would be updated by the TRB AED80 Visualization in Transportation Committee yearly by acknowledging award winning entries.

Urgency and Potential Benefits

Effective data visualization has the power to dramatically improve the safety and efficiency of the transportation system. Previous research demonstrates that state DOTs have invested considerable time and expertise in developing visualizations for performance measures and need to communicate results effectively.

This guide would build on and evolve prior work by developing clear guidance on how to create effective visualizations and how to evaluate their effectiveness. It will enable states to focus and capitalize upon the investment, time and expertise they are currently deploying. It will provide a roadmap to the states who are in the early development of their visualization efforts and will provide an opportunity for well-established programs to expand their efforts by evaluating the effectiveness of their visualizations.

Addressing the creation and evaluation of effective visualizations together creates a feedback loop that enables and promotes continuous improvement.

Implementation Considerations

Transportation planners and practitioners responsible for analyzing and communicating data through visualization have a great need for this research. This guide has a built-in audience of the users of both previous research efforts and the Transportation Asset Management (TAM) portal. Additionally, the guide would lend itself to promotion through the committees of the TRB data section, particularly AED80; and the AASHTO Committee structure, particularly CDMA (Data), COP (Planning), CPBM (Performance), and TAM (Asset management).

Recommended Research Funding and Research Period

This research could be executed and implemented for \$415k, over two years

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

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Person Submitting The Problem Statement: Name, affiliation, email address and phone.

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On behalf of the AASHTO Committees on Planning (COP), Performance Based Management (CPBM), and Data Management and Analytics (CDMA)

NCHRP Review of B-08

Reviewed By:

Jennifer L. Weeks

jweeks@nas.edu

Comments:

This is a very broadly scope. The target audience(s) is not clear. The effectiveness of visualizations will depend on the targeted audience. Visualizations to guide managers and decision makers may be different than for members of the general public and elected officials. What works for one targeted audience may not be so great for another. The same basic information may merit different approaches for communication and visualizations depending on the context of the communication and the targeted audiences. There is a fair amount of research produced by NCHRP and TCRP on differences in the need for and the mode of communications. NCHRP cannot host and maintain a website. The budget is appropriate.

Review Date:

12/13/2021

FHWA Evaluation of B-08

Reviewed By:
Spencer Stevens/HEPP

Comments:

We support this research as it addresses the Planning regulation requirements that States and MPOs employ visualization techniques to describe their planning. 23 CFR 450.316(A)(1)(iii)

Review Date:
December 17, 2021

AASHTO Committee Evaluation for B-08

Submitted By:
Matthew Hardy
AASHTO staff
AASHTO Committee on Performance-Based Management

Priority #: 2

Comments: N/A

Submitted By:
Kyla Elzinga
AASHTO staff
AASHTO Committee on Planning

Priority #: 2

Comments: N/A

Submitted By:
Chad Baker
Research Subcommittee Chair
Data Management and Analytics

Priority #: 2

Comments:

Messaging can be a challenge for DOT practitioners and the use of visualization tools could help deliver the message.

Submitter Response for 2023-B-08

From:
[email: pweinberger@aashto.org,]

Comments:

We appreciate the FHWA comments and are gratified for the support of other potential users of the research. As to the TRB comments, we are fully aware the TRB cannot host or maintain a website. The work that this work will be predicated upon is hosted externally at <https://communicatingperformance.com>, supported by AASHTO. Further, the TRB comments reinforce the summary of the NCHRP 52-16 Synthesis: Tell your performance Story with Visualizations that resonate with your Audience. The effectiveness of visualizations will depend on the targeted audience. Visualizations to guide managers and decision makers may be different than for members of the general public and elected officials. What works for one targeted audience may not be so great for another. The same basic information may merit different approaches for communication and visualizations depending on the context of the communication and the targeted audiences. There is a fair amount of research produced by NCHRP and TCRP on differences in the need for and the mode of communications that can be incorporated into this research.

The target audience for this research is the practitioner who will identify the target audience and the message, and then use the results of this study to create more effective visualizations.

Additionally, there is a great deal known about the science of data visualization that is not well understood by transportation professionals. The transportation community could greatly benefit from a guide that brings together this knowledge and presents it in a form that is accessible and usable. Some aspects of this already exist with the VizGuide hosted by AASHTO, but there is much more needed to grow the available resources and examples and to further provide guidance to practitioners. The research proposal also extends the idea further, but suggesting a framework for agencies to evaluate the effectiveness of visualizations.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-09

Problem Title

Analysis and Assessment of the National Performance Management Data

Background Information and Need For Research

MAP-21 and the FAST Act laid the groundwork for a comprehensive national-level performance management framework. The first four-year reporting period began on January 1, 2018 and ends on December 31, 2021 and will result in the first complete set of consistent national-level performance management data. This will result in a unique opportunity to conduct the first analysis and assessment of this unique data set as well as combined with other data sets to tell a more complete and consistent state DOT performance management story.

An initial assessment of these data sets has been conducted. In 2020, FHWA sent out letters to each state DOT indicating whether they had made significant progress towards their target achievement for the five safety performance measures. And, in 2021, FHWA sent out subsequent letters about making significant progress with respect to the asset measures and system performance measures. AASHTO obtained copies of these data and conducted its own preliminary analysis of the data to better understand:

1. How far off were the targets from the actual numbers?
2. What is the impact of those states that did not make significant progress?
3. How many states' targets showed improvement?
4. What kind of targets did states establish?
5. What is the correlation between target setting technique and making significant progress?
6. Are there other techniques that could be used to determine making significant progress?

The results of this preliminary analysis was insightful and revealed a lot of good information. For example, a number of visuals were developed to show the how impactful missing a target by less than 0.05% can have on a state DOT not making significant progress. It also demonstrated the complexity associated with understanding what it meant for a state DOT to meet or exceed a target. However, this preliminary analysis, conducted by AASHTO staff and consultant support through the TPM Pooled Fund project, was very limited due to the resources available.

In fall 2021, the Committee on Performance-Based Management leadership group agreed that a more robust and extensive analysis is warranted that includes not only an analysis and assessment of the data, but recommendations on future capacity building

activities to support state DOTs in the future as well as an assessment of future performance measures that may be better at telling the national TPM story.

Literature Search Summary

- National Bridge Inventory (NBI): <https://www.fhwa.dot.gov/bridge/nbi.cfm>
- 17 National Performance Measure Reporting System:
<https://www.fhwa.dot.gov/tpm/reporting/state/>
- National Performance Management Research Data Set (NPMRDS):
<https://npsrds.ritis.org/analytics/>
- Highway Statistic Series:
<https://www.fhwa.dot.gov/policyinformation/statistics.cfm>
- FHWA Performance Management Data
 - o Results from the current reporting period (January 1, 2018 through December 31, 2021)
 - o AASHTO Analysis of the National PM Safety Data (May 2020)
 - o Target Data Analysis of the Federal Performance Measures (July 2021)

Research Objective

The objective of this research is to prepare an authoritative analysis and assessment of the national performance management data and, based upon the analysis and assessment, to provide recommendations on future capacity building activities and possible new performance measures. There are three sub-objectives focused on:

- 1) Analysis of the national performance management data for the three performance measurement areas (safety, assets, and system performance) will be conducted to better understand trends, target setting approaches, and target achievement by state DOTs; and
 - 2) Assessment of the performance management data that provides a comprehensive and compelling story on the results of the performance management provisions.
 - 3) Identification of future capacity building needs and performance measures.
- This research will be conducted in three parts:

Part 1 will focus on the detailed analysis of each of the 17 performance measures for the three federal performance measurement areas (safety, asset condition, and system performance). The analysis will primarily include the four years of performance measurement data reported by state DOTs as part of the federal performance management requirements for the first reporting period which goes January 1, 2018 through December 31, 2021. This data is consistent among all of the states and for all of the performance measures resulting in important consistency among the performance measures.

For each of the performance measurement areas, the following will be conducted:

- Data Analysis—Analysis of the performance measures data to better understand how states are performing. All of the data should be made available through the

- Target Setting Approach—Analysis of what type and how state DOTs established targets.
- Target Achievement—Assessment of the extent to which state DOTs achieved their targets.

All of this data and analysis, where applicable, should be made available through the AASHTO TPM Portal Benchmarking website at <https://benchmarking.tpm-portal.com/>.

Part 2 will focus on developing a comprehensive performance management story which provides an authoritative assessment and narrative of how state DOTs are performing. The performance management story should be based upon the following three categories:

- Funding Sources—A detailed analysis and assessment of the funding sources that state DOTs use to fund transportation projects in their states. This should include an assessment at the individual state as well as at the national level.
- Project Selection Process—A summary of the approaches, frameworks, and techniques state DOTs use to identify projects to fund using their funding sources.
- Condition, Outputs, and Outcomes—Using the results of the Data Analysis from Part 1, provide a summary of the condition of critical assets, the type of outputs state DOTs are seeing through their project selection process, and the long-term outcomes of the project selection process.

The State DOT TPM Story should be made available through the AASHTO TPM Portal website at www.tpm-portal.com. The State DOT TPM Story should include a print version and interactive web-based version that can be reasonably updated as new data is made available.

Part 3 will focus on future capacity building activities and performance measures that could be used to better tell the national TPM story. First, based upon the results and insights gained from Part 1 and 2, needed capacity building activities will be identified and delivered as resources allow. These activities could include training programs offered through the AASHTO TC3 program, new/updated NHI training, or peer exchanges. The focus should be on how best to build the capacity of transportation agencies to deliver a performance-based management program gained from the insights and experiences of the first performance management reporting period.

Second, the final report will provide some conclusions on future performance measures, approaches, and technologies that could be used by transportation agencies to implement and deliver a performance-based management program. These recommendations should be based upon the insights and experience from the first performance management reporting period. It should reflect the idea that the performance management field is constantly changing and evolving, just as society and technology does, and that what and how we measure performance is dynamic.

Urgency And Potential Benefits

There is an urgency to get in place a framework to analyze the national performance management data because nothing currently exists. The results of this research will be critical to telling the state DOT TPM story as well as documenting the performance of the transportation system in the US.

Implementation Considerations

Part 1 data and analysis, where applicable, should be made available through the AASHTO TPM Portal Benchmarking website at <https://benchmarking.tpm-portal.com/>. This will be done in partnership with the AASHTO Transportation Performance Management Technical Service Program.

The results of Part 2, State DOT TPM Story, should be made available through the AASHTO TPM Portal website at www.tpm-portal.com. The State DOT TPM Story should include a print version and interactive web-based version that can be reasonably updated as new data is made available. This will be done in partnership with the AASHTO Transportation Performance Management Technical Service Program.

Part 3 focuses on the capacity building activities for the state DOTs based upon lessons learned from this research.

Recommended Research Funding And Research Period

Funding: \$550,000 (estimated)

- Phase 1: \$255,000
 - o Safety (5 performance measures): \$75,000
 - o Asset Management (4 performance measures): \$60,000
 - o System Performance (8 performance measures): \$120,000
- Phase 2: \$100,000
- Phase 3: \$150,000
- Final Report: \$45,000
- TOTAL: \$550,000

Research Period: 18 months

PROBLEM STATEMENT AUTHOR(S): For each author, provide their name, affiliation, email address and phone.

The problem statement was developed by Matthew Hardy, Ph.D., AASHTO staff liaison for the Committee on Planning and Performance-Based Management. It included review and comments from other AASHTO staff liaisons.

The problem statement is supported by the following AASHTO committees:

- Committee on Performance-Based Management, Tim Henkel, Chair
- Committee on Transportation System Operations, Scott Marler, Chair
- Committee on Safety, Patrick McKenna, Chair
- Committee on Data Management and Analytics, Greg Slater, Chair

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Please contact Matt Hardy, AASHTO Program Director for Planning and Performance Management, for a list of recommended panel members representing the AASHTO Committee on Performance-Based Management.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Matthew Hardy

202-624-3625

mhardy@ashto.org

Affiliation: AASHTO staff on behalf of the AASHTO Committee on Planning, Kristina Swallow, Chair.

NCHRP Review of B-09

Reviewed By:

Jennifer L. Weeks

jweeks@nas.edu

Comments:

This scope is close to federal responsibilities and if selected this project will need to be carefully managed to avoid federal policy considerations. The budget is appropriate, but 24-30 months will be required to accomplish this..

Review Date:

12/14/2021

FHWA Evaluation of B-09

Reviewed By:

Stephen Gaj/HISM-30

Comments:

It needs to be recognized that FHWA will be developing a report focusing on the first complete performance period in 2022. This proposal appears to be covering a broad array of topics from target setting to potential new measures. Good project that needs to be focused, including the application of TPM for managing the highway network.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-09Submitted By:

Matthew Hardy

AASHTO staff

AASHTO Committee on Performance-Based Management

Priority #: 6Comments:

Please note: This should say it was submitted by the Committee on performance-Based Management. The Committee on Planning did not submit this or development the problem statement.

Submitted By:

Kyla Elzinga

AASHTO staff

AASHTO Committee on Planning

Priority #: 5Comments:

Please note that while the AASHTO Committee on Planning is ranking this #5, the problem statement was submitted by the AASHTO Committee on Performance-Based Management.

Submitted By:

Chad Baker

Research Subcommittee Chair

Data Management and Analytics

Priority #: 6Comments: N/A

Submitted By:

Kelly Hardy

AASHTO staff

Safety

Priority #: N/AComments:

Hopefully the target setting process each entity goes through (at least for safety) is critical to its relationship with meeting / not meeting targets. The critical part of the research is if the performance measure setting process and meeting/not meeting actually drives the way work is done and projects are selected. In other words, understanding the value of setting the targets to begin with. So research proposal B-12 is the crux of this and should be integrated. This research has a medium to high priority.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation****FY2023 NCHRP PROBLEM STATEMENT TEMPLATE****Problem Number: 2023-B-10****Problem Title**

EDI (Equity, Diversity, and Inclusion) and Other Indicators to Improve TAM Impact and Outcomes

Background Information and Need For Research

Investments in roadways have historically been focused on safety, mobility, and system preservation considerations. As our understanding of the impacts of roadway decisions mature, other factors such as socio-economic impact, sustainability, accountability, transparency, integrity, and innovation are increasing in importance by State Departments of Transportation (DOTs). Recently, strategic initiatives related to DEI are growing in importance and need to be considered in transportation investment planning. Advancing the understanding of DEI and other related indicators can help DOTs improve the impact of TAM investment decisions, especially to underserved communities.

Literature Search Summary

- American Association of State Highway and Transportation Officials (AASHTO). 2021. State DOT CEOs Talk Transportation Equity at EPW Hearing. Online article published May 12, 2021. AASHTO, Washington D.C.
- Archer, D. (2021). Transportation Policy and the Underdevelopment of Black Communities, New York University School of Law, Public Law Research Paper No. 21-12, New York, NY.
- Colorado Senate Bill 21-260, Sustainability of the Transportation System. Signed June 17, 2021. <https://leg.colorado.gov/bills/sb21-260>.
- Connect Oakland, TRB Webinar: Addressing Justice in Transportation, June 28, 2021
- ICF Incorporated, LLC. (2020). Summary of Critical Issues for Transportation and Equity. Transportation Research Board. Washington, D.C.
- Larson, S. (2021) How Chicago Could Build Equity into Transportation. Chicago Metropolitan Agency for Planning, Chicago, IL
- Litman, T. (2021). Evaluating Transportation Equity: Guidance for Incorporating Distributional Impacts in Transportation Planning. Victoria Transport Policy Institute, Victoria, British Columbia, Canada.
- Minnesota DOT (MnDOT). (2019). Advancing Transportation Equity: Strategies for Reducing Transportation Disparities, CTS Research Brief 2019-01, St. Paul, MN.
- National Public Radio (NPR). (2021). A Brief History of How Racism Shaped Interstate Highways, NPR Online News Article published April 7, 2021
- North Front Range Metropolitan Planning Organization (NFRMPO). 2021. Environmental Justice (EJ) Plan. North Front Range Metropolitan Planning Organization, Fort Collins, CO.

- Singer, J. (2018). Inside the Nation's First Transportation Equity Program. Vision Zero Cities Journal, Transportation Alternatives, Published Online November 13, 2018.
- Twaddell, H. and B. Zgoda. (2020). Equity Analysis in Regional Transportation Planning Processes – Volume 1: Guide. Transit Cooperative Research Program (TCRP) Research Report 214. Transportation Research Board. Washington, D.C.
- Van Dort, L. A. Guthrie, Y. Fan, G. Baas. (2019). Advancing Transportation Equity: Research and Practice – Final Report. Center for Transportation Studies, University of Minnesota, Minneapolis, MN.
- Van Orden, D., and C. Grauberger. (2002). Environmental Justice Report. CDOT-DTD-R-2002-7. Colorado Department of Transportation, Research Branch. Denver, CO.

Research Objective

The objective of this research is to produce guidance on how DOTs can improve the use of DEI and other related indicators in TAM investment decision making processes.

Tasks will include:

- Compile DEI and other related indicators for use in TAM decision-making
- Develop a framework for applying DEI and other related indicators in TAM decision-making processes, including:
 - o analysis activities to forecast impact
 - o scenario planning including identifying alternate investment options with an equity lens
 - o investment tradeoff decision-making
 - o community engagement activities including increasing the involvement of underserved communities.
- Develop additional quantitative and qualitative performance measures for asset management and planning that consider DEI and other factors in transportation investment decisions
- Produce a summary of challenges, inherent inequities, and obstacles in asset management and planning activities in order to help transportation add value to underserved communities
- Develop guidance for transportation agencies to use the DEI and other related indicators to balance competing strategic objectives related to asset performance, safety, mobility, and DEI.

Urgency and Potential Benefits

Most of the recent research related to environmental justice process have been focused on new transportation development. As state focus more of their budgets on maintaining their systems through TAM, better guidance is needed to ensure DEI and related considerations can be applied in a holistic view of investment decisions in transportation agencies.

The Biden administration and Secretary of Transportation Buttigieg stated that the administration's priority encompasses efforts to "finally address major inequities – including those caused by highways that were built through Black and Brown communities, decades of disinvestment that left small towns and rural main streets stranded, and the disproportionate pollution burden from trucks, ports, and other facilities (AASHTO Daily Brief 03/29/21)." On May 25, 2021, the U.S. DOT published a Request for Information (ROI) on Transportation Equity Data in response to the Executive Order signed January 20, 2021, "Advancing Racial Equity and Support for Underserved Communities Through the Federal Government (Equity E.O.)." The information obtained through the ROI is intended to support the U.S. DOT's determination of "whether, and to what extent, programs and policies perpetuate systemic barriers to opportunities and benefits for people of color and other underserved groups (Federal Register V. 86, No. 99, May 25, 2021)." The ROI specifically seeks input regarding the availability of potential data and assessment tools in the transportation sector that can support the U.S. DOT's evaluation.

Implementation Considerations

- Transportation agency chief engineers, planning directors, asset managers, and transportation performance management leads will use the research products to improve their decision impact.
- The research will provide guidance on specific application and/or calculable modifications to existing tools and methods that transportation agencies can follow to make the changes needed for research implementation.
- The AASHTO Committee on Performance-Based Planning, the AASHTO TAM Portal, TRB Standing Committee on Transportation Asset Management (AJE30), TRB Standing Committee on Performance Management (AJE20) will support the research implementation.
- TRB presentations and webinars are will be required for research implementation.
- Workshops, peer exchanges, pilot testing, verification and validation of research results are possible implementation actions.

Recommended Research Funding And Research Period

- Research Funding: \$400,000
- Research Period: 18 to 24 months

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

- William Johnson, Colorado DOT, Performance and Asset Management Branch Manager, will.johnson@state.co.us, 303-512-4808
- Hyun-A Park – Spy Pond Partners, President, hpark@spypondpartners.com, 617-875-9614

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Please contact Matt Hardy, AASHTO Program Director for Planning and Performance Management, for a complete list of recommended panel members representing the

AASHTO Committee on Performance-Based Management. Below are some initial recommendations:

- Jeff Neal, North Central Texas Council of Governments, Senior Program Manager-Streamlined Project Delivery and Data Management jnael@nctcog.org 817-608-2345
- Edgardo Block, Connecticut Department of Transportation, Policy and Planning Edgardo.block@ct.gov, 860-594-2495
- Rachel Roper, Hawaii Department of Transportation, Planning Engineer•

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Matthew Hardy
202-624-3625

mhardy@ashto.org

Affiliation: AASHTO staff on behalf of the AASHTO Committee on Performance-Based Management, Tim Henkel, Chair.

Submitting on behalf of:

William Johnson, Colorado DOT, Performance and Asset Management Branch Manager, will.johnson@state.co.us, 303-512-4808

NCHRP Review of B-10

Reviewed By:

Jennifer L. Weeks
jlweeks@nas.edu

Comments:

There is other DEI-related NCHRP research newly underway, but not with this specific focus. DEI in a state DOT operational and decision making context is still new, and there is not a lot of information yet available to build on. The budget should be increased to \$500,000 and the duration to 24-30 months.

Review Date:

12/14/2021

FHWA Evaluation of B-10

Reviewed By:

Stephen Gaj/HISM-30

Comments: We support fully as it addresses a priority.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for B-10

Submitted By:
Matthew Hardy
AASHTO staff
AASHTO Committee on Performance-Based Management

Priority #: 4

Comments: N/A

Submitted By:
Bud McDonald
AASHTO staff
Agency Administration Managing Committee

Priority #: N/A

Comments:

Support.

Submitted By:
Bud McDonald
AASHTO staff
Committee on Civil Rights

Priority #: N/A

Comments:

Support.

Submitted By:
Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A

Comments:

Recommend ensuring that active transportation assets are incorporated. Underserved communities are more reliant on walking, biking, and transit, yet state DOTs don't have consistent and complete data on relevant assets.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-11

Problem Title

Keeping Inventory and Condition Data Up to Date

Background Information and Need For Research

Emerging technologies, such as the use of drones for inspections, LiDAR field data collection, and continuous monitoring of real-time sensor data (among others), hold the promise of transforming asset data collection for transportation asset management. As this technology has been evolving and improving, federal regulation, specifically, MAP-21 and the FAST Act, has pushed many agencies to collect and utilize a detailed inventory of infrastructure assets and transportation data. With the collection of high-volume asset inventory and condition data, such as LiDAR point cloud data, the accessibility and affordability of data collection has become a clear issue for agencies, particularly as they aim to manage and visualize collected data for both strategic and operational transportation asset management planning purposes. Therefore, research and guidance on the benefits and applications of these emerging technologies as well as how frequently that inventory and condition data need to be collected or assessed is necessary.

The focus of this research would be on the following:

- Address the adoption and practical application of these emerging collection technologies and the rapid pace of technological advancement.
- Provide guidance on the level of detail and frequency interval necessary for data collection to support TAM at both the state and local levels.
- Determine how condition assessment can be applied to the performance measures of both pavement and non-pavement assets.
- Further investigate and recommend tools capable of visualizing asset extraction layers, as well as presenting data to stakeholders in powerful GIS formats with standardized TAM graphics for universal interpretation.
- The research should consider any refinements that would need to occur in network level asset management data collection to make the data useful for compliance (i.e. ADA), safety (i.e. bridge clearances) or engineering (design or construction) purposes.

Literature Search Summary

PROJECT: Best Practices on Collecting Asset Information from the Construction Stage
South Carolina Department of Transportation, 2021, Proposed 2021-10-01

PROJECT: Automated Guardrail Inventory and Condition Evaluation

- Massachusetts Department of Transportation, 2021, Active 2021-01-18
- Highway Asset and Pavement Condition Management using Mobile Photogrammetry
- Transportation Research Record: Journal of the Transportation Research Board, 2021
- Automated Real-Time Roadway Asset Inventory using Artificial Intelligence
- Transportation Research Record: Journal of the Transportation Research Board, Volume 2674, Issue 11, 2020, pp 220-234, 2020-11
- Computer Vision for Rapid Updating of the Highway Asset Inventory
- Transportation Research Record: Journal of the Transportation Research Board, Volume 2674, Issue 9, 2020, pp 245-255, 2020-09
- GIS Tools and Apps—Integration with Asset Management, 2020, 155p, 2020-02
- PROJECT: A Method for Pavement Marking Inventory and Retroreflectivity Condition Assessment Using Mobile LiDAR
- Massachusetts Department of Transportation, \$200,000, 2019, Active, 2019-10-21
- SCDOT Asset Data Collection Assessment, 2019, 99, 2019-08
- PROJECT: GIS Tools and Applications: Integration with Asset Management
- Minnesota Department of Transportation, \$59,021.12, 2019, Completed, 2019-04-19
- Novel Cloud and Mobile Technology for Road Asset Management in Saint Lucia
- 26th World Road Congress, 2019, 9, 2019
- Implementation of Road Asset Management System in Saint Lucia
- 26th World Road Congress, 2019, 16, 2019
- Innovative Approaches to Asset Management, 2019, 110, 2019
- Machine Learning Powered Roadside Asset Extraction using LiDAR
- TAC 2018: Innovation and Technology: Evolving Transportation - 2018 Conference and Exhibition of the Transportation Association of Canada, 2018
- Life-Cycle Approach to Collecting, Managing, and Sharing Transportation Infrastructure Asset Data
- Journal of Construction Engineering and Management, Volume 143, Issue 6, 2017-06
- Highway Asset Inventory Data Collection Using Airborne LiDAR
- Transportation Research Board 96th Annual Meeting, 2017, 15
- Evaluation of High-Speed Mobile Technologies for Sign Inventory and Maintenance
- Transportation Research Board 96th Annual Meeting, 2017, 13, 2017
- Implementation of Aerial LiDAR Technology to Update Highway Feature Inventory, 2016, 133, 2016-12
- Guide for Efficient Geospatial Data Acquisition using LiDAR Surveying Technology, 2016, 12, 2016
- LEVERAGING CONSTRUCTION INSPECTION AND DOCUMENTATION FOR ASSET INVENTORY AND LIFE CYCLE ASSET MANAGEMENT
- Transportation Research Board 95th Annual Meeting, 2016, 20, 2016

- Handbook For Including Ancillary Assets in Transportation Asset Management Programs, Federal Highway Administration, 2018

Research Objective

Working backward from the key decisions that need to be made across stakeholder groups over an asset's lifecycle, this project seeks to identify current practices and recommend ongoing improvements in relation to collecting, storing, sharing, and maintaining asset inventory and condition data ("data management"). With a focus on implementation, the project will build on existing research by identifying the pros and cons of different data management methods and technologies, so that decision makers across departments can collaborate more effectively when planning and investing in data management approaches. The practice of data management is evolving at a rapid pace, given the proliferation of new technologies that are being used increasingly alongside traditional approaches. In parallel, agencies are recognizing the multi-stakeholder nature of asset management, as departments such as compliance, safety, engineering, operations and environmental begin to see the benefits of access to reliable, accurate asset information. This project will answer key data management questions such as: What data should be collected to address all stakeholder needs? How, when, and how often? Using which technologies and platforms? At what cost? And why?

It will also provide guidance to agencies on the most appropriate approaches to collecting, storing, sharing and maintaining asset data, based on the needs of the various stakeholders involved in data-based decision-making.

Urgency and Potential Benefits

Inventory and condition data collection and data management are continuously changing in response to changing demands of state and local agencies. However, despite these changing demands, inventory data is constantly being used by multiple stakeholders to make decisions (planning, operations, safety, contractors). While the inventory data may not necessarily be accurate or timely due to these agency constraints or because the agency's collection processes lack maturity (i.e. ancillary assets), this data is still being used to make decisions at all levels within an agency, yet there is little consensus on how to manage data related to those assets.

The benefits of this research are that it will provide a complete view of inventory and condition issues across asset classes; support agencies with lessons learned from others (from data collection to post-processing/extraction and related decision making) and enable collaboration on new approaches, particularly for secondary asset data management; support implementation of TAMPs by helping to ensure data is reliable and accurate; support preparation for emerging technologies such as CAVES, which will be dependent on secondary assets, such as striping, roadside units (RSUs) and signals.

Implementation Considerations

Methods to incorporate products into practice:

- Web-based training for agency staff
- Case studies from peer agencies
- Assessment of existing technologies including functionalities, pros/cons, and costs

Intended audience:

- Decision makers at all organizational levels and across departments/disciplines
- Contractor and consultant community

Recommended Research Funding and Research Period

Research funding:

- \$500,000

Research period:

- 18 – 24 months

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Steve Wilcox, P.E. New York State Dept of Transportation, steve.wilcox@dot.ny.gov
518-527-4318

Suzie Heap, PMP WSP USA Inc, Suzie.Heap@wsp.com 972-762-5503

Lauren Gardner, EIT, Wood PLC, lauren.gardner@woodplc.com 908-892-5568

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Please contact Matt Hardy, AASHTO Program Director for Planning and Performance Management, for a list of recommended panel members representing the AASHTO Committee on Performance-Based Management.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Matthew Hardy

202-624-3625

mhardy@ashto.org

Affiliation: AASHTO staff on behalf of the AASHTO Committee on Performance-Based Management, Tim Henkel, Chair.

NCHRP Review of B-11

Reviewed By:

Trey Joseph Wadsworth

twadsworth@nas.edu

Comments:

The proposed research could be valuable to DOTs, especially if there is anything to learn about data needs and requirements from the first round of state DOT transportation asset management plan submissions to FHWA. However, there is a chance this could be duplicative of NCHRP 08-137 *Updates to the Digital Edition of the AASHTO Transportation Asset Management Guide* which is estimated to be underway this spring. The research objective should be narrowed to ensure that there is not duplication and also needs to be careful with suggesting that pros and cons be identified. Such an effort would need to stay away from endorsements of any proprietary offerings that assist with data collection or asset management. The timeline seems reasonable, however the budget seems a little high provided some of the scope could be accomplished by NCHRP 08-137.

Review Date:

12/14/2021

FHWA Evaluation of B-11Reviewed By:

Derek Constable/HIBS-30

Comments:

We agree that present/future data collection, integration, and visualization technologies offer great potential for assets/features that are lower priority for data collection and digitization, and agree with the focus point to provide guidance on frequency and level of detail. The assets/features recommended for inclusion may also need to be studied, which will be dependent on factors such as network performance drivers, investment proportions, and project selection needs. Also format of location and geometric data to fit within present/future integration and visualization methods seems important. The future perspective overlaps with BIM and managing big data which the European Union may have more experience to share. Integration and visualization will yield greatest value when in addition to informing network level performance measurement, they support assessment of combined needs along roadway segments. The study of existing technologies which is a moving target seems of lesser priority other than to identify where does and does not have capability to assess recommended asset/feature types, data and format. That could inform industry development.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-11Submitted By:

Matthew Hardy

AASHTO staff
AASHTO Committee on Performance-Based Management

Priority #: 7

Comments: N/A

Submitted By:
Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A

Comments:

Recommend including consideration of active transportation data.

Submitted By:
Kelly Hardy
AASHTO staff
Design-Technical Committee on Roadside Safety

Priority #: N/A

Comments:

This research would be very beneficial to the roadside safety community as well as many other groups. States have spent a lot of money developing inventories of roadside safety features, and it is imperative those databases be updated in order to conduct in-service evaluations and make determinations for hardware upgrades. TCRS considers this medium- to high-priority

Submitted By:
King Gee
AASHTO staff
Knowledge Management

Priority #: 6

Comments:

Inventory and condition data are central to DOTs' reporting, planning, and project development. Since MAP-21 was passed in 2012, performance measures and transportation asset management (TAM) added these requirements into appropriations law. Accurate inventory and condition data are essential for DOTs to most efficiently spend taxpayer funds and be accountable and transparent. Inventory and condition

data are central to DOTs' reporting, planning, and project development. Since MAP-21 was passed in 2012, performance measures and transportation asset management (TAM) added these requirements into appropriations law. Data collection is often expensive and labor-intensive, with DOTs either having to maintain staff and/or contract out the collection. Emerging technologies offer potential to collect asset data more often and economically. Further, these new technologies could allow for collection and maintenance of non-pavement/bridge asset data, such as signs, guard rails, etc., without increasing already strained budgets. Timely and accurate inventory and condition data are essential for DOTs to most efficiently spend taxpayer funds and be accountable and transparent.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-12

Problem Title

Ex Post Project Evaluation: Frameworks, Guidance and Tools to Support Post-Implementation Evaluation of Transportation Projects

Background Information and Need For Research

State DOTs and MPOs throughout the US have implemented robust performance-based planning and programming processes in their agencies due to the federal requirements articulated in the MAP-21, FAST Act and other state federal laws. According to the FHWA Performance-Based Planning and Programming Guidebook, there are three core elements of the PBPP framework:

1. Strategic Direction: Where do we want to go?
2. Analysis: How are we going to get there?
3. Programming: What will it take?
4. Implementation and Evaluation: How did we do?

The first three elements are well-documented and conducted in existing transportation planning and programming processes. The fourth element - implementation and evaluation phase - seeks to answer the questions: What did we do? How did we do? How can we improve? This fourth element, which include monitoring, evaluation and reporting, is something that the transportation industry has struggled with. Since the PBPP process includes an aspect of a feedback loop that attempts to assess whether projects built actually delivered the performance predicted, the implementation and evaluation is a critical component that is not done on a regular basis. This feedback loop is essential for understanding the impacts and effectiveness of transportation projects and investments. It is crucial to evaluate what has been delivered and what the performance was so that better, well-informed decisions can be made in the future. The evaluation piece is necessary to continue the feedback loop and what the benefits are.

Already, there are many state transportation agencies and MPOs that have well-documented processes to identify a program of projects that is predicted to have certain impacts on the performance of the transportation system. For example, the Virginia SMART SCALE program, well known to many in the transportation planning industry, uses a scoring method to allocate funding to prioritize project selection. The SMART SCALE program adopts a sophisticated, data-supported process to select projects based on their forecasted benefits. The SMART SCALE framework is a great example for the first three steps, yet for the fourth step on implementation and evaluation is not conducted but would be critical to understanding if the process is working and affecting the performance of the transportation system. In fact, VDOT has determined that the

program's performance-based approach can be enhanced by developing methods to evaluate the level to which completed projects, and the program as a whole, have contributed toward critical goals such as reducing congestion, improving reliability, and increasing safety for all travelers. By developing a methodology to achieve a holistic view of a transportation agency's program of projects impacts on performance, planners and program managers will be better suited to determine what elements of projects – regardless of their funding source – will be most effective.

The purpose of this research is to provide needed frameworks, guidance and tools for transportation planners and analysts to better evaluate both transportation projects and program of projects. Evaluating post-implementation benefits provides a feedback loop to help ensure that information on the effectiveness of projects and programs informs future project selection and implementation. Strong findings of effectiveness from implemented project and program can encourage their further implementation, while weak effectiveness may suggest using alternative solutions. In addition, findings from post-implementation studies can help to identify the characteristics of a corridor or situation under which certain projects and program are most effective. Finally, results can be useful for communicating with the public and decision-makers about the benefits of strategies such as demand management and operational improvements, where projects/programs are often not as readily visible to the public.

Literature Search Summary

A preliminary literature search shows that there is already a great deal of information available about how to measure before/after impacts on individual transportation projects. The evaluations often focus on a particular area such as safety, asset condition (e.g., pavements and bridges), and economic impacts. For safety, researchers have, and continue to, study the impacts of various safety practices on outcomes such as fatalities, serious injuries, and crash rates. For asset condition, there is a significant amount of research and findings on the impact that various funding levels and programs will have on pavement and bridge condition based upon the work to be performed. And, for economic impacts, the SHRP2 program developed EconWorks which is a collection of before-after case studies that focuses on the impact of transportation projects from an economic perspective. EconWorks assists planners in assessing the possible economic implications of projects and considers outputs such as travel time reliability, access to labor and goods markets, and intermodal connectivity. The purpose of this research is to not repeat and replicate these evaluation processes and areas.

In addition, the evaluation of major infrastructure investments has been well researched and used to improve the modeling and predictive capabilities of models and tools used by the industry. For example, Pickerel in his seminal piece on assessing spending for large-scale transit systems found that analysts routinely overstated the benefits and underestimated the costs to justify these projects. Similarly, Flyvbjerg found these results in other large-scale transportation infrastructure projects throughout the world. These types of evaluations had an impact on improving the predictive models, tools, and techniques that analysts used to justify spending large sums of money on transportation infrastructure. However, it is still rare for any ex post analysis of large

transportation infrastructure project to be conducted to better learn if the benefits predicted did indeed come to fruition.

What has not been well-researched or understood is how to measure the impact project-level evaluation for operational and economic outcome type measures as well as program-level evaluation of completed projects. Currently, the only known research underway to better develop the feedback loop that analyzes the effects of a transportation program on the transportation system is that of the Virginia DOT that is measuring the SMART SCALE project performance. This project, begun in 2020, will determine the appropriate measures, methodology and process to assess SMART SCALE project performance. An important aim is to find evidence of transportation agency practices and methods to support project-level and program-level evaluation of completed projects.

Research Objective

The objective of this research is to develop guidance and tools for conducting post-implementation evaluation of the transportation projects and programs. The guidance and tools will provide transportation planners and analysts with the necessary resources in order for them to conduct effective post-implementation evaluations of transportation projects and programs and further support implementation of the performance-based planning and programming processes that transportation agencies are required to do.

The following are the key phases of this research:

1. Conduct a literature review looking at methodologies used by DOTs and other transportation agencies (e.g., MPOs, RPOs, tolling agencies, international agencies, etc.) to gather information about how they evaluate the impact of transportation projects and programs.
2. Survey transportation agencies on what their needs are as it relates to conducting post-implementation project evaluations.
3. Conduct a gap analysis that identifies how this research can address the gaps in needed frameworks, tools and resources.
4. Develop the needed frameworks, tools and resources for conducting post-implementation project and program evaluations. This should include practical guides for practitioners to use in conducting post-implementation evaluation and models and tools that could be used. The guides need to be practical step-by-step resources for planning practitioners seeking to understand what information is needed and how to conduct such analyses.
5. Work with selected state DOTs and MPOs on implementing the results.

Urgency and Potential Benefits

Given the requirements of the FAST Act, transportation agencies will need to have clear strategies in place for providing feedback on performance efforts, and for using this information to improve future decision making outcomes. This project is expected to add value for performance monitoring and decision making at the local, state, and federal

levels. It is expected that this work will provide some of the guidance needed to close the performance planning loop.

By summarizing the various existing methodologies for analyzing and measuring changes to performance attributes, transportation agencies will be provided additional tools to understand the impacts of different types of projects on different performance attributes. Agencies will then understand the types of projects they need to initiate and implement in order to achieve their agency's performance measure targets.

Agencies are currently in various stages of developing and implementing performance measures required federally. Completing this research and guide now will provide states with a pivotal resource in evaluating performance measures in the near future and longer term.

Implementation Considerations

These research results will be of primary interest to state DOT and MPOS, as well as offices responsible for performance and asset management, public engagement, and research. The guidebook and toolkit should be developed to be easily implemented by these offices, such as easy to use self-assessments, checklists, and methods and examples of effective practices that could be adapted.

Recommended Research Funding And Research Period

Research Funding: \$600,000

Research Period: 30 months

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

- Bradley Sharlow, Michigan DOT
- Cynthia Landez, KCI
- Bryan Pounds, WSP
- Scott Phinney, Ohio DOT
- April Delchamps, City of Kent, Washington
- Matthew Hardy, PhD., AASHTO
- Kyla Elzinga, AASHTO

This research problem statement was developed in cooperation between the AASHTO Committee on Planning and the TRB Committees AEP 10 (Transportation Planning Policy and Processes) and AEP 15 (Transportation Planning Analysis and Application).

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Please contact Matt Hardy, AASHTO Program Director for Planning and Performance Management, for a list of recommended panel members representing the AASHTO Committee on Planning. Below is a preliminary list of interested panel members:

- David Wasserman – STIP Western Region Manager (NCDOT),
dswasserman@ncdot.gov
- Shante Hastings, Deputy Secretary and Chief Engineer (DelDOT),
Hastings@state.de.us
- Justin Bruner, Bridge Asset Management Division Chief (PennDOT),
jbruner@pa.gov
- Mark Nelson, Director, Office of Statewide Multimodal Planning (MnDOT),
mark.B.nelson@state.mn.us
- Scott Phinney, Ohio DOT
- April Delchamps, City of Kent, Washington
- Bradley Sharlow, Michigan DOT

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Provide contact information for the individual submitting this problem statement.

Matthew Hardy

202-624-3625

mhardy@ashto.org

Affiliation: AASHTO staff on behalf of the AASHTO Committee on Planning, Kristina Swallow, Chair.

NCHRP Review of B-12

Reviewed By:

Jennifer L. Weeks

jweeks@nas.edu

Comments:

The budget and duration are appropriate.

Review Date:

12/15/2021

FHWA Evaluation of B-12

Reviewed By: Spencer Stevens/HEPP

Comments:

We support this research as it confirms the need for evaluation (looking back) post project/program implementation.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-12**Submitted By:**

Kyla Elzinga
AASHTO staff
AASHTO Committee on Planning

Priority #: 1**Comments:** N/A

Submitted By:

Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A**Comments:**

Recommend including active transportation practices, gaps, and needs. Recommend including active transportation effects, such impacts of projects on connectivity and safety for pedestrians and bicyclists, in the evaluation framework.

Submitted By:

Chad Baker
Research Subcommittee Chair
Data Management and Analytics

Priority #: 11**Comments:** N/A

Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: N/A**Comments:**

Can this be combined with B-09? This is the crux of B-09 outcomes. This research is a low to medium priority.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-13

Problem Title

Institutionalizing Safe Systems and Safety Culture in the Transportation Planning Process

Background Information and Need For Research

Conventional transportation planning and policies, and engineering and design standards, operate under the assumption that people can safely use the roadway system that is in place. Working against this assumption are the actual crash statistics. Over the last 10 years, severe crash numbers have not seen any significant rates of improvement and in 2020, a year when people drove less and walked and biked more, traffic fatalities increased by about 8 percent.

In 2015, NCHRP published Report 811: Institutionalizing Safety in Transportation Planning Processes: Techniques, Tactics, and Strategies. The outcome was a Transportation Safety Planning (TSP) process framework to help planners at State Departments of Transportation (DOTs) and Metropolitan Planning Organizations (MPOs) integrate safety into the different aspects of the transportation planning process (public engagement, stakeholder coordination, goal and objective setting, data analysis, performance management, project prioritization, and monitoring and evaluation). The goal was to give planners practical guidance on how to address transportation safety in the context of their current responsibilities.

Because planners are required to take a holistic view of the entire system and foster partnerships with the public, elected officials, and other transportation and safety stakeholders, they sit in one of the best positions and have ample opportunities to consider a Safe System Approach during the transportation planning process and influence safety culture. To advance the state of the practice, consideration and implementation of this Approach needs to be further researched to be prioritized as part of an agency's mission and work.

This research directly supports the AASHTO Committee on Safety's Strategic Plan goal to "partner in the implementation of a national highway safety strategy and performance measures to reduce fatalities and serious injuries on all public roads and locations where roads intersect with other modes of transportation." In addition, the strategic goal to "provide data-driven safety technical and policy advice" by "incorporating the knowledge and processes for scientific-based safety methods throughout the planning and programming process" is supported by this research. This also supports the AASHTO Committee on Planning's Strategic Plan goal to "provide innovative planning technical products and professional services."

Literature Search Summary

This research will provide specific transportation planning processes to advance the Federal Highway Administration (FHWA) published “Integrating the Safe System Approach with the Highway Safety Improvement Program: An Informational Guide”. This research will build upon the international practices highlighted by the Organization for Economic Cooperation and Development (OECD) International Transportation Forum’s “Zero Road Deaths and Serious Injuries: Leading a Paradigm Shift to a Safe System”. This research will provide planning considerations to the practices highlighted in The Institute of Transportation Engineers (ITE) document “Case Studies on Implementing the Safe System Approach in the U.S.” In addition, this research will complement the NCHRP 17-101 project “Safe System in the U.S.: Developing a Roadmap for Transportation Road Designers, Planners, and Engineers” as a first step in Safe System implementation in the United States.

Research Objective

The objective of this research is to investigate the opportunities and challenges for MPO and DOT planners, and safety partners, to integrate safety culture and safe system elements into the planning process.

Major activities:

- a. Review the previous research products (Framework and Workshop materials) to understand how safe system elements (safe vehicles, safe speeds, safe users, safe roads, and post-crash care) can be integrated in the transportation planning process and the role planners, and safety partners, can play to advance the state of the practice. This action would produce a gap analysis of the existing TSP process and identify opportunities for enhancing the process. This review would include how safety culture can play a role in supporting the implementation of a safe system approach in the TSP process.
- b. Develop a refined framework that addresses the implementation of a safe system approach and the significance of safety culture in a successful TSP process.
- c. Produce new or revised TSP workshop materials supporting the integration of safety culture and the safe system approach.
- d. Pilot test the new or revised materials. Pilot testing of the revised guidance could benefit the pilot states and continue to strengthen the research.
- e. Develop final materials for use by transportation planning agencies in the integration of safety culture and the safe system approach, including items such as self-assessment tools and presentations.

Research results should be presented in a final report and guidance that gives clear and actionable strategies to state DOTs and other agencies to effectively integrate safe system principles and safety culture into the transportation planning process.

Urgency And Potential Benefits

Several States and MPOs are interested in moving towards a Safe System Approach to find opportunities to reverse the upward trend in traffic fatalities. Worldwide, the use of Safe System principles for transportation planning, design, and operations is showing significant success in driving down fatal and serious crashes for all road users, including those who walk and bike.

According to the FHWA, there are six principles that form the basis of the Safe System approach: deaths and injuries are unacceptable, humans make mistakes, humans are vulnerable, responsibility is shared, safety is proactive, and redundancy is crucial. The TSP process tacitly encompasses these principles. Many strides have been made in the field of transportation safety since the original TSP research was conducted and workshop content created. The workshop materials have been updated to reflect current examples of safety integration, but safety culture and safe systems are not specifically addressed in the original research or the workshop materials. To advance the state of the practice, consideration and implementation of these two safety concepts need to be part of an agency's mission and work. Without this research, advancement in a holistic and proactive application of the Safe System approach could be limited. ITE and FHWA have published materials on these two topics, but to date, none address how to incorporate them into the transportation planning process.

This research will help planning and safety professionals more fully understand the relationships between transportation planning, safe systems, and safety culture with insights that can be used to target fatality reduction programs and projects.

Implementation Considerations

There are several potential users of this research, namely state DOT traffic and safety engineers, MPO planning staff, State Governor's offices of Highway Safety, and local agencies. Sixteen states including ME, VT, PA, VA, IN, FL, AL, KY, MO, AR, CA, ID, LA, AK, OR, and SC have utilized the TSP Framework and reported favorable results through a separate Volpe Study. Moving forward, several of those states and others are now interested in exploring the Safe System Approach to continue to enhance their integration of safety into the planning process. The research will have direct application to state and MPO transportation planning processes, development of Strategic Highway Safety Plans, and future safety funding requests. The results of the research could be disseminated through technical presentations and workshops.

The AASHTO Committee on Safety is interested in this research and will assist the member states with implementation. The FHWA Office of Safety and the Transportation Research Board (TRB) Standing Committee on Transportation Safety Management Systems (ACS10) are also supportive of this research.

Recommended Research Funding and Research Period

Research Funding: \$400,00 consisting of \$300,000 to complete the research tasks and an additional \$100,000 for pilot testing and training via 3 workshops.

Research Period: The expected time-period to complete the research is 12 months with an additional 12 months for pilot testing and the workshops.

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Nicole Waldheim
Burgess & Niple
202-577-3474
Nicole.waldheim@burgessniple.com

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Emily Thomas, South Carolina DOT, thomaseg@scdot.org
Cindy Burch, Baltimore Metropolitan Council, cburch@baltometro.org
Margaret Herrera, Maricopa Association of Governments, mherrera@azmag.gov
Mike Vaughn, Kentucky Transportation Cabinet, mike.vaughn@ky.gov
Jon Schermann, MWCOG, jschermann@mwkog.org

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Matthew Hardy, Ph.D.
202-624-3625
mhardy@ashto.org
Affiliation: AASHTO staff on behalf of the AASHTO Committee on Planning, Kristina Swallow, Chair.

NCHRP Review of B-13

Reviewed By:

Jennifer L. Weeks
jlweeks@nas.edu

Comments:

The objective is comprehensive. A recently completed study by the Governor's Highway Safety Association *Putting the Pieces Together: Addressing the Role of Behavioral Safety in the Safe System Approach* seeks to address and integrate behavioral science into safety planning and could be a resource for this research. The budget of \$400,000 is appropriate, but the duration should be increased to 30 months.

Review Date:

12/15/2021

FHWA Evaluation of B-13Reviewed By:

Spencer Stevens, HEPP

Comments:

We support this research as it supports FHWA's effort to advance a Safe Systems Approach.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-13Submitted By:

Kyla Elzinga

AASHTO staff

AASHTO Committee on Planning

Priority #: 3Comments: N/A

Submitted By:

Bud McDonald

AASHTO staff

Council on Active Transportation

Priority #: N/AComments:

Recommend directly addressing planning for active transportation safety and connectivity, and identifying safety benefits for all road users that flow from improving VRU safety.

Submitted By:

Kelly Hardy

AASHTO staff

Safety

Priority #: N/AComments:

This should be coordinated with 17-101 in order to build on those results. This research is a medium to high priority.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-B-14

Problem Title

Benefit Analysis of Private Health Sector Investments in Public/Human Transportation

Background Information and Need For Research

People who are unable to transport themselves and require recurring medical trips for chronic conditions that cannot be served through telehealth, such as diabetes or cancer, face numerous challenges to receiving much-needed care. Public or human services transportation might be lifeline for individuals without a support network, but they then face transit service limitations, prohibitive costs, or the complete lack of access to public transportation depending upon location. Moreover, those with access to public transportation may be without options in response to other challenges, like service delays, interruptions, or closures. While health care transportation (commonly called Non-Emergency Medical Transportation or NEMT) is a benefit of some public insurance plans, the uninsured, under insured, or those who have insurance without this transportation benefit continue to struggle.

For a medical provider, success is only attainable if individuals are able to access their health care facilities for service. When a provider reduces services or the service does not meet its projected levels, that provider can relocate to improve access. While beneficial to the provider, relocations and service reductions often cause further stress on transportation-disadvantaged individuals already struggling to access services.

State departments of transportation (DOTs) are responsible to the transit-dependent public of maximizing investments of state and federal dollars in public transportation, but available funds often leave needed projects partially or wholly unfunded. Simply, available public funding is not sufficient to meet all transportation needs, particularly in those areas where public transit does not currently exist. Planning efforts that focus on maximizing transportation availability and accessibility may not be furthered due to lack of implementation resources. Mobility managers, who are frequently housed within DOTs, are responsible for coordinating transportation resources for individuals with unique access needs and are sometimes challenged to find any transportation options for the individuals they aim to serve. While the Coordinating Council on Access and Mobility (called CCAM) is addressing NEMT from a federal policy and funding perspective, additional, unencumbered private resources for this transportation need could create meaningful change in support of CCAM's work.

If private and nonprofit funding from the health care industry, including hospitals, is available to subsidize transportation, opportunities exist to increase the availability of NEMT while also providing an even greater monetary benefit to the health care industry.

In some cases, health care providers and hospital systems are able to provide transportation funding or develop their own services to transport their clients. But this support is the exception rather than the rule. The aim of this research is to convince the systems that do not participate in transportation funding that it could result in greater service delivery at a profit.

This research will serve as a foundation to incentivize private health investment in NEMT by demonstrating its returned value, and for future research to examine the effects of such an investment. Ultimately, by improving access to health care services through NEMT in areas most in need, not only will public health improve but the overall impacts to local, regional and statewide economies can be significant.

Literature Search Summary

During this literature search, the following citations with summaries were discovered in relation to best practices on private health sector investments in transportation:

- **Cost-Effectiveness of Access to Nonemergency Medical Transportation: Comparison of Transportation and Health Care Costs and Benefits.** Summary – This research compares the costs and benefits of providing NEMT and identifies a net cost savings across transportation and health care for four chronic conditions and determines cost-effectiveness for eight additional conditions.
- **Implementation of a Non-Emergent Medical Transportation Programme at an Integrated Health System.** Summary – This research included a needs assessment and request for proposals to develop and implement a transportation service at a 15-hospital integrated network and several smaller community hospitals in Missouri and Illinois.
- **Exploring Data and Metrics of Value at the Intersection of Health Care and Transportation: Proceedings of a Workshop.** Summary – The objective of this research was to explore partnerships, data, and measurement at the intersection between health care and transportation.
- **Guidebook and Research Plan to Help Communities Improve Transportation to Health Care Services.** Summary – The objectives of this research are to develop a guidebook to help communities improve transportation to health care.
- **Transportation to Dialysis Centers: Health/Transportation Policy Intersection.** Summary – The objective of this research is to quantify the current and projected demand and associated costs of transportation for kidney dialysis and identify current effective practices and new strategies for funding and providing transportation for dialysis.

NEMT is necessary for health care, affecting providers and patients. This proposed research would expand upon existing research and provide an actionable solution with multi-faceted benefits, including improved NEMT services for patients resulting from the healthcare industry's increased investment in NEMT.

Research Objective

The objective of this research is to conduct a benefits analysis that state DOTs, public transit and NEMT providers, and transportation stakeholders could utilize to influence

hospitals and other health care providers to make small, supportive private investments in NEMT. This research will explore the effects of healthcare investments in communities with existing public transit, human services transportation, and other NEMT. This research needs to include several cost-benefit analyses of healthcare investment in transportation, specifically, one analysis each in a rural, small urban, and urbanized area in at least three states with varying geography, demographics, and economies. The research should include: a report of findings, a tool for measuring the direct and indirect benefits (monetary and public health) of transportation subsidies by healthcare providers, and a recommended process for presenting the findings to the healthcare industry to incentivize investment.

Urgency And Potential Benefits

Federal, state, and local funding is insufficient to meet the NEMT needs across the country. Transportation will continue to be an issue, and challenges to accessing healthcare will continue to increase as the population ages. Medical and other large-scale emergency events that increase the public need to access transportation will further strain the system, particularly when protective measures such as social distancing are also implemented. There may be many solutions to the transportation funding challenge, but until they are explored and vetted, there will be no definitive way to determine where investments can afford sufficient benefit. By not furthering this research now, the transportation challenges will persist while the available funding will remain deficient.

Implementation Considerations

Transit program managers, planners, and mobility managers at state departments of transportations (DOTs) will use this research when working with transportation operators, other state agencies that fund or have a vested interest in transportation, and state committees responsible for overseeing and implementing activities in the Coordinated Human Service Mobility Plans. Because available transportation funding is limited and does not meet the need in every area, state DOTs will benefit from involving all partners in efforts to increase private NEMT investment. Once available, this information will be valuable for use during public meetings and made available for presentations, trainings, and peer exchanges; in brochures, websites, and guidance documents for transit providers; for large healthcare systems with multiple locations in a state or region; and for transportation providers to use within their communities to solicit funding from healthcare providers.

Recommended Research Funding and Research Period

Research funding: \$400,000

Research period: 18 months: 12 months of research and six months of communication and implementation

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Brittany Voll, Virginia Department of Rail and Public Transportation, (804) 786-4637, brittany.voll@drpt.virginia.gov

Ian Ritz, Wisconsin DOT, (608) 266-0189, ian.ritz@dot.wi.gov

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Brittany Voll, Virginia Department of Rail and Public Transportation, (804) 786-4637, brittany.voll@drpt.virginia.gov

Ian Ritz, Transit Section Chief, Wisconsin Department of Transportation, (608) 266-0189, ian.ritz@dot.wi.gov

Charles Carr, Research Chair, AASHTO's Council on Public Transportation; Mississippi Department of Transportation, (601) 359-7025, ccarr@mdot.state.ms.us

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

AASHTO's Council on Public Transportation

Contacts: Shayne Gill

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AASHTO

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rprice@ashto.org

NCHRP Review of B-14

Reviewed By:

Jennifer L. Weeks

jlweeks@nas.edu

Comments:

The funding of \$400,000 is appropriate, but the effort will require at least 24 months.

Review Date:

12/15/2021

FHWA Evaluation of B-14

Reviewed By:

Tom Harman/HIT; Fred Bowers/HEPP

Comments:

Tom Harman - Non-Emergency Medical Transportation or NEMT is a clear need.

Fred Bowers - Strong points include research that will serve as a foundation to incentivize private health investment in NEMT(Non- Emergency Medical Transportation) by demonstrating its returned value, and for future research to examine the effects of such an investment and ultimately improving access to health care. This is a very similar and supporting of the HIRTA project currently moving forward. The draw backs is a high funding amount of \$400K.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-14
Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: N/A

Comments:

This research is a low priority. If approved, the panel should include non-emergency medical transportation providers.

Submitter Response for 2023-B-14

Comments: Thank you for reviewing this research proposal. Your comments demonstrate that NEMT is an important form of public transportation and truly in need of research to support further investments from the private sector.

Enclosed is a Word document with the complete response to the FHWA Evaluation of and NCHRP Reviewer Comments on B-14 - Benefit Analysis of Private Health Sector Investments in Public/Human Transportation.

Contact Info:

RICHARD B. PRICE
Associate Program Manager, Transit Policy and Technical Assistance
American Association of State Highway and Transportation Officials (AASHTO)
Work: (202) 624-5813
Cell: (202) 427-5600

Review Date:

Monday, February 7, 2022

Response to Harman/Bowers

Thank you for reviewing this research proposal. Your comments demonstrate that NEMT is an important form of public transportation and truly in need of research to support further investments from the private sector.

This proposal has been submitted to NCHRP for a few years, each time receiving more and more positive comments. One year, a commenter recommended that, due to the complexity of the issue, this proposal's budget should be increased to \$500,000. As a result, we thought that previously considered budget was insufficient to meet the research objectives and implementation considerations included in the proposal. As a result, we increased the budget to \$400,000 to allow for the complexities of the issue to be fully explored and accounted for in the research results.

We would entertain a reduction in the overall budget but fear that would result in a reduced scope, such as removing the objective associated with developing a process to present the finding to the healthcare industry, a much needed step. Alternately, we could consider reducing the state analysis from three to two states, as written. But then again, by reducing the research scope, we fear endangering the success of the research objective.

Please know that this problem statement ranked #3 in priority for members of AASHTO's Council on Public Transportation and Multi-State Transit Technical Assistance Program.

Response to NCHRP comment:

Thank you for reviewing this research proposal. NEMT is an important form of public transportation and truly in need of research to support further investments from the private sector.

By providing a budget of \$400,000 and extending the timeframe to 24 months, instead of 18 months, we know that it would allow those overseeing and those conducting the research to better achieve the scope of research, including the objectives and implementation considerations included in the proposal.

Please know that this problem statement ranked #3 in priority for members of AASHTO's Council on Public Transportation and Multi-State Transit Technical Assistance Program.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-15

Problem Title

Update the National REMEL Database Used in FHWA Traffic Noise Model

Background Information and Need For Research

The Reference Energy Mean Emission Level (REMEL) database is an inventory of different vehicle pass-by noise levels which is the basis for the FHWA Traffic Noise Model analysis software. It is 25 years old and in need of updating. Internal combustion engines have become more efficient, overall vehicle technology has evolved, truck exhaust stack noise has decreased, truck exhaust stack locations are changing, and electric and hybrid vehicles are entering the vehicle population. Newer noise measurement technology has also evolved, and it can be applied to locate and quantify noise generators on a moving vehicle. The old REMEL database positions and distributes a significant amount of vehicle noise energy at 5 and 12 feet above the pavement. Recent NCHRP research shows that most vehicle noise energy is at the tire/pavement interface or only 3.3 feet above the pavement. The 5- and 12-foot energy distributions used in TNM, strongly biases analysis toward tall, and expensive, sound walls, and it underestimates noise reductions which shorter berms and concrete safety barriers can provide. The old REMEL database also underestimates the acoustic variation caused by different pavements and how the different pavements influence roadside noise levels. This outdated REMEL database adversely impacts sound wall analysis and limits available design options. Tall sound walls are about \$2M/mile and shorter less-expensive noise barriers would provide state DOTs much more design flexibility in mitigating highway noise impacts. Quieter pavement strategies keep money in the road – not in barriers. More design options would help DOTs better address noise-related inequity issues also.

This research will use the two new highway acoustic measurement technologies of OBSI and acoustic beamforming, in combination with the old measurement process - SPL, to develop a new REMEL database for the current vehicle fleet. All the five basic acoustic vehicle classifications: heavy truck, medium trucks, passenger cars, buses, and motorcycles will be remeasured and updated. The beamforming will show the relative amount and location of vehicle noise in the vehicle profile and OBSI will more accurately measure the pavement acoustics and how it correlates to roadside noise. These two new measurement processes will be combined with the old-school, roadside SPL measurements. Based on previous NCHRP research, this will reduce noise contributions from the old-and-outdated 5 ft and 12 ft vehicle sub-source positions currently used in TNM, and more accurately distribute the noise energy in the vehicle

profile. This new REMEL database could then be used to update and improve the accuracy of the FHWA TNM software.

Highway noise is always a top environmental concern with the public on any highway project. Updating and improving the 25-year-old vehicle noise REMEL database will improve the accuracy of traffic noise analysis. This will provide state DOTs with more design options and flexibility to mitigate the environmental impacts of highway noise. The use of shorter less expensive noise barriers and quieter pavement strategies will also help address equity related issues and would save a significant amount of taxpayer dollars.

Literature Search Summary

The 1995 REMEL database was developed under a transportation pooled fund research project and included 25 state DOTs and measured about 6000+ vehicle pass-bys in about six different states. This proposed research will use some of the methodology of the old 1995 REMEL study and include the work done under recent NCHRP 630, 635, and 842 projects which validated the new OBSI and beamforming measurement technologies. NCHRP 630 measured the pavement acoustic variation for both light vehicles (passenger cars) and heavy trucks. NCHRP 635 and 842 measured about 1600 individual heavy trucks and a few medium trucks and passenger cars. This proposed research would combine measurement procedures of the old 1995 REMEL study with the new NCHRP measurement technologies to create an updated REMEL database which would be about 6000+ vehicles and include heavy trucks, medium trucks, passenger cars, buses, motorcycles, and newer all-electric or hybrid vehicles operating under typical conditions.

Research Objective

The final product will be an updated vehicle noise REMEL database based on the current vehicle fleet and measured with both old and new acoustic measurement technologies which will better quantify and position the vehicle noise sub-sources: mechanical, exhaust, tire/pavement. The new REMEL database could ultimately be implemented into the FHWA TNM software to improve its accuracy. A preliminary analysis will also be included with the database to discuss the differences between the new REMEL database and the older REMEL data.

Pass-by noise levels will be measured for different acoustically isolated individual vehicles operating under different conditions using SPL, OBSI, and beamforming acoustic measurement technology. The measurement matrix would include different vehicle types, different speeds (10 to 80 mph), cruising, acceleration/deceleration, flexible and rigid pavements, and different road grades.

The REMEL database should be thoroughly documented and the data made available in an open-source format for immediate use by state DOT engineers and noise analysts and other third-party noise simulation software vendors such as SoundPlan and CadnaA . To better accommodate future updates and improve accuracy and limit computational adjustment factors, the REMELs will be based on source measurements

and referenced relative to the vehicle position in the traffic lane and will not be based on measurements taken at a distant receptor position. Most noise barrier design is performed on federally funded public works transportation projects and the REMEL database directly impacts structural noise barrier design. All stages and phases of the development of the REMEL database will be managed and reviewed by an experienced and responsible registered engineer. Implementation into the FHWA TNM software is not included in this research and would be a separate from this work.

Urgency and Potential Benefits

Complaints and concerns over traffic noise levels is a constant issue for SDOTs. The public is demanding SDOTs reduce highway transportation infrastructure noise levels and the current analysis process does not present many viable low-cost alternatives. More accurate acoustic data and modeling will offer more flexibility, help SDOTs develop more noise mitigation design strategies, better address noise complaints/concerns, and save money. This will also provide more options to help address inequity related to noise impacts.

The 1995 REMEL database did not accurately quantify pavement acoustic variation and its impact on roadside noise levels. A great deal about pavement acoustics has been learned in the last fifteen years through the development of the AASHTO T-360-16 Standard, and in Transportation Pooled Fund Studies 5-135 and 5-139, NCHRP 630 research. Quieter pavement strategies may not have the acoustic durability of noise barriers, but they work on both sides of the highway and potentially impact more receptors. A noise barrier only works for one side of the road and may create reflection problems for the opposite side of the road. Quieter pavements also keep funds in the maintaining the pavement. FHWA has an established pavement rehabilitation program for routine replacement of worn-out, and louder, pavement. Quieter pavements are also an effective tool for addressing community noise complaints and could also be used on state-funded projects.

This research would provide State DOTs with less-expensive noise barrier options and more flexibility in mitigating noise impacts of projects. Between 2014 and 2016, \$224 million was spent on noise walls annually in the United States. If this cost were to be reduced by even a small percentage, the result would be tens of millions of taxpayer dollars saved annually. Regardless of how much money is ultimately saved, more realistic modeling of noise barriers will ensure that the money invested in noise abatement is spent effectively and wisely.

Implementation Considerations

Cooperation with FHWA will be important to ensure this updated REMEL database will be adopted and implemented into FHWA's TNM software as a much-needed update. Once implemented, this new REMEL database would be used by all state DOTs for noise analysis on federal-aid, and possibly state-funded, highway projects. The REMEL data should also be made available in an open-source or spreadsheet format, so that others could access it and perform their own acoustic analysis for certain scenarios. An open-source REMEL dataset would facilitate and nurture faster development of

additional analytical digital tools. Existing third-party noise simulation software like SoundPlan or CadnaA are already sophisticated and flexible enough to accommodate this new REMEL data and could also be used to develop acoustic design guidance for earthen berms, short concrete safety barriers, and quieter pavement strategies. The AASHTO Noise Working Group has discussed the importance of this issue at length and strongly supports this research.

Recommended Research Funding and Research Period

This research would be expected to cost \$500,000 to \$1,000,000 and take 24 to 36 months. This considers the following conditions that can be anticipated to be part of this effort.

Measurement sites may be scattered around several states. Multiple days of measurement may be required at each site to capture enough vehicles for each operational condition. Typically, measurements are done in dry temperate weather conditions and wet, cold winters would be used to reduce and analyze the data and document the measurement work. Measurements are done in dry temperate weather conditions and wet, cold winters would be used to reduce and analyze the data and document the measurement work and plan logistics for next batch of measurements. Site selection can be challenging due to a multitude of variables: safe and flat side slope for measurement equipment placement, correct traffic flow conditions, pavement, grade, speeds, etc.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Bruce Rymer, Caltrans, bruce_rymer@dot.ca.gov, 916-956-3272

Daniel Burgin, Oregon Dept. of Transportation – Research Coordinator AASHTO CES Environmental Process Subcommittee, Daniel.G.BURGIN@odot.state.or.us, 503-509-7415

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

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Noel Alcala, Ohio Dept. of Transportation – Chair AASHTO Noise Work Group, Noel.Alcala@dot.ohio.gov, 614-466-5222

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Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Tim Hill, Ohio DOT - Vice Chair AASHTO CES, Tim.Hill@dot.ohio.gov, 614-644-0377

NCHRP Review of B-15

Reviewed By:

Ann M. Hartell
ahartell@nas.edu

Comments:

The proposed research would focus on field work to collect highway noise data for a range of vehicle types using up-to-date methods. A budget of \$750,000 would support a field data collection for a focused list of vehicle types and site/pavement conditions. However, as the research problem statement notes, the new measurement data would need be accepted by FHWA for use in an updated version of the TNM. Notably at the time of this review, the release of TNM 3.1 is currently pending so it is unclear when a subsequent update could be anticipated. The previously used mechanism to collect data for the REMEL database through a Transportation Pooled Fund, which closely involves FHWA, may be the more appropriate vehicle for this work than an NCHRP research study.

Review Date:

12/15/2021

FHWA Evaluation of B-15

Reviewed By:

Cecilia Ho, Aileen Margolles-Varella - HEPN-10

Comments:

This proposal is timely and FHWA supports the research to update the REMEL database. The 1995 REMEL database is used in FHWA's Traffic Noise Model and should be updated to reflect the current fleet characteristics. In 2021, FHWA initiated a research study to start the process of updating the database. This research would be complimentary to FHWA's on-going effort. However, we do have several comments on the problem statement: (1) the problem statement seems to pre-suppose the research outcome, especially related to vehicle noise sources and pavement; (2) data collection using beamforming should include full frequency range of vehicle noise; (3) research objective should specify that data should be collected on a 1/3 OB basis and ideally, audio recordings sampled at 44.1 Khz or better, as well, and (4) specifying several commercial software packages may appear as endorsement.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-15

Submitted By:

Tim Hill

Vice Chair

AASHTO Committee on Environment and Sustainability

Priority #: 1

Comments:

Response to FHWA Evaluation of B-15: Rank 1 In response to the comment that this problem statement seems to pre-suppose the outcome, the expectation that results would allow for more accurate modeling of heavy trucks is based on a large quantity of prior research which used more advanced measurement methods including NCHRP 630, 635, and 842. In response to the comment that data collection using beamforming should include a full frequency range of vehicle noise, we agree that to the extent possible, this should be done, but current beamforming technology does not cover the full range of vehicle noise. Current beamforming technology would still be a massive improvement over Sound Pressure Level measurements taken 50 feet from the source, which is what the current REMEL's are based on. For this research, the beamforming would be supplemented by both Sound Intensity and Sound Pressure Level measurements. In response to the comment "specifying several commercial software packages may appear as endorsement", it's not intended as an endorsement of any specific product, but it will be useful for the results of this research to be an open source REMEL database such that users have the flexibility to utilize whatever software package offers the features they need, especially in situations where TNM is not mandated for use. Response to NCHRP comment on B-15: FHWA has stated that this research is timely and fits into their goals. Regardless, having this new dataset open source and available would be a resource for state DOT's and other researchers to build upon. Caltrans continues to develop processes and products that utilize prior NCHRP 630, 634, 635, 738, and 842 (and current NCHRP 984) research and are now being used by several other states as well as industry.

Submitter Response for 2023-B-15

From:

[email: Tim.Hill@dot.ohio.gov,]

Comments:

Response to FHWA Evaluation of B-15: Rank 1 In response to the comment that this problem statement seems to pre-suppose the outcome, the expectation that results would allow for more accurate modeling of heavy trucks is based on a large quantity of prior research which used more advanced measurement methods including NCHRP 630, 635, and 842.

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Response to NCHRP comment on B-15:

FHWA has stated that this research is timely and fits into their goals. Regardless, having this new dataset open source and available would be a resource for state DOT's and other researchers to build upon. Caltrans continues to develop processes and products that utilize prior NCHRP 630, 634, 635, 738, and 842 (and current NCHRP 984) research and are now being used by several other states as well as industry.

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Review Date:

2/4/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-16

Problem Title

Addressing Traditionally Marginalized and Underrepresented Groups in Cultural Resource Management

Background Information and Need For Research

Environmental justice, racial equity, and the inclusion of traditionally marginalized and underrepresented groups in relation to historic preservation is an emerging topic and little specific or practical guidance exists to support FHWA and state DOTs relative to Section 106 review. This topic emphasizes the urgency of research and education and the risk of not properly addressing these groups in Section 106 review (and other historic preservation regulations) for transportation projects. While there is a lot of literature and policy statements available, it is unclear how much or in what ways this literature and discourse is filtering into the on-the-ground practice of Section 106 review of how the existing information is actually addressing traditionally marginalized and underrepresented groups in Cultural Resource Management. In coming years, efforts to diversify the National Register of Historic Places will affect the Section 106 review process in ways that will create uncertainty for transportation projects, unless Section 106 (and NEPA) practitioners take a proactive role in understanding the issue and updating agency practices.

This research is directly responsive to Goal No. 1 of AASHTO's Standing Committee on the Environment and Sustainability (CES): "provide technical support to members to increase their capacity to efficiently and reliably deliver environmentally sound transportation programs and services", especially to "provide various forums and facilitate member information peer exchange of successful practices ..."

Literature Search Summary

Professional and industry organizations have provided the most guidance and resources for this topic within the Section 106 regulatory context.

- AASHTO - The board of directors unanimously passed a resolution pledging to address issues related to race, equity, diversity, and inclusion .
- National Park Service - The Underrepresented Community Grant Program (URC) works towards diversifying the nominations submitted to the National Register of Historic Places and its "Telling All Americans' Stories" initiative includes numerous publications on Diverse and Inclusive. Also, NPS's Heritage Initiatives, is aimed at recognizing several groups that are traditionally underrepresented.

- The National Trust for Historic Preservation - The Trust also focusing on raising awareness of properties associated with traditionally marginalized and underrepresented groups.
- American Cultural Resources Association - providing multiple webinars beginning in July 2021 and into 2022 on the topic and hosted a dedicated session on CRM and traditionally marginalized and underrepresented groups at its 2021 annual conference in which the ACHP and FHWA staff participated.
- American Association for State and Local History (AASLH) and the National Council on Public History (NCPH) - Co-developed The Inclusive Historian's Handbook that aligns with AASLH's and NCPH's goals of building diversity and inclusion across the historical community.

Academia is the realm in which the most is being written and developed. One example is the Buildings-Landscapes-Cultures (BLC) Program at University of Wisconsin, Madison and Milwaukee which hosts a participatory action-research project that explores history and heritage of local neighborhoods. Other academic materials include sources such as "Issues in Preservation Policy, Preservation and Social Inclusion – Preservation's Reckoning". Further work to find relevant examples within academia would provide useful.

Research Objective

The goal of the research is to develop a guidance document on effective ways for state DOTs to identify traditionally marginalized and underrepresented groups, to appropriately evaluate properties associated with these groups, to develop pertinent mitigation within Section 106 or other regulatory processes.

Four elements are required: (1) identifying practices that lead to early and effective public involvement with these groups; (2) developing strategies to identify and evaluate properties with local significance by more comprehensively considering properties overlooked by current survey and evaluation methods, including integrity considerations; (3) finding new ways to integrate perspectives from such groups when considering adverse effects to historic properties; and (4) pinpointing best-practices, case studies and available training venues.

Work needed to accomplish these goals include the following tasks:

1. Researching and identifying creative and best practices for public outreach to traditionally marginalized and underrepresented groups, including looking at public outreach for NEPA, Section 106 outreach, and by cities and communities in urban planning and historic preservation. The result will develop a detailed resource guide to traditionally marginalized and under-represented groups that identifies key themes and topics based on available research and synthesizes the results. Research would include work completed by federal and state agencies, local governments, CRM NGO organizations, and academia. The resource guide would be organized around providing answers to common questions and needs related to meeting requirements under Section 106.

2. Complete a survey of FHWA, state DOTs, SHPOs, CRM NGO organizations, and academia of the topic as it relates to environmental regulations - specifically Section 106 - to understand the state of the industry on creative and best practices and existing agency policy practices, and training for public outreach and mitigation.
3. Compile the results of the survey and develop a document that captures the state of the industry, identifies existing resources and needs, and case studies on successful outcomes. Case studies would include successful projects regarding the identification and evaluation of properties and through public engagement and involvement in the consultation, evaluation, and mitigation processes. The results will include a list of best practices for outreach, evaluation of historic resources and mitigation.

Urgency and Potential Benefits

Urgent need to proactively address the needs of Executive Order Directing Federal Actions to Address Environmental Justice, Minority Populations & Low-Income Populations that calls for a review of environmental regulations with a focus on the issue of environmental justice to consider environmental effects on low-income and minority communities across the United States and changes already underway in within the historic preservation field to understand how Section 106 and other historic preservation regulations can properly address traditionally marginalized and under-represented groups.

Benefits include:

1. Providing examples and effective practices on the identification and engagement with traditionally marginalized groups and under-represented groups as part of public involvement to reduce unanticipated discoveries.
2. Understanding how to creatively work within the existing regulatory environment (Section 106/ 110, NEPA) to engage traditionally marginalized and under-represented groups to initiate public involvement in regulatory processes and provide case studies of successful outcomes.
3. Providing examples on how the National Register Criteria for Evaluation were used to evaluate a range of property types associated with traditionally marginalized and under-represented groups and provide case studies of successful outcomes.

Implementation Considerations

The outcomes of this research would primarily be used by state DOT CRM programs, including planning and environmental programs, implemented through review and adoption of research results and participation coupled with a consultant with experience on the subject matter. Other organizations that might be interested in the research results and could help support implementation include:

- Federal Highway Administration
- Federal Transit Administration
- Federal Railway Administration
- Advisory Council on Historic Preservation
- State Historic Preservation Officers

Recommended Research Funding and Research Period

Funding: \$250,000

Period: 2 years

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Chad Moffett, Mead & Hunt, Inc. chad.moffett@meadhunt.com 916-993-4655;

Kyle Obenauer, Senior Architectural Historian, Vermont Agency of Transportation, kyle.obenauer@vermont.gov, (802) 279-7040

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

AME60 Committee of the Transportation Research Board has a subcommittee that are active and assisted in development of the problem statement that could serve or identify panel members:

Kyle Obenauer, Vermont Agency of Transportation; Hannah Braun, Colorado DOT; Anthony Ross, Indiana DOT; Kristen Zschomler, Mead & Hunt, Inc.; Steve Archer, Maryland DOT; Terri Lotti, Georgia DOT; Althea Asaro, Caltrans; and Jessica Feldman, ICF.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Kyle Obenauer

Senior Architectural Historian

Vermont Agency of Transportation

(802) 279-7040

kyle.obenauer@vermont.gov

NCHRP Review of B-16

Reviewed By:

Ann M. Hartell

ahartell@nas.edu

Comments:

The proposed research addresses a current and expanding need among cultural resource staff and state DOTs. Although a number of NCHRP projects addressing equity in the transportation decision-making process and in public outreach, these projects do not include the specific challenges and requirements of the Section 106 regulatory process. The proposed project should build on but not duplicate NCHRP Web-Only Document 281: Integrating Tribal Expertise into Processes to Identify, Evaluate, and Record Cultural Resources (published in 2020). An increased level of

funding to \$300,000 is suggested to support a robust level of outreach to informants that will be required to supplement published research and resources.

Review Date:
12/15/2021

FHWA Evaluation of B-16

Reviewed By:
Fleming El-Amin/HEPH-10

Comments:

We see benefit in this research. The effort includes researching and identifying best practices for public outreach to traditionally marginalized and underrepresented groups, including looking at public outreach for NEPA, Section 106 outreach, and by communities in project planning and historic preservation. Ensuring meaningful public involvement of all stakeholders in transportation planning and environmental review is critical to ensuring equitable outcomes. The proposal specifically examines part of the environmental review process with a focus on Section 106 and NEPA, but could lead it help to promote equity in this realm, and provide strategies to increase representation of underrepresented groups in cultural management resource processes, and historic preservation.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for B-16

Submitted By:
Tim Hill
Vice Chair
AASHTO Committee on Environment and Sustainability

Priority #: 7

Comments:

NCHRP Problem Statement response: remove the two consultants from the "Potential Panel Members", so that each of these firms can pursue the project if funded. Their participation on the panel would present a conflict of interest. Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone. AME60 Committee of the Transportation Research Board has a subcommittee that are active and assisted in development of the problem statement that could serve or identify panel members: Kyle Obenauer, Vermont Agency of Transportation; Hannah Braun,

Colorado DOT; Anthony Ross, Indiana DOT; Steve Archer, Maryland DOT; Terri Lotti, Georgia DOT; Althea Asaro, Caltrans.

Submitter Response for 2023-B-16**From:**

[email: Tim.Hill@dot.ohio.gov]

Comments:

Rank 7

NCHRP Problem Statement response: remove the two consultants from the "Potential Panel Members", so that each of these firms can pursue the project if funded. Their participation on the panel would present a conflict of interest.

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

AME60 Committee of the Transportation Research Board has a subcommittee that are active and assisted in development of the problem statement that could serve or identify panel members:

Kyle Obenauer, Vermont Agency of Transportation; Hannah Braun, Colorado DOT; Anthony Ross, Indiana DOT; Steve Archer, Maryland DOT; Terri Lotti, Georgia DOT; Althea Asaro, Caltrans.

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**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation****FY2023 NCHRP PROBLEM STATEMENT TEMPLATE****Problem Number: 2023-B-17****Problem Title**

Best Management Practices to Identify and Mitigate PFAS Impacts on State DOT Construction Projects and Maintenance Operations

Background Information and Need For Research

Per- and polyfluoroalkyl substances (PFAS) are a group of manmade fluorinated chemicals that have been manufactured and used in a variety of industries since the 1940's. They are persistent in the environment and the human body, and there is evidence that exposure to PFAS can lead to adverse health effects and ecological risks. PFAS are considered contaminants of emerging concerns, with regulatory standards that are evolving due to new science, detection capabilities, and transport pathways. The Environmental Protection Agency has issued Health Advisories at parts per trillion levels in drinking water for two PFAS compounds (PFOA, PFOS), and many State Environmental Agencies are regulating additional PFAS compounds and lowering groundwater standards for PFOA and PFOS. Without Federal Maximum Contaminant Level standards for PFAS compounds, States have regulated various PFAS compounds at varying standards and in varying media. Many of the States regulating PFAS in drinking water have just as stringent standards for groundwater. Additionally, large industrial PFAS air deposition areas exist, with no Federal guidance yet on soil leaching standards, leaving Transportation Agencies to evaluate the risk and liability of relocating PFAS-impacted soil.

DOT agencies like New Hampshire DOT, Michigan DOT, and Minnesota DOT are navigating PFAS-related issues, at significant expense, due to, but not limited to, the following situations: DOT-owned legacy sites with PFAS impact; road construction and improvement through PFAS-contaminated soil and groundwater due to aerial deposition, stormwater runoff and groundwater migration; increased assessment and analytical cost for soils to be graded, cut, or excavated; storage and disposal of spoil materials from road way maintenance in areas with PFAS aerial deposition; PFAS impact in dewatered construction groundwater and the requisite parts per trillion treatment goals; and, landfill testing requirement and restrictions leading to increased transportation and disposal costs.

Literature Search Summary

Research exists related to airports, but there is a lack of DOT-focused research. The National Academies of Sciences, Engineering, and Medicine (2017) published a comprehensive resource document for airport industry practitioners on the fundamentals and recommended best practices for management and remediation of PFAS found at airport sites. Currently, no analogous document exists that addresses PFAS management

as for general transportation infrastructure. Based on the current literature, no state DOTs have developed an analogous comprehensive guide for identifying and/or managing PFAS that may be encountered when constructing or repairing transportation infrastructure outside of airport source sites.

While a number of states directly address PFAS, their action plans focus on the following: biosolids and wastewater treatment; drinking water sources (e.g. groundwater and soil near the water table); sources that impact air quality, landfills or other waste disposal sites; food safety; and/or airports where firefighting foams containing PFAS (AFFF) were known to have been used (Alaska DEC 2021; Massachusetts DEP 2021; MPART 2019; among others). With these focus areas in mind, several states have formed interagency groups to address minimizing human exposure to PFAS within their state. These groups are charged with developing PFAS management strategies, such as locating likely contaminated areas, sample collection and analysis, remediation/removal strategies, surveying inventory and improving storage practices of unused supplies of products containing PFAS, etc. For example, the state of Connecticut formed the Connecticut Interagency PFAS Task Force to develop an action plan addressing the challenges related to PFAS (Connecticut Interagency PFAS Task Force 2019). The CT Task Force consists of 16 different organizations and is led by the CT Department of Public Health and the CT Department of Energy and Environmental Protection. Other states with similar interagency groups include Michigan (MPART 2019), Minnesota (Greene and Neuschler 2021), Pennsylvania (PFAS Action Team 2019), and Wisconsin (WisPAC 2020). However, none of the identified state action plans explicitly address the impact of PFAS contamination on state transportation agency construction and maintenance sites.

Research Objective

The objective of this research is to provide DOTs a reference document with technical guidance on status of PFAS regulatory requirements and risks, current PFAS impacts on DOTs, tools to screen and identify locations of potential PFAS contamination that could impact DOT operations, and methods to mitigate identified PFAS impacts.

The research objectives will be met through the following tasks and related activities:

Task I: Review and Summarize Regulatory Literature:

- Status of the U.S. regulatory environment for PFAS as it pertains to Transportation Agencies, particularly in light of EPA PFAS Action Plan
- State Requirements

Task II: Survey and Summarize Current DOT PFAS Case Studies and DOT-Developed PFAS Guidance or Other PFAS Guidance Used by DOTs

- Screening tools used to determine potential areas of concern for PFAS during the NEPA process
- Guidance or current practice to identify nearby sources
- Guidance on when to sample and the sampling approach for a DOT project
- Guidance for geotechnical explorations in known or suspected PFAS-impacted areas

- Current practices and resources for evaluating PFAS impacts to DOT projects and operations

Task III: Conduct a comprehensive literature review of potential PFAS sources adjacent to and within existing DOT right of ways.

- An overview of current and historic PFAS uses and applications with potential impacts for transportation agencies
- A summary of products currently or historically used by Transportation Agencies which are known or suspected to contain PFAS

Task IV: Develop general mitigation and management strategies

- Temporary storage, management, disposal or relocation and treatment options for waste construction water or soil impacted by PFAS
- On-site remediation technology options for PFAS-impacted construction dewatering
- Development of draft specification templates
- Decision tree with potential options depicted

Task V: Production of final report synthesizing results of Tasks I through IV.

Urgency And Potential Benefits

With the increase in knowledge about the existence of PFAS in all environmental media, and concern about environmental and human health impacts, DOTs are in need of guidance on how to manage PFAS on their properties and projects. DOTs lack a full understanding of where PFAS may be present within DOT Rights of Way, and when PFAS are found, there are concerns with limited and expensive disposal options and a need for management strategies. Moreover, on October 18th, 2021 the EPA launched a PFAS Roadmap that includes regulatory and administrative actions and enforcement approaches that they intends to take, using existing authorities, to comprehensively address PFAS throughout the environment. EPA's move to regulate PFAS will require manufacturers to provide detailed data about entire classes of compounds they produce, with plans to designate some of them as hazardous chemicals under the nation's Superfund law. Also on that date, the Defense Department announced that it will finish initial assessments of possible PFAS contamination stemming from nearly 700 of its installations by 2023.

Potential benefits enabled through the proposed technical guidance measures include:

- Assist DOT with understanding the emerging impacts on construction and maintenance projects associated with PFAS
- Avoidance and Minimization strategies
- Greater predictability for construction and maintenance costs
- Public relations with respect to DOTs being proactive about PFAS; these "forever chemicals"

Implementation Considerations

The primary drivers of implementation for the proposed work will be DOT staff involved in environmental management, sustainability, and waste management. Another important target includes regulatory agencies that are responsible for developing regulatory approaches to address PFAS impacts and approving waste management plans associated with PFAS impacted soil and groundwater. Deliverables shall be created with both end users in mind, as DOTs will likely need to present technical justification to regulatory agencies to gain approval for PFAS waste management.

Recommended Research Funding and Research Period

\$350,000 over a 24-month period

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

David Wilson; VDOT, (804) 840-7065; david.wilson@vdot.virginia.gov; Chair TRB AMS20
Angel Palomino, Ph.D.; U of Tennessee; (865) 974-7757; apalomin@utk.edu; Chair TRB AKG30

Helen Corley, LG; Wood E&IS; (704) 357-5516; helen.corley@woodplc.com; Member TRB AMS20

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

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Harold Zweng, P.E.; Michigan DOT; ZwengH@michigan.gov; (517)-243-5495

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Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Tim Hill, Ohio DOT, Vice Chair, AASHTO CES, Tim.hill@dot.ohio.gov, (614) 644-0377

NCHRP Review of B-17

Reviewed By:

Ann M. Hartell

ahartell@nas.edu

Comments:

The development of information on PFAS and descriptive information about the emerging regulatory environment for this category of pollutants may be of value for state DOTs, although changing regulatory requirements will reduce the long-term relevance of some of the proposed elements of the project. Further, the development of guidance

on how to identify, manage and mitigate PFAS as part of a DOT project will be developed by environmental regulatory agencies (state or federal). A budget of \$200,000 is appropriate for development of basic information on PFAS for state DOT project managers, environmental analysts, and other relevant staff; a scan of current practice at state DOTs; examples of potential mitigation and management practices from other relevant contexts; and emerging approaches to mitigating and managing PFAS.

Review Date:
12/15/2021

FHWA Evaluation of B-17

Reviewed By: Susan Jones/HEPE-30

Comments:

We see the benefit in this proposed research since USEPA does consider PFAS a detrimental pollutant on water sources. Current research does indicate that conventional stormwater treatment controls are needed for PFAS and more studies will be needed to contain PFAS from stormwater runoff. USEPA currently has quite a lot of information on PFAS on drinking water, PFAS studies at airports and from fire-retardants. Potential panel members should include USEPA and members of AKD50.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for B-17

Submitted By:
Tim Hill
Vice Chair
AASHTO Committee on Environment and Sustainability

Priority #: 3

Comments:

The problem statement authors would like to provide the following perspective and response based on our internal discussions and from input from the audience at our PFAS Workshop at the TRB 2022 Annual Meeting:

- The potential impacts of PFAS on DOT operations continue to be a topic of interest and concern for those who attended the workshop;
- There is agreement from the authors and workshop attendees that PFAS and Stormwater is an issue and should be addressed by the proposed research. While it

was not specifically mentioned in the background section, the statement, as written, is broad enough to encompass stormwater aspects in the research scope and would not necessitate a revision;

- While a research panel member from EPA would provide a regulatory perspective to the research objectives, the other proposed panel members are well versed in addressing contaminant impacts in DOT projects and operations and would be able to provide the needed research perspective related to PFAS impacts in stormwater. Accordingly, additional panel membership from the stormwater committee may not be necessary;
- The authors and input from a DOT survey AMS20 and AKG30 conducted in preparation for the TRB 2022 Annual Meeting PFAS workshop, continue to indicate an interest in Task I and support for some level of regulatory summary as part of the research. The authors agree that this section is one of the more minor sections of the research and conclude that it can be handled in an efficient manner through largely referencing existing summaries and as such would not represent an expensive or time consuming aspect to the research;
- Similarly, the DOT survey results and author discussion continue to support including Task III, as it is specific to current and historic DOT uses of PFAS and should have long-term relevance as DOTs address PFAS impacts to their projects and operations; and,
- All of these items considered, we feel that the original proposed budget is reasonable to address the scope.

Submitter Response for 2023-B-17

From:

[email: Tim.Hill@dot.ohio.gov,]

Comments:

Rank 3

The problem statement authors would like to provide the following perspective and response based on our internal discussions and from input from the audience at our PFAS Workshop at the TRB 2022 Annual Meeting:

- * The potential impacts of PFAS on DOT operations continue to be a topic of interest and concern for those who attended the workshop;
- * There is agreement from the authors and workshop attendees that PFAS and Stormwater is an issue and should be addressed by the proposed research. While it was not specifically mentioned in the background section, the statement, as written, is broad enough to encompass stormwater aspects in the research scope and would not necessitate a revision;
- * While a research panel member from EPA would provide a regulatory perspective to the research objectives, the other proposed panel members are well versed in addressing contaminant impacts in DOT projects and operations and would

be able to provide the needed research perspective related to PFAS impacts in stormwater. Accordingly, additional panel membership from the stormwater committee may not be necessary;

* The authors and input from a DOT survey AMS20 and AKG30 conducted in preparation for the TRB 2022 Annual Meeting PFAS workshop, continue to indicate an interest in Task I and support for some level of regulatory summary as part of the research. The authors agree that this section is one of the more minor sections of the research and conclude that it can be handled in an efficient manner through largely referencing existing summaries and as such would not represent an expensive or time consuming aspect to the research;

* Similarly, the DOT survey results and author discussion continue to support including Task III, as it is specific to current and historic DOT uses of PFAS and should have long-term relevance as DOTs address PFAS impacts to their projects and operations; and,

* All of these items considered, we feel that the original proposed budget is reasonable to address the scope.

Again, we appreciate the opportunity to provide our insight and perspective on the continuing need for this valuable research.

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**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-18

Problem Title

Concrete Curing pH Level Impacts for Minimization of Harm to Aquatic Species

Background Information and Need For Research

Construction and maintenance actions regularly require state Department of Transportation(s) (DOT) to cast concrete structures below the ordinary high water lines of streams. Recently-cast concrete is known to increase the pH level of water it contacts, which has the potential harm to aquatic species. This and other in-water work are typically done within dewatered work areas. Restoring flow too early may result in harm to aquatic organisms and enforcement actions by environmental regulators. Restoring flow too late may unnecessarily delay removal of work area isolation structures, delay restoration of full fish passage through the stream crossing, conflict with in-water work timing requirements, and extend project schedules. Excessive delay may therefore harm natural resources, project budgets and schedules.

Because freshly set concrete can affect the pH of water it contacts, the concrete must be isolated from stream flow, usually by diverting the stream using a pipe or parallel channel, until the curing process sufficiently reduces the probability of an adverse effect to aquatic habitat. However, the precise effect of recently-set concrete on the pH level of water is not well understood. Specifically, it is not clear how long it takes for curing concrete's effect on water pH to be reduced to a level that minimizes potential to harm to aquatic species. Understanding this timing is important for ensuring that following cast-in-place operations, DOT's restore flow to streams at the appropriate time and can demonstrate to regulators using reliable data that these practices will not result in harm.

This is a relevant topic anywhere grout and concrete products are used in aquatic habitats, in addition to being a statewide issue in states such as Oregon.

Literature Search Summary

In 2016, the California Department of Transportation's Division of Research published the results of a preliminary investigation to identify the existing body of knowledge on the topic (<https://dot.ca.gov/-/media/dot-media/programs/research-innovation-system-information/documents/preliminary-investigations/pcc-and-water-ph-pi-revised-2-1-16-a11y.pdf>). This investigation was motivated in part by the California Department of Fish and Wildlife's requirement that Portland cement concrete be isolated from flowing water for 30 days. The research found some relevant past research, but found significant gaps and was not focused on the specific products used in states such as Oregon. A follow-up inquiry to Caltrans in May 2019 found that although the report identified potential next steps including further research, the investigation's champions had retired from

Caltrans and no further action had been pursued. Caltrans' preliminary findings may be an appropriate point to build upon in conducting further research. In 2014 the published research evaluating techniques to meet pH standards during in-stream construction that might

Also potentially useful for this proposed research effort are prior investigations into pH remediation techniques, such as a 2014 Maryland State Highway Administration study (Identification of Techniques to Meet pH Standard during In-Stream Construction (maryland.gov)) and a 2014 RMIT University study (The impact of curing compounds on the leaching from concrete).

Research Objective

The objective of this research is to develop field applicable pH reduction curves for curing concrete to inform in-water work processes for DOTs and their regulatory agencies. This research should encompass a multi-parameter model that includes the effects of variables such as: 1) concrete and grout type used by state DOTs in aquatic applications, 2) volume of water and duration of contact with concrete (which is a function of water velocity, length of concrete structure along the stream, and the hydraulic radius of the concrete portion of the channel), and 3) water temperature. Additionally, mitigation factors that enable more efficient construction should be explored including: low pH cement, quick drying cement, and sealants.

Expected Tasks:

- Literature Review and Data Acquisition that includes: 1) state DOT survey for precedent data and development of concrete and grout product list commonly used, 2) industry data if available, 3) identification of knowledge gaps needed to estimate the appropriate curing time before water containing aquatic organisms is returned to the structure.
- Laboratory and Field-scale experiments that identify ideal curing time and pH conditions for aquatic species site return that includes pH effects post-water return (up to 1yr)
- Laboratory and Field-scale experiments that explore the feasibility (pilot) the use of remedial solutions.
- Report that highlights recommendations, reviews the state of practice, and details the methodology, findings, and limitations of the research study.

Depending on timing and budget considerations, it may be appropriate to explore the potential to reduce the delay of streamflow restoration by applying effective curing compounds, including the effects of the most effective and available compounds on the receiving waters.

Urgency And Potential Benefits

DOTs may presume that the effects of pH on fish of various species and life stages are well understood by agencies state Fish and Wildlife Agencies and/or the National Marine Fisheries Service (NMFS); however, these agencies are not expected to be

authorities on the specific effects of concrete on the pH of flowing water. More information about the effects of recently cast-in-place concrete on pH of flowing water is needed to ensure that regulations are informed by good science, impacts are minimized, and appropriate water quality contract specifications are used for state DOT construction projects.

Implementation Considerations

Stormwater professionals including hydraulic engineers, water resource specialists, and biologists within DOTs are likely to be responsible for implementing this research. This research may likely inform project delivery budget and timelines, so prior to full implementation, field-scale pilots may be needed/expected.

The AASHTO Natural Resources Subcommittee of the Committee on Environment and Sustainability and the AASHTO Technical Committee on Hydrology and Hydraulics may be interested in these research results and assist with implementation.

Recommended Research Funding and Research Period

Research Funding: \$400,000

Research Period: 3 years

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Cory Engel, Oregon DOT; Cory.C.ENGEL@odot.state.or.us; 503-986-6641

Kira Glover-Cutter, Oregon DOT; Kira.M.GLOVER-CUTTER@odot.state.or.us; 503-986-2851

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Cory Engel, Oregon DOT; Cory.C.ENGEL@odot.state.or.us; 503-986-6641

Kris Gade, Arizona DOT; kgade@azdot.gov; 602-292-0301

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

AASHTO Committee on Environment and Sustainability

Tim Hill, CES Vice Chair, Ohio Department of Transportation

Tim.hill@dot.ohio.gov, (614) 644-0377

NCHRP Review of B-18

Reviewed By:

Ann M. Hartell

ahartell@nas.edu

Comments:

If a limited number of concrete and grout types can be identified that are commonly used across the country for in-water work, the proposed research is appropriate for the NCHRP. For a study involving field tests, a larger budget of at least \$600,000 will be required.

Review Date:

12/15/2021

FHWA Evaluation of B-18

Reviewed By:

Buford/HEPE-30

Comments:

The proposed research would benefit state DOTs to better manage concrete toxicity in the aquatic environment to reduce impacts and construction delays.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-18

Submitted By:

Tim Hill

Vice Chair

AASHTO Committee on Environment and Sustainability

Priority #: 11

Comments:

Response to NCHRP: We agree that a limited number of concrete and grout types can be identified for the focus of this project. FHWA: no response needed.

Submitter Response for 2023-B-18

From:

[email: Tim.Hill@dot.ohio.gov,]

Comments:

Rank 11

Response to NCHRP: We agree that a limited number of concrete and grout types can be identified for the focus of this project.

FHWA: no response needed

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Review Date:

2/4/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-19

Problem Title

7691: Cultural Resources Mitigation: What Works and What Doesn't?

Background Information and Need For Research

When a transportation project has an adverse effect to historic properties under Section 106 of the National Historic Preservation Act, the project proponent is required to complete mitigation measures. Development of mitigation is done in consultation with the Section 106 stakeholders. Mitigation measures, such as HABS/HAER/HALS completion, archaeological data recovery and associated research, educational publications, etc., are considered typical mitigation. Different, new or creative mitigation measures are not normally considered due to time constraints and funding limitations. Recent years have seen a shift to greater consideration of creative mitigation alternatives; however, the degrees of success of implemented mitigation are rarely discussed. Creating a list and identifying how to make mitigation measures work for a project, including budget, schedule and type of historic property effected (building, structure, object, site, & district) would enable project proponents the opportunity to develop meaningful cultural resource mitigation for the public benefit. For AASHTO, this research is applicable to other functional units that develop environmental mitigation measures and could provide additional insight to help in further developing and implementing successful mitigation in those areas.

Literature Search Summary

Past research efforts have focused on effective mitigation strategies and more recently, creative mitigation. However, limited attention has been given to the success of each mitigation measure and the degree of their effectiveness with regard to implementation and public benefit. The Research in Progress Database and the Transportation Research Integrated Database gives very broad search results using the terminology "cultural resources mitigation". Focus on specific cultural resource property types and specific project examples are not readily identifiable. By developing subcategories for commonly encountered historic property types, having a reference list of intended mitigation measures and discussing why a measure was successful or not, would build upon the existing body of research.

Research Objective

The objective of the research is to identify mitigation strategies previously implemented and categorize the degree of success in producing a public benefit. Four tasks are outlined to complete this research objective:

Task 1 - providing a list of the most common historic properties adversely affected by transportation projects based on research and communication with federal and state transportation agencies, SHPOs, the National Park Service and other cultural resource professionals.

Task 2 - identify the mitigation measures that were identified in Task 1, including the resource type, what National Register Criteria the resource was significant under, if it was implemented, and if it was completed.

Task 3 - in consultation with the project proponent, lead agency, consultants or peers, identify the degree to which mitigation measures were successful in producing a benefit to the public and the possible reasons for the degree of success, and any impediments to that success. Certain criteria to measure successful mitigation efforts can include (1) the number and manner of public responses or comments, i.e. public support and level of community impact; (2) involvement or active participation from interested stakeholders and/or cooperation among the different agencies involved; (3) the future benefits of the mitigation to others (does it convey a purpose or have applicable meaning for future generations?); (4) the implementation and fulfillment of the agreed upon terms; and (5) quantitative analysis, such as results of the mitigation tied into cost benefit or cost-effectiveness.

Task 4 - summarize the best practices for mitigation development and implementation based on the research completed in Tasks 1-3. The work should be compiled in short report (50 pages or less) to be utilized as guidance for agencies seeking mitigation options.

Urgency And Potential Benefits

State DOTs struggle with developing cultural resources mitigation to meet the current demands of the public and the requirements of the State Historic Preservation Officer. Identification of mitigation measures that have been successfully implemented or not, would allow state DOTs to more effectively plan a project's compliance with Section 106 of the National Historic Preservation Act and ensure that the project is delivered according to the cost, scope and schedule. This research will also provide project proponents the opportunity to share this research with the public, Section 106 stakeholders and other consulting parties and ensure that everyone is aware of possible mitigation options, giving a starting point for collaborative mitigation development. While this study will focus on State and Federal DOTs, the research will be widely applicable to other federal agencies who would benefit from having mitigation dos and don'ts outlined by historic property type, their sub-categories, and how to implement the measures successfully. With this research, state DOTs will have the opportunity to create more meaningful mitigation measures that benefit the public, which will improve the public trust.

Implementation Considerations

Cultural Resources professionals (SHPOs, State and Federal DOT staff and their consultants) would utilize this research. The research would be implemented within the DOTs throughout the Section 106 compliance process for every project. Additionally, the document could be provided to Section 106 Stakeholders to enable more transparent consultation. This report would enable collaborative consultation on the

development of Section 106 mitigation measures and allow for a better awareness of cultural resources and the Section 106 process. The information provided in the report can be distilled by each DOT as needed into a one-page brochure or a pamphlet to best support their own Section 106 consultation. Additionally, the information provided would support public presentations, roundtables, and workshops that seek to develop a project's cultural resources mitigation measures. This information can be posted on the public meeting page of state DOT websites.

Recommended Research Funding And Research Period

For research objectives outlined above, a total of nine months are expected to acquire the necessary data and produce a short report of approximately 50 pages. One full-time professional (\$187,500) and one-part time supporting staff (\$93,750) would be required for an estimated total of \$281,250. Additional resources, such as web survey service subscription (\$25 per month for 3 months) and purchasing articles for research (estimated \$150), will be required. An additional two weeks of work is proposed for implementation procedures, such as distribution of report, questions, and presentations for a cost of \$7,211.

The research funding requested is for a rounded total of \$290,000.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Reviewed By:
Ann M. Hartell
ahartell@nas.edu

Comments:

The proposed research would evaluate mitigation strategies and determine how successful they were in providing a public benefit. The research has the potential to yield some useful insights, but will place a research team in the position of adjudicating the degree of success in any cases where there is wide variation in opinion among those who were involved with the project (including among regulatory agencies). The research would likely rely on generalizations about mitigation measures taken from a limited sample of projects, which will have unique characteristics and stakeholders that shape the material and/or perceived success of outcomes. Data for a cost-benefit or cost effectiveness analysis will be scarce.

The proposed research suggests an element of field work might be required to determine if mitigation measures were completed, collect information from stakeholders and partner agencies, and to evaluate the on-site properties. For a robust evaluation study of this scope and the development of communications resources for use by state DOTs, a budget of \$500,000 is reasonable to conduct a limited set of cases, defined by property type or by mitigation measure.

Review Date:
12/15/2021

FHWA Evaluation of B-19

Reviewed By:
David Clarke/HEPE-30

Comments:

We see the benefit of this research, however, the funding and time do not match up with the goals of the research.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for B-19

Submitted By:
Tim Hill
Vice Chair
AASHTO Committee on Environment and Sustainability

Priority #: 5

Comments:

The Problem Statement authors agree with the comment that gathering un-biased opinions as to the degree of success of mitigation will be difficult to accomplish as will determining the degree of success of mitigation. As a result, we believe the research should shift in emphasis from measuring the degree of success of mitigation to an assessment of how to accomplish effective mitigation. We still have opinion gathering as a component, but the goal now is to identify the requirements of and impediments to effective mitigation to the adverse effects on cultural resources. In terms of aligning research project costs with the tasks, we believe the research could be done without travel to specific locations but rather through electronic means via email, survey, phone conference and online resources. We believe this may be achievable within the \$200,000-300,000 range.

Submitter Response for 2023-B-19

From:

[email: Tim.Hill@dot.ohio.gov,]

Comments:

Rank 5

The Problem Statement authors agree with the comment that gathering un-biased opinions as to the degree of success of mitigation will be difficult to accomplish as will determining the degree of success of mitigation. As a result, we believe the research should shift in emphasis from measuring the degree of success of mitigation to an assessment of how to accomplish effective mitigation. We still have opinion gathering as a component, but the goal now is to identify the requirements of and impediments to effective mitigation to the adverse effects on cultural resources.

In terms of aligning research project costs with the tasks, we believe the research could be done without travel to specific locations but rather through electronic means via email, survey, phone conference and online resources. We believe this may be achievable within the \$200,000-300,000 range.

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**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-20

Problem Title

DOT Guidance on Induced Demand Effects of various Roadway Investments

Background Information and Need For Research

Operational improvements such as auxiliary lanes and intelligent transportation system treatments are designed to reduce congestion. Even these minor congestion improvement strategies and investments intended to optimize existing roadway system assets are increasingly facing opposition in the name of “induced demand”, often pointing to potentially disparate impacts on Environmental Justice (EJ) communities. The public raises concerns about increased greenhouse gases (GHG) and air quality impacts of such projects and lack trust that the traffic analyses are accurately accounting for induced demand. The concern has been used as a cudgel to suggest that even historically understood congestion improvement activities may actually be hurting, rather than helping, the air quality of the commuting and near-road communities. DOTs need assistance in understanding the best investments in lieu of induced demand to reduce roadway congestion.

Recognizing even operational and safety improvements may have some level of induced demand, and induced demand makes it more difficult to build our way out of congestion, DOTs are planning such investments and need to better understand their potential unintended consequences. Some data have shown substantial reductions in congestion with auxiliary lanes by reducing conflicts in complex weaving areas, brings these segments back up to their theoretical capacity. However, results are complicated by changes in travel patterns (re-routing, time of day), measuring reductions in incidents, and capturing safety impacts on parallel local roads and alternative modes. Even auxiliary lanes less than one mile to remove bottlenecks, which EPA has explicitly identified as exempt from conformity in their last PM Hot-Spot FAQ, now have had public concerns raised regarding their potential to induce demand. These challenges call for consistent analysis and transparency.

Most induced demand research is tied to significant new lane-mile capacity changes and has often been theoretical. Limited research has evaluated the real-world effects of these smaller roadway treatments, leaving key questions unanswered:

- Under what conditions do major and minor induced demand issues occur?
- Does the induced demand counteract the congestion improvement entirely or even substantially?
- Can these effects be mitigated (e.g., through tolling or land use controls, etc...)?

- How can roadway improvements be a responsible component of a transportation system with regards to tackling air quality and GHG emissions?

A definitive study of these and other minor capacity enhancements on both freeways and arterials, as well as mitigation options is needed to improve DOT investment decisions for the long term and enable more productive conversations with the public.

Literature Search Summary

Recent research, such as that supporting the new Caltrans Induced Demand Tool, have incorporated ranges of elasticity findings from different induced demand studies and project conditions. However the literature has less to say about the influencing factors and mitigation. The literature also focuses on larger capacity projects, and assume those relationships scale to much smaller projects where the perceived benefit to a user may be negligible. The proposed effort should build on a research-based usage of the term “induced demand” and its many variants, to provide nuance to the colloquial public usage and establish definitions that distinguish induced demand effects from small to large roadway investments. In order to develop a methodology to determine overall congestion changes and fill gaps in the literature, the research will need to evaluate and build on existing research on operational and minor capacity enhancements.

Research Objective

To provide confidence to both the travelling public and near-road communities (including EJ communities) that DOTs are taking the induced demand concern seriously and to implement roadway enhancements that are truly beneficial to them by:

- Perform a literature review, that informs the Assessment Framework, isolated new analysis, and outreach materials:
- Create an Assessment Framework that would:
 - o Definitions. Defines induced demand in a consistent way, i.e. between build and no-build future scenarios, and covers the spectrum of projects, i.e. large capacity enhancements to smaller operational improvements.
 - o Evaluation. Enable a structure way to evaluate the relative potential for generating typical induced demand “effects” resulting from various “project types”; and how those effects impact agency “outcome areas” such as air quality and climate, teasing out significant differences in effects across project types. Definitions and evaluation framework should be reviewed with selected outside reviewers prior to finalization.
 - o Factors & Mitigation. Identify contextual factors that alter potential latent and induced demand (i.e., base travel cost, land use, tolling, and improved local street connectivity). These factors should be supported with examples in practice.
 - o Analysis Best Practices. Identify Best Practices in modeling & analysis to capture the effects defined above consistently.
- Create and implement isolated new research (analysis and/or modeling) to fill Assessment Framework gaps. Preference is for observed over modeled theory; anticipate gaps in smaller ITS, auxiliary lanes, operational projects. If modeling is used, air quality models may be unnecessary as improvements can be assumed if congestion

improvements are demonstrated. However, evaluation of network models may be important to evaluate overall VMT and associated congestion changes.

- Create and pilot outreach materials, build on latest behavioral science on changing attitudes, including:
 - o Guidance. Develop materials to clearly define the various induced and latent demand causes and effects, typical project induced effects and mitigation options using the assessment framework. Case study examples will provide narratives to communicate complexities.
 - o Lookup Tool. Provide a lookup tool by which DOTs can match combinations of project types, treatments, and mitigation actions that will best meet various congestion circumstances to lead to desired public goals (i.e., congestion, air quality improvement)
 - o Pilot Implementation. Coordinate with a few DOTs to apply the outreach materials process in a couple locations, (urban/rural project applications by different DOTs), to assess how it affects relationship with the public on the project.

Urgency and Potential Benefits

The public and interested groups are using induced demand arguments to oppose new roadway investments and small operational and safety roadway projects by DOTs across the country. In order to invest responsibly – balancing safety, economic, equity, and climate concerns – DOTs need to better understand the actual effects of these projects, especially of smaller roadway treatments and other mitigation options. Additionally, with tough tradeoffs, DOTs would engender more public buy-in through more nuanced discussions grounding in understandings of comparisons with other areas of the country. Ultimately this study would provide a broader understanding of effective roadway congestion strategies, and would help DOTs avoid investing tax dollars in projects/treatments that if left unmitigated are unlikely to achieve their intended goals.

Implementation Considerations

The proposed study includes a peer exchange to draw on the experience of the states that already consider induced demand and development of new resources to be most helpful to state DOTs as funds allow. The contractor would give a presentation of the final product to AASHTO's AQCCES committee. The new resources would be implemented by individual state DOTs, which could customize the materials to their specific needs (types of projects, resident concerns, etc.). DOT planners, project delivery coordinators, NEPA practitioners, and other DOT staff engaging with the public throughout transportation project development and delivery would be responsible for utilizing the results of this research and for integrating the methods of analysis and framework definitions into their existing business practices and communications strategies. Interested DOTs could use this research and the resulting tools to:

- Better capture and analyze potential for induced demand associated with proposed transportation projects using best practice analysis methods designed to consistently analyze and quantify measurable differences in induced demand between projected future build congestion and projected future no-build congestion as part of transportation project planning and design.

- Based on analysis results, determine the appropriate level of mitigation needed where project evaluation identifies high potential for induced demand as a result of the project as proposed.
- Improve public conversations about this issue and how potential impacts are factored into project considerations, to better distinguish the potential for induced demand that stems from issues unrelated to a specific transportation project i.e. planned land use, human behavior influences (e.g. gas prices, economy, alternative choices).
- Best practices analysis methods that consistently capture the various induced demand effects, i.e. tool feedbacks, comparison of build and no- build future scenarios.

Recommended Research Funding and Research Period

Cost estimate for the workplan (#5), including pilot efforts of final communication materials.

\$250k for 18-month effort, assuming last 6 months for DOT pilot usage

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Tara Weidner, Oregon DOT-Climate Office, Tara.J.Weidner@odot.state.or.us, 503-986-4226

Katherine Silva, Oregon DOT-Climate Office, Katherine.SILVA@odot.state.or.us, 503-986-3495

Tim Wood, Texas DOT - Environmental, Tim.Wood@txdot.gov, 512-416-2659

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

☐ Robert Bertini, Oregon State University, Civil & Construction Engineering, School Head/Professor, robert.bertini@oregonstate.edu, 541-737-5682

☐ Susan Handy, University of California at Davis, Department of Environmental Science and Policy, Professor, slhandy@ucdavis.edu, 530-752-5878

☐ Alexander Bigazzi, University of British Columbia, Dept. of Civil Engineering and School of Community and Regional Planning, Associate Professor, abigazzi@civil.ubc.ca, 604-822-4426

☐ Tim Wood, AASHTO Air Quality, Climate Change & Energy Subcommittee member, Texas DOT - Environmental, Tim.Wood@txdot.gov, 512-416-2659

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Tim Hill, CES Vice Chair, 614-644-0377, Tim.hill@dot.ohio.gov,

Affiliations: Ohio DOT & AASHTO Committee of Environment and Sustainability

NCHRP Review of B-20

Reviewed By:

Trey Joseph Wadsworth
twadsworth@nas.edu

Comments:

The proposed research would be valuable to DOTs as the problem statement suggests, especially if they can learn how to avoid induced demand which would allow their investments to last longer. The research would be more valuable if the outcome could also assist in factoring in induced demands impact on air quality improvements and GHG emission impacts. However, the creation of a tool may prove to have limited value since the tool would be a one-time creation and there would be no mechanism to support or maintain it (e.g., data gets outdated, new methods are identified, or it breaks). An alternative approach may be the development of a framework for DOTs to consider in creating tools for their specific contexts (e.g., identification of parameters, data inputs, or equations, with guidance on how and where to update those elements). The research timeline is too short and the budget too low. Recommend at least 24 months and \$500,000 to achieve desired objectives and implementation activities.

Review Date:

12/14/2021

FHWA Evaluation of B-20
Reviewed By:

Getachew Mekonnen/HPTS, Charles Noble/HPTS, Mona Asudegi/HPTS, Patrick DeCorla-Souza/HCFB

Comments:

Getachew Mekonnen, Charles Noble, Mona Asudegi - Roadway capacity or service improvements are expected to create induced demand and associated impacts (such as congestion, emissions, and safety). Roadway improvements also bring about changes in land use, employment, and other economic benefits. This study will support understanding of induced demand due to new transportation projects. It would be a good idea to provide a concise description of the objectives and the information gap the research is intended to address. One of the objectives listed in the proposal is to "Create and implement isolated new research (analysis and/or modeling) to fill Assessment Framework gaps." Does this mean analysis tools and/or models will be developed to fill in gaps through this research? "Transportation planners use a traditional four-step model (i.e., trip generation, trip distribution, modal split, and trip assignment) for estimating changes in travel demand resulting from transportation projects, and the potential impacts of changes in travel demand on travel time and externalities. Depending on the level and scope of analysis, the trip generation component of the traditional model should account for induced demand. However, induced demand is a complicated problem that can have different underlying reasons

depending on specific project conditions. One of the typical factors impacting it is the shape of the transportation network of the project location and distribution of traffic across the network. These impacts can be analyzed in detail and more appropriately through network modeling. For this project, and to generalize such complicated concepts without a detailed model, it is important to be aware of influencing factors and how they work together. As so, we would recommend inclusion of a modeler on the research panel. Also, use of appropriate typology could be helpful in avoiding detailed modeling of projects and networks to come up with appropriate factors based on similarities of locations and projects. GEMS, a new model under development in the FHWA Office of Transportation Policy Studies, has already developed typology with this goal in mind and can be helpful for this study.

Patrick DeCorla-Souza - We looked at the California "induced travel calculator" that this research will build on. It is a very crude elasticity-based tool. It's going to be hard to defend its results. I think it would be better to use a 4-step model with feedback into land use to get good estimates of induced VMT.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-20

Submitted By:

Tim Hill

Vice Chair

AASHTO Committee on Environment and Sustainability

Priority #: 2

Comments:

Response to FHWA Comment 1: We appreciate the feedback. With regards to the product of the research, we left this open but feel observed before and after data under documented project conditions is better than models due to many feedbacks. We support inclusion of a model versed in 4-step and ABM models. Alex Bigazzi has expertise in travel modeling. Great to hear of existing typology that the work might build upon.

Response to FHWA Comment 2: We appreciate your supportive feedback. We concur network modeling may be the best way to get at induced demand; and, that could be evaluated as part of the "Analysis Best Practices" and "Isolated New Research" components of this problem statement. I have no concerns with having a modeler on the research panel. Totally agree. According to the authors of that tool, it is intended to raise awareness of induced/latent demand phenomenon, as a screening tool. However the complex induced/latent demand phenomenon requires more understanding of the network, existing demand, trip re-routing, local land use laws and other project

attributes. The GEMS tool seems like a good starting point for tailoring the tool to some of those key elements.

Response to NCHRP We appreciate your supportive response and suggestions. We referenced emissions generally which could include air quality if budget and scope allows. We believe it is important for this work to create a tool and believe that a framework could be a logical extension of what we have proposed. We support increasing the overall cost and timeframe of the problem statement accordingly.

Submitter Response for 2023-B-20

From:

[email: Tim.Hill@dot.ohio.gov,]

Rank #2

FHWA Comment 1: Getachew Mekonnen, Charles Noble and Mona Asudegi - "Create and implement isolated new research (analysis and/or modeling) to fill Assessment Framework gaps." Does this mean analysis tools and/or models will be developed to fill in gaps through this research?

As so, we would recommend inclusion of a modeler on the research panel (versed in 4-step and ABM models typically used in practice).

-appropriate typology could be helpful in avoiding detailed modeling of projects and networks to come up with appropriate factors based on similarities of locations and projects. GEMS, a new model under development in the FHWA Office of Transportation Policy Studies, has already developed typology with this goal in mind and can be helpful for this study.

Review Date:

Response to FHWA Comment 1:

We appreciate the feedback. With regards to the product of the research, we left this open but feel observed before and after data under documented project conditions is better than models due to many feedbacks. We support inclusion of a model versed in 4-step and ABM models. Alex Bigazzi has expertise in travel modeling. Great to hear of existing typology that the work might build upon.

FHWA Comment 2: Patrick DeCorla-Souza - We looked at the California "induced travel calculator" that this research will build on. It is a very crude elasticity-based tool. It's going to be hard to defend its results. I think it would be better to use a 4-step model with feedback into land use to get good estimates of induced VMT. - Review Date:

Response to FHWA Comment 2:

We appreciate your supportive feedback. We concur network modeling may be the best way to get at induced demand; and, that could be evaluated as part of the "Analysis

Best Practices" and "Isolated New Research" components of this problem statement. I have no concerns with having a modeler on the research panel. Totally agree. According to the authors of that tool, it is intended to raise awareness of induced/latent demand phenomenon, as a screening tool. However the complex induced/latent demand phenomenon requires more understanding of the network, existing demand, trip re-routing, local land use laws and other project attributes. The GEMS tool seems like a good starting point for tailoring the tool to some of those key elements.

NCHRP Comment: Trey Joseph Wadsworth

More valuable if the outcome could also assist in factoring in induced demands impact on air quality improvements and GHG emission impacts. However, the creation of a tool may prove to have limited value since the tool would be a one-time creation and there would be no mechanism to support or maintain it.

An alternative approach may be the development of a framework for DOTs to consider in creating tools for their specific contexts (e.g., identification of parameters, data inputs, or equations, with guidance on how and where to update those elements).

The research timeline is too short and the budget too low. Recommend at least 24 months and \$500,000 to achieve desired objectives and implementation activities. -

Response to NCHRP

We appreciate your supportive response and suggestions. We referenced emissions generally which could include air quality if budget and scope allows. We believe it is important for this work to create a tool and believe that a framework could be a logical extension of what we have proposed. We support increasing the overall cost and timeframe of the problem statement accordingly.

Contact Info:

Tara Weidner, Oregon DOT-Climate Office, Tara.J.Weidner@odot.state.or.us, 503-986-4226
Tim Wood, Texas DOT - Environmental, Tim.Wood@txdot.gov, 512-416-2659

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**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-B-21

Problem Title

Framework for Analyzing and Mitigating Highway-related Noise and Vibration Impacts on Terrestrial Wildlife

Background Information and Need For Research

Currently, there is minimal guidance from federal agencies on how to conduct noise and vibration analyses specific to wildlife, which results in differing approaches to noise analyses that may be inaccurate, non-comparative from state to state (or study to study), or result in unnecessary analyses. The current FHWA Noise Abatement Criteria (NAC) approach is based on striking a balance between desirable and feasible approaches for human receptors, with a focus on hearing, annoyance, sleep, and task interference or disturbance. Interference with speech communication is used as basis for determining the NAC. Such an approach is insufficient in addressing issues with wildlife.

As a result, there is a need for a framework for analyzing the effects of anthropogenic noises and vibrations associated with highway construction and operations on wildlife. Specifically, an approach is needed to use current noise analysis tools to address effects on essential activities for wildlife, including feeding, sheltering, breeding, dispersal, and communication. This requires input both from noise specialists and biologists. The goal is to streamline and move toward a more standard approach for these analyses.

Streamlining does not mean waiving or relaxing regulatory requirements or neglecting best available practices. Streamlining identifies a common denominator between the project delivery, environmental effects, and applicable regulatory framework. In other words, ways to meet requirements more efficiently, by establishing, and adhering to, more realistic project budgets, schedules, and possible mitigation obligations through interagency cooperation.

This research task supports the Committee on Environment and Sustainability's (CES) initiative to streamline the environmental review process and their promotion of practices that encourage interagency cooperation and coordination in the resolution of environmental issues.

Literature Search Summary

A search of the TRID database (<https://trid.trb.org>) resulted in recent documents on the general effects of noise on bats, monarch caterpillars, deer, coyote and bobcats, but these do not address an approach for analyzing noise and vibration impacts on different terrestrial species. A search of the Research in Progress database (<http://rip.trb.org/>) did not produce any additional studies. Caltrans protocols for addressing noise impacts to birds and bats were identified. The FHWA Synthesis of Noise Effects on Wildlife and other literature from outside the transportation realm (e.g. National Park Service) also provides information on approaches to evaluating impacts to species.

Research Objective

The objective of this project is to develop focused, streamlined, concise and consistent practices and methodologies for analyzing and mitigating noise and vibration impacts on terrestrial wildlife species (including those that are listed under ESA), that would be conducive to efficient and regulatory compliant noise analyses performed by state DOTs and their partners. To that effect, it is essential to determine:

- The stressor(s)/noise and vibration descriptors (un-weighted vs. weighted, statistical, other as appropriate, and inter-correlation), and propagation over terrain and other physical variables
- An understanding of how the stressors of project-related noise and vibration might affect responses of different species and individuals within the species, and related life-history influences, and a tiered approach on how an impact may be identified
- Evaluation of available modeling tools that are provided by federal authorities, such as FHWA TNM 3.0, RCNM 2.0, and Quarry for use for wildlife analysis as well as the representation of subject activities and resources analyzed
- Appropriate techniques on establishing a common noise environment based on the anthropogenic sound landscape
- Risk assessment approach that considers the conservation status of the resources involved
- Reasonable and feasible mitigation measures that can be considered as environmental commitments, if impacts are identified
- Appropriate tiered level of reporting and documentation of decisions and interagency coordination

Tasks and Deliverables

Task 1: Conduct Interviews or Virtual Discussions with DOTs

Conduct interviews or convene virtual discussions with DOTs in representative ecoregions for information on species consultations, for existing guidance, and assessment of potential savings from streamlined processes. Altogether, 19 states have expressed an interest in this project, including AL, AZ, CO, ID, IL, KY, ME, MT, ND, NH, NV, OH, OK, UT, VA, VT, WV, WY. Additional interviews or inclusion of oil and gas industry representatives and regulatory or resource agencies in the discussions is suggested.

Task 2: Literature Review

Develop a summary of existing relevant literature; documents developed by/for the oil and gas industry may be of particular interest.

Task 3: Develop Guidance Strategies for Methodologies Used for Analyzing Noise and Vibration Impacts on Various Wildlife Species

Further to the stipulations made in the Research Objective section, the following deliverables are expected, as a minimum:

- Template protocol and cross-functional flowchart on tiered approach and project-related activity screening
- Instructions on determination of noise and/or vibration sensitive areas and species' sensitivities (species grouped by identical or similar response or interference, cause-effect-severity matrix) and activities represented (nesting, roosting, foraging)
- Instructions on measurement and determination of existing common noise and vibration environment and anthropogenic noise and vibration sources (baseline conditions)
- Instructions on noise modeling techniques for FHWA TNM 3.0, RCNM 2.0, and Quarry, and representation of species and habitats
- Instructions on determining appropriate noise and vibration mitigation strategies and examples of best management practices
- Report template for documentation of decisions and interagency coordination, and biological evaluation programmatic agreements

Task 4: Summary of Results/Final Report

Combine the highlights of the results of Tasks 2 and 3 into a concise summary document targeted at DOT biologists and project managers. Make recommendations on where further research is needed.

Urgency and Potential Benefits

This project will increase the quality and defensibility of noise and vibration analyses for terrestrial wildlife. In turn, this will assist DOTs to improve and expedite noise and vibration impact analyses as well as better justify instances where road-related noise will not affect wildlife. This will result in time and money savings by standardizing approaches to analysis and mitigation as well as avoiding unnecessary mitigation. Increased consistency in the methodologies used by DOTs will result in studies that are comparable and improve the predictability of the level of effort needed for these analyses.

Implementation Considerations

The results of this research would improve project planning by improving estimates of the level of effort needed to analyze and mitigate noise and vibration impacts and provide a framework for DOT biologists and noise specialists to conduct the analyses. It will provide clear guidelines to DOTs on a standardized approach to assessing these impacts. The summary document will be disseminated to all state DOTs and it is anticipated that additional implementation activities such as webinars and/or training on how to implement the guidance could be offered to state DOT noise and wildlife specialists as a follow on activity to this project.

Recommended Research Funding and Research Period

Recommended Funding: \$375,000

Research Period: 30 months

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Jeff Peterson, Colorado DOT

Wildlife Program Manager

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Ivan Racic, Arizona DOT,

Environmental Science Specialist, Air and Noise Planner

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Kris Gade, Arizona DOT

Roadside Resources Specialist/ Biology Team

kgade@azdot.gov, 602-292-0301

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Noel Alcala, Ohio DOT, AASHTO Noise Work Group Coordinator

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303-512-4959 Cinnamon Levi-Flinn, Colorado DOT, Biologist
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970-683-6222

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

AASHTO Committee on Environment and Sustainability
Tim Hill, CES Vice Chair, Ohio Department of Transportation
Tim.hill@dot.ohio.gov, (614) 644-0377

NCHRP Review of B-21

Reviewed By:
Ann M. Hartell
ahartell@nas.edu

Comments:

The proposed research addresses an important gap in road ecology practice for state DOTs and their partners. The study design would likely require exploratory modeling of existing data along with other research tasks. Because the proposed project includes considerable technical work and the development of training materials in addition to typical NCHRP report materials, increasing the budget to \$450,000 is appropriate.

Review Date:
12/15/2021

FHWA Evaluation of B-21

Reviewed By:
Buford/HEPE-30

Comments:

The proposed research would benefit the transportation sector by standardizing methods for developing defensible environmental reviews and approaches to managing construction and its potential impacts to terrestrial wildlife.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for B-21

Submitted By:
Tim Hill
Vice Chair
AASHTO Committee on Environment and Sustainability

Priority #: 9

Comments:

Response to NCHRP: We agree with the suggestion to increase the budget to \$450,000. FHWA: no response needed.

Submitter Response for 2023-B-21

From:
[email: Tim.Hill@dot.ohio.gov,]

Comments:
Rank 9

Response to NCHRP: We agree with the suggestion to increase the budget to \$450,000.

FHWA: no response needed.

Contact Info:
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Administrator-OES
ODOT Office of Environmental Services
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Review Date:
2/4/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-22

Problem Title

Stormwater Management to Address Highway Runoff Toxicity Associated with Tire Wear

Background Information and Need For Research

Recent research findings identified 6PPD-quinone as the major agent responsible for exceptionally high levels of rapid mortality of adult Coho salmon in some urban streams . Lethal effects occurred in Coho at very low concentrations of 6PPD-quinone. Related studies have found the chemical is also toxic to rainbow trout, and King Salmon, and other aquatic species may be at risk as well , . So far, the lethal impact, presumably from 6PPD-quinone, has only been documented in urban streams that receive runoff from high average daily traffic (ADT) highways.

6PPD is a chemical added to tires to increase their life by reducing tire oxidation. It has been used for over 40 years in almost all tires and is assumed to be ubiquitous in roadway runoff, as are tire particulates that have been detected in fish across the country . Potential sources of 6PPD-quinone in stormwater include tire wear particulates, abrasion of pavement that contains tire derived aggregate (TDA), and potentially leachate from fill incorporating ground tires. Although standard analytical test methods are not yet available, researchers have detected 6PPD and linked it to toxicity in runoff; standard methods are currently under development by the WA Department of Ecology.

Questions of importance for DOTs are: 1) Under what conditions and where is 6PPD-quinone related toxicity an issue, 2) what highway related and receiving water factors are implicated, and 3) what drainage characteristics and stormwater management techniques are practical (feasible) to build and capable of reducing or eliminating the toxicity of highway runoff due to 6PPD-quinone and other pollutants (zinc, copper, PAHs, etc.).

There are also concerns about use of TDAs in the roadway environment. DOTs and other transportation agencies will be a primary target of regulatory efforts to address 6PPD-quinone toxicity. Projects have already been delayed due to uncertainty as to where, what type, and how much treatment of roadway runoff is necessary.

The research, identified as a priority for a Research Needs Statement by the TRB AKD50 Stormwater Subcommittee, will 1) identify where and what features within the highway environment contribute acutely toxic runoff associated with 6PPD-quinone and

2) identify and develop practical treatment facilities and stormwater management approaches that can be used in urban and rural areas.

Literature Search Summary

Only limited research has been published on 6PPD-quinone in stormwater and its toxicity. Initial results indicate that filtration of highway runoff through or contact with bioretention media/compost appears to eliminate lethal toxicity to Coho^{1,2}. Previous research on copper toxicity in highway runoff found that filtration of highway runoff through a biofiltration media significantly reduced toxicity, indicating that the mix is effective in reducing the toxicity of 6PPD-quinone². This research did not address practical structural BMP design elements nor effects of earthen or vegetated drainage systems. The NCHRP study Environmental Impact of Construction and Repair Materials on Surface and Ground Waters (NCHRP Report 448), found that within a short distance of contacting soils, toxicity from leachate and runoff was significantly reduced. The TRID database includes a few reports on toxicity reduction effectiveness, specifically by filtration through dead vegetation in vegetated ditches and in detention ponds as well. These studies indicate that the drainage conveyance type can play a major role in addressing potential 6PPD-quinone toxicity.

Research Objective

The objective of this research is to identify under what conditions runoff intervention is needed and develop and provide design guidance for stormwater treatment and management techniques that substantially reduce or eliminate highway runoff toxicity, as well as 6PPD-quinone specifically. Toxicity testing is vital because there is no formal toxicity criteria for 6PPD-quinone, and other components of highway runoff likely affect toxicity as well.

Major tasks or activities:

- Literature review on 1) highway runoff toxicity, with an emphasis on 6PPD-quinone toxicity and 2) effectiveness of treatment and stormwater management, including the effect of vegetated drainage system types on toxicity reduction.
- Field collection of highway runoff and laboratory analyses to:
 - i. Assess toxicity reduction of high traffic highway runoff routed through bare soil, compost amended soil and vegetated conveyances
 - ii. Design and conduct a laboratory study to determine filtration material characteristics and mechanisms (such as layer thickness, infiltration rate, contact times, etc.) necessary for effective toxicity and/or 6PPD-quinone concentration reduction by BMPs
 - iii. Conduct selected 6PPD-quinone leachability tests for tire derived aggregate/crumb rubber containing pavement materials
- Identify the components and features of the highway system and receiving waters that affect 6PPD-quinone toxicity and its impacts.

Deliverables:

- A report that provides 1) guidance on identifying situations where 6PPD-quinone targeted BMPs are appropriate to avoid toxic impacts, 2) an initial assessment of the potential for TDAs to contribute to toxicity, and 3) design criteria for 6PPD-quinone targeting BMPs. Research documenting toxicity reductions by drainage systems and BMPs etc. should be prepared for peer reviewed publication.

Urgency and Potential Benefits

The demonstrated toxicity of 6PPD-quinone for at least one listed Threatened and Endangered species and the potential for toxic impacts to other aquatic species means that regulatory agencies will likely impose treatment requirements on highway projects. It may also limit the ability to use recycled tire paving products that meet other agency environmental goals. Permit conditions could include requirements for retrofits as well as new/re-development projects. This research will help inform cost-effective solutions for DOTs to implement as well as appropriate regulatory requirements.

Without this research, regulatory requirements may be based on insufficient information, resulting in overly broad requirements, misapplied and misdirected resources, and implementation of BMPs where they are not necessary and so provide no appreciable benefit, or conversely do not provide sufficient treatment. Also, regulatory requirements may be ad hoc, providing no consistency and creating confusion, inefficiencies and delays.

As a result of this research, DOTs will have the information necessary to better understand where to focus more specific treatment efforts to effectively manage highway runoff for 6PPD-quinone toxicity. Regulatory agencies will have a better understanding of stormwater management options and treatment methods that reduce and/or remove toxicity. Sensitive aquatic species will benefit from reduced toxicity in their environment. Lastly, knowledge regarding the potential release of 6PPD-quinone and its toxicity will help DOTs in selection and placement of paving materials that are composed in part of TDA.

Implementation Considerations

Stormwater engineers and environmental staff, including water resources specialists and biologists, will benefit from applying the research results and recommendations. Pavement engineering staff will also benefit from assessment of TRD paving materials and fill. State DOTs can implement the research within their own organization by utilizing the site selection and design guidance developed by the project. The content could be included in Hydrology and Hydraulics manuals or via technical bulletins so implementation would not likely require new procedures. Professional conferences, including the Hydrology and Hydraulics conference and the TRB annual meeting, professional peer reviewed and trade publications, and webinars could be used to support implementation.

Statement reviewed and submitted on behalf of the TRB Committee on Hydrology, Hydraulics and Stormwater (AKD50). Contact: Michael Perez, mike.perez@auburn.edu, (334) 844-6267. The proposal is co-sponsored by TRB Committee on Environmental

Analysis and Ecology in Transportation (AEP70). Contact: Daniel Smith, Daniel.Smith@ucf.edu, (386) 785-1565. The proposal is also endorsed by the AASHTO Technical Committee on Hydrology and Hydraulics. State and federal natural resource and regulatory agencies (such as California Department of Toxic Substances Control) would likely be highly interested in this research.

Recommended Research Funding and Research Period

Research Funding: \$400,000-\$600,000 (depending on extent of lab and field testing)

Research Period: 3 years

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

- William Fletcher, Independent (retired Oregon DOT), (503) 679-4160, svartstone2@yahoo.com
- Eric Strecker, PE, Terraphase Engineering Inc., (503) 889-0367 ext. 66, eric.strecker@terraphase.com

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

- California Department of Transportation, Joshua Gualco, (916) 956-4732, Joshua.Gualco@dot.ca.gov
- Oregon Department of Transportation, Kira Glover-Cutter, (503) 843-1176, Kira.M.GLOVER-CUTTER@odot.state.or.us
- US Geological Survey, Greg Granato, (508) 490-5055, ggranato@usgs.gov

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

AASHTO Committee on Environment and Sustainability

Tim Hill, CES Vice Chair, Ohio Department of Transportation

Tim.hill@dot.ohio.gov, (614) 644-0377

NCHRP Review of B-22

Reviewed By:

Ann M. Hartell

ahartell@nas.edu

Comments:

The proposed research will address what is potentially a priority, emerging issue in stormwater management. The project would entail lab testing, followed by field testing. A phased approach is suggested so that the field testing is focused on applications/designs most likely to be feasible for state DOT implementation. A total

budget of \$750,000 would support a series of rigorous lab tests, followed by a field test of one or perhaps two of the most promising solutions.

Review Date:
12/15/2021

FHWA Evaluation of B-22

Reviewed By:
Susan Jones/HEPE-30

Comments:

Dr. Jennifer McIntyre from the Washington State University or Dr. Ed Kolodziej from the University of Washington-Tacoma have been on the fore-front in researching on stormwater and tire chemical toxicity to aquatic organisms, specifically salmon. The current research statement may be redundant to studies that McIntyre/Kolodziej have already completed, but this project statement can be more defined to determine what follow-up research can be accomplished based upon work by McIntyre/Kolodziej. This topic is timely since the agency has received requests from Congressional staff on FHWA and EPA's efforts in 6ppd.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for B-22

Submitted By:
Tim Hill
Vice Chair
AASHTO Committee on Environment and Sustainability

Priority #: 10

Comments:

Response to FHWA: We agree Dr. McIntyre and Dr. Ed Kolodziej, and their research team, are the leading researchers on this topic and we are very familiar with their research and findings. The intent of this research is to complement and build upon the work of Dr. McIntyre and Dr. Ed Kolodziej but not be redundant or duplicative. This proposed research extends the practical aspects of their research for DOTs by determining toxicity reduction via contact with soils, compost-amended soils, vegetated drainage systems and roadway embankments. This would extend their work evaluating toxicity reduction with Biofiltration systems. Previous NCHRP research has shown significant toxicity reduction with those media/drainage types. An important goal of this research would be to identify where treatment systems would be most cost-effective

and therefore where efforts to address 6ppd-quinone should be focused. Additionally, a component of this research will include 6PPD-quinone leachability tests for tire derived aggregate/crumb rubber containing pavement materials that is used by some DOTs in the highway environment.

Response to NCHRP: We agree with Ms. Hartell's comments. We would want solutions to include understanding different drainage systems and how they result in reduced toxicity. A field test could look at a typical drainage swale or overland flow of highway runoff and the change in toxicity from 6PPD-quinone assessed.

Submitter Response for 2023-B-22

From:

[email: Tim.Hill@dot.ohio.gov,]

Comments:

B-22: Rank 10

Response to FHWA: We agree Dr. McIntyre and Dr. Ed Kolodjiez, and their research team, are the leading researchers on this topic and we are very familiar with their research and findings. The intent of this research is to complement and build upon the work of Dr. McIntyre and Dr. Ed Kolodjiez but not be redundant or duplicative. This proposed research extends the practical aspects of their research for DOTs by determining toxicity reduction via contact with soils, compost-amended soils, vegetated drainage systems and roadway embankments. This would extend their work evaluating toxicity reduction with Biofiltration systems. Previous NCHRP research has shown significant toxicity reduction with those media/drainage types. An important goal of this research would be to identify where treatment systems would be most cost-effective and therefore where efforts to address 6ppd-quinone should be focused. Additionally, a component of this research will include 6PPD-quinone leachability tests for tire derived aggregate/crumb rubber containing pavement materials that is used by some DOTs in the highway environment.

Response to NCHRP: We agree with Ms. Hartell's comments. We would want solutions to include understanding different drainage systems and how they result in reduced toxicity. A field test could look at a typical drainage swale or overland flow of highway runoff and the change in toxicity from 6PPD-quinone assessed. We agree with NCHRP on increasing the budget to \$750,000

Contact Info:

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Review Date:
2/4/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-23

Problem Title

Successful Practices in Tracking and Implementing Environmental Commitments

Background Information and Need For Research

Commitments resulting from the environmental clearance document are intended to avoid, minimize, or mitigate impacts to environmental resources. These commitments vary in scope and may be derived from federal environmental laws (National Environmental Policy Act, National Historic Preservation Act (Section 106), Clean Water Act, Endangered Species Act, permit conditions, or other state-level laws and regulatory requirements. Federal agencies and state DOTs are responsible for ensuring these legally binding commitments are implemented throughout the life of a project and ultimately fulfilled. Proper implementation of environmental commitments impacts project delivery through all phases, including planning, design, construction, and post construction.

While these commitments may be codified in publicly available formal documents and are presumably binding, agencies and DOTs nationwide face challenges in the successful management and implementation of such commitments. Common challenges that result in lost and unfulfilled commitments include DOT size and NEPA assignment status, inventory and access, inconsistencies in MOA/MOU language, successful communication with contractors, ensuring commitments are incorporated into the PS&E, change order tracking during construction, and permit expiration during the construction process. Lost and unfulfilled commitments can lead to bad publicity, legal issues, violations and fines from regulatory agencies, and loss of funding. As a result, DOTs have started developing resources and practices to minimize these challenges and ensure quality control and proper implementation, but no nationwide synthesis exists.

Tracking of commitments is considered the main tool for ensuring that specific commitments are implemented. However, as with design, construction and post construction, the quality of the tracking is dependent on both the tracking system that exists and the actors who are responsible for following that system. In design, construction and post construction, the system includes guidance manuals, specifications, flow charts for review and inspection, as well as a tracking platform. The actors responsible may have specific qualifications and training. In the environmental world, defining and standardizing such things as context sensitive design, restricted areas, or monitoring, is not the same as standardizing rebar, the former being highly specific to the situation and extremely challenging to create specifications for. Writing a manual to consider all or even most situations would seem to be a nearly impossible

task. As a result, there can be one or more breakdowns in communication, commitment enactment, contracting, checks and reviews and nearly any and all understandings between the environmental group that establishes the commitment, the contractor responsible for implementing it, and the engineer responsible for inspecting it.

Literature Search Summary

There is little literature to address this problem from a comprehensive perspective among state DOTs. The only relevant study is NCHRP 25-25, Task 109: Successful Practices for Environmental Commitments in Public/Private Partnerships (P-3) and Design-Build (D-B) Contracts. That study, now 11+ years old, quick-response research that focused on elements of this problem specific to design-build and P3 project, not DOT commitment management generally. This research proposed here will significantly expand the scope covered by Task 109 and ensure the results are up to date.

Research Objective

All environmental units in all state DOTs have encountered situations where the environmental commitment was not adequately implemented. This can lead to bad publicity and a perception that the DOT does not care about the environment. Both NEPA and Section 106 are both laws with a strong public involvement component. Reaching an environmental commitment often is done openly and transparently and creates a public expectation it will be met. Because negotiation of the commitment may have been predicated on gaining hard-fought agreement among many competing interests, failure to meet a commitment can also lead to demoralization among the environmental staff. Mistakes can lead to lawsuits, loss of project funding, and in some cases loss of delegated review authority from FHWA. Consequently, many environmental units have developed tools and techniques to at least minimize if not eliminate situations where the resulting commitments were incomplete, poorly met, or ignored.

The objective of this study is a nationwide review of how state DOTs have constructed workable systems for tracking and implementing environmental commitments, permit conditions, jurisdictional impact drawings and a compilation of best practices. By systems, we mean more than simply noting a commitment in a handoff document and relying on trust to meet it. Both formal processes (digital tracking applications, DOT standards, handbooks, environmental plan sheets, punch lists) and less formal processes (pre-construction meetings, on-site inspections) are regularly used to ensure project designs and plans are fulfilled. We seek to capture the full range of processes and systems that integrate these processes used by DOT's that are targeted to environmental commitments.

Formal examples may include:

- Generalized environmental specifications and scopes of work that may be in handbooks;
- Requirements that the contractor sign off on having completed mitigation commitments;

- Project tracking of the environmental commitments in the same project management platform as other design commitments, and/or digital environment tracking applications;
- Environmental plan sheets;
- Requirements of field inspections and sign-offs by DOT staff at specific stages;
- Use of environmental on-calls to perform project inspections, including samples of scope, contract and deliverables

Less formal examples may include:

- Specific meetings with environmental sub-consultants on the mitigation requirements;
- Production of and adherence to quality control plans by the prime consultant to ensure communication within the project team;
- Ongoing training by DOT environmental staff to project engineers and construction team, including inspectors, on typical environmental commitments and what to expect;

This study should produce a compendium of all formal and less formal processes used by surveyed DOTs, best practices in standard environmental specifications (and NSSP), and suggestions for improving the overall systems for meeting environmental commitments, looking at both effectiveness and level of effort.

Anticipated Tasks:

1. Survey State DOTs for the following but not limited to:
 - a. What systems are used and what guidance is there on it?
 - b. What are the structural relationships of those systems to other applications used by DOTs?
 - c. What training programs exist to teach people how to implement successful commitments?
 - d. What types of commitments implemented?
 - e. How are commitments and conditions implemented and how are they checked?
 - f. How are commitments and conditions translated into construction contracts? What are the penalties for contractors not meeting explicit environmental commitments? How often are these enforced?
 - g. What methods are there for tracking project commitments from one project phase to the next?
 - h. What ways are there of tracking commitments for local or private projects when the DOT is the lead agency?
 - i. What other areas of transportation practice (P3s, et al) track commitments, what practices are used?
 - j. What trainings or certifications are needed for different commitments to be monitored? Does the agency have a process to identify who is responsible for the commitment being completed? How are monitors selected? Do they require discipline-specific training?

- k. What are the staffing allocations for tracking commitments?
- l. What tools are there for management of environmental assets that become the responsibility of the DOT for long term and/or permanent mitigation and maintenance?
- m. Are the commitments disclosed publicly and completion tracked publicly?
- n. Is there succession planning for the systems used?
- 2. Summary of existing state of practice, including but not limited to:
 - a. Standard and nonstandard specification
 - b. Systems and methods used for tracking commitments
 - c. Evaluation of the state of practice and determine successful practices.
- 3. Compile a compendium of cases of successful commitment tracking and implementation.

Urgency and Potential Benefits

Environmental commitments are fundamental performance obligations that are legally attached to NEPA clearances, permits, and associated project agreements. As such, failure to implement environmental commitments can jeopardize project funding, permits and approvals while also undermining the valuable trust relationships between DOTs, their regulatory agency partners, and the public. DOTs understand this and have made vast improvements over the years in tracking and implementing environmental commitments, but often in their own silos without being aware of progress outside of their state boundaries. This research will allow all state DOTs to be cognizant of how environmental commitments are managed across the country and be able to adopt successful practices of value to their programs without having to invent them from scratch.

Implementation Considerations

This research would primarily be implemented by state DOT environmental programs, including NEPA, 4(f), cultural resources, and permit staff, implemented through review and adoption of research results and participation in a webinar prepared for this project. Training workshops and peer exchanges among practitioners would also be effective in implementing the identified successful practices among state DOTs.

Other organizations that might be interested in the research results and could help support implementation include:

- Federal Highway Administration
- Federal Transit Administration
- Federal Railway Administration
- U.S. Army Corps of Engineers
- Advisory Council on Historic Preservation
- State Historic Preservation Officers

Recommended Research Funding And Research Period

Funding: \$350,000

Research Period: 3 years

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Helen Blackmore (lead author); California Department of Transportation

Helen.Blackmore@dot.ca.gov ; 510-504-2182

Antony Opperman (editor); Virginia Department of Transportation

a.opperman@vdot.virginia.gov ; 757-254-9045

Potential Panel Members: For Each Panel Member, Provide Their Name, Affiliation, Email Address And Phone.

TBD from State DOT, FHWA, other transportation modes, and regulatory agency practitioners.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Tim Hill; Ohio Department of Transportation; Tim.Hill@dot.ohio.gov ; 614-644-0377

NCHRP Review of B-23

Reviewed By:

Ann M. Hartell

ahartell@nas.edu

Comments:

The proposed research is appropriate for the NCHRP and could provide a resource for state DOTs seeking information on effective tools and practices to set up and sustain a system to track environmental commitments. The research should build on but not duplicate recent NCHRP research. *NCHRP 25-25, Task 109: Successful Practices for Environmental Commitments in Public/Private Partnerships (P-3) and Design-Build (D-B) Contracts* (note that this report was published in 2019) included some information about effective practices used by state DOTs outside P3 and D-B contracting arrangements. *NCHRP 25-25, Task 111: Environmental Management System Perspectives for State Departments of Transportation* (also published in 2019) reviewed national practice in EMS systems, surveying agencies on the factors that triggered adoption of the use of these systems. Notably, the findings for this latter study included a general shift in the use of EMSs from highway maintenance towards NEPA compliance; while tracking of environmental commitments is common, few agencies were found to be using feedback mechanisms to assess performance and identify any needed changes. Based on the identified needs among state DOTs, a downloadable resource was created with examples and resources along with a benchmarking tool, which could provide a starting point for developing training material on systems to track environmental commitments. Both of these previous projects documented current practice at state DOTs through surveys and interviews. Any additional research should

be carefully designed to extend the previous work in directions that will produce new insights and implementable resources.

Review Date:
12/15/2021

FHWA Evaluation of B-23

Reviewed By:
Neel Vanikar/HEPE-30

Comments:

We see the benefit in the proposed research. We suggest the research focus on determining best practices and identifying specific DOT's whose tracking systems have been effective in tracking and meeting environmental commitments. Try to avoid a blanket study of all DOTs and minimize involvement of outside organizations until the results can be reviewed by AASHTO and FHWA.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for B-23

Submitted By:
Tim Hill
Vice Chair
AASHTO Committee on Environment and Sustainability

Priority #: 4

Comments:

We agree with the suggestions provided by both FHWA and NCHRP.

Submitted By:
King Gee
AASHTO staff
Knowledge Management

Priority #: 4

Comments:

The ability to maintain commitments made to partners throughout transportation system development and management is important for a state DOT's credibility and reputation

as well as efficiency. This project examines this in the environmental context and provides an excellent example of how siloed knowledge can be better disseminated and consumed across the organization. The objective of this study is a nationwide review of how state DOTs have constructed workable systems for tracking and implementing environmental commitments, permit conditions, jurisdictional impact drawings and a compilation of best practices. This project's objective helps knowledge identification and sharing of best practice.

Submitter Response for 2023-B-23**From:**

[email: Tim.Hill@dot.ohio.gov,]

Comments:

B-23 Rank: 4

We agree with the suggestions provided by both FHWA and NCHRP.

Contact Info:

Timothy M. Hill

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Review Date:

2/4/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-24

Problem Title

Template for State DOT Guidance for Project-Level Air Quality Analyses

Background Information and Need For Research

The recently completed NCHRP study (20-05 Topic 51-18 Practices for Project-Level Analyses for Air Quality) included a recommendation for the development of template state DOT guidance to facilitate the preparation of project-level air quality analyses to meet federal and state regulatory requirements for NEPA and conformity. This proposed study would review existing state DOT guidance documents and develop a standard template for state DOTs that would embody best practices from across the nation. It would help maintain high standards for quality, ensure that all federal requirements are met, and streamline analyses to the extent feasible and appropriate, reducing not only the time and cost for analyses but also the risk for litigation. State DOTs could at their discretion customize the new template guidance for their respective jurisdictions before implementing it. All pollutants subject to NEPA and transportation conformity would be addressed, including particulate matter (PM), carbon monoxide (CO), mobile source air toxics (MSATs) and greenhouse gases (GHGs).

Literature Search Summary

Related reports found on TRID (<http://trid.trb.org>) include the NCHRP study (20-05 Topic 51-18) (<https://trid.trb.org/View/1605746>) that recommended the development of template guidance for state DOTs as proposed here, and NCHRP 25-25 Task 96 (<https://trid.trb.org/View/1705847>) that developed a “Quick Reference Guide for Traffic Modelers for Generating Traffic and Activity Data.” The latter received the Silver Award in the category of Category A: Studies, Research and Consulting Engineering Services in the American Council of Engineering Companies of New York (<https://acecny.org/>) Engineering Excellence Awards (ca 2019) and as such would provide a good foundation or reference for the traffic portion of the proposed template guidance. Additionally, a number of state DOTs have developed their own guidance or related documents that are available on their respective websites, for example, California, Colorado, Texas, and Virginia, as well as the District of Columbia, that would provide a good starting point for determining best practices.

Research Objective

Develop template guidance for project-level air quality analyses for NEPA and conformity that state DOTs can customize and apply for their respective jurisdictions. To help streamline analyses to the extent feasible and appropriate, the template guidance would differentiate between best practices for smaller or more routine projects versus those for larger or more complex projects or ones that are of more public interest that

may warrant more detailed or refined analyses. The template guidance would provide detailed direction on process that is consistent with the established best practices and guidance of FHWA, EPA and other agencies as applicable.

Deliverables would include:

- Documents and tools, including the template guidance, any associated software tools (e.g., as may have been developed by one state DOT but may be of interest to others), guidance for an optional associated state data repository for project-level analyses, and template presentation. The template presentation would be designed to support implementation efforts, including specifically states with nonattainment or maintenances areas that are subject to EPA conformity rule requirements for project-level inter-agency consultation for conformity.
- A virtual peer exchange may be held in the initial phase of the study to share state practices as well as discuss options for the template guidance best practices.
- Pilot testing of the draft template guidance may also be conducted in select states before being finalized.

Urgency and Potential Benefits

The template would be particularly helpful given that regulatory requirements and guidance for air quality analyses have evolved considerably over the past fifteen years with the addition of requirements for analyses for MSATs, PM, and more recently GHGs and climate change. State DOTs that do not already have guidance documents may benefit substantially from implementing the template guidance to streamline analyses, improve quality control, and reduce risk for litigation, and also be better positioned to conduct refined analyses for more complex projects when needed. Increased national consistency among state DOT practices would mean more predictable approaches to analyses which could improve inter-agency consultation timelines and further reduce litigation risk.

Implementation Considerations

The template guidance from this study would be designed to be readily implemented by state DOT air quality staff, who may customize it as needed for their respective jurisdictions. For states that are subject to conformity requirements, inter-agency consultation for conformity may be conducted as part of the implementation process. Implementation funding may therefore be sought to assist state DOTs that would like assistance in customizing the template guidance for their respective jurisdictions and/or in inter-agency consultation for conformity for interested states.

Recommended Research Funding and Research Period

Budget: \$250,000 Time Period: One year

The study is expected to take the equivalent of one professional one year or \$250,000 based on current NCHRP guidance. Given the breadth of material to be covered spanning transportation, emission and air quality dispersion modeling, the project may

be expected to involve multiple professionals with expertise in each of the requisite areas, with a combined total time of one year.

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Christopher Voigt, Virginia DOT (christopher.voigt@vdot.virginia.gov) 804.371.6764

Naomi Kisen, Utah DOT (nkisen@utah.gov) 801.965.4005

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Christopher Voigt, Virginia DOT (christopher.voigt@vdot.virginia.gov) 804.371.6764

Naomi Kisen, Utah DOT (nkisen@utah.gov) 801.965.4005

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

NCHRP Review of B-24

Reviewed By:

Ann M. Hartell

ahartell@nas.edu

Comments:

The problem statement notes that the recently published NCHRP Synthesis 576 Practices for Project-Level Analyses for Air Quality suggested the development of a template for project-level air quality analysis. Yet that report also noted, “The template would need to be maintained and updated into the future as models, air quality standards, federal policies, or other analytical or regulatory aspects change.” It is unclear what mechanism could be used to accomplish this. Notably, Synthesis 576 also found: (1) few state DOTs are conducting project-level air quality analyses and when they do, few generate a result of exceedance; (2) only one agency reported facing litigation in connection with a project-level air quality analysis; and (3) state DOTs use a wide range of practices for project-level analysis which are tailored to their specific needs, suggesting limited interest in a standardized template and a limited audience for the proposed pilot testing.

The problem statement suggests that the development of a template be based on a review of tools and state-level policies and practices. It is likely that a robust template would also require technical analysis. A budget of \$350,000 and time period of two years is more feasible for such an effort. The scope of the project must clearly delineate the NCHRP research effort from the development of guidance on air quality analysis methods, which is the purview of regulatory agencies.

Review Date:
12/15/2021

FHWA Evaluation of B-24

Reviewed By:
Victoria Martinez/HEPN-10

Comments:

We see the benefit of this effort and are supportive of the customizable nature of the proposed template. We suggest framework rather than guidance, however, as guidance has a strong connotation and there is existing CAA/Conformity and NEPA Guidance. The funding level seems reasonable.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for B-24

Submitted By:
Tim Hill
Vice Chair
AASHTO Committee on Environment and Sustainability

Priority #: 8

Comments:

Response to FHWA: RESPONSE: We appreciate the positive feedback from FHWA and agree with their suggestion to use the term "framework" (or a similar term) instead of "guidance" to avoid confusion with federal guidance.

Response to NCHRP: RESPONSE: We appreciate the suggested increased budget and timeframe. We also agree with the need to avoid confusion with federal guidance and clearly delineate NCHRP research from the development of guidance, and would use the term "framework" as suggested by FHWA, or a similar term. In response to other comments: * Future updates to the framework may be needed, most typically in response to incremental changes in federal guidance. However, such updates tend to be minor and state DOTs may prefer to do these in-house on their state-specific versions and not on the original master template framework. If there is a need to update the master template in whole or in part in the future, various means are possible, including pooled fund efforts, FHWA funding, and possibly NCHRP funding. * Contrary to the comment about lack of interest by state DOTs, this proposal was one of the highest ranked by state DOT members of the AASHTO Air Quality, Climate Change and Energy Subcommittee this year. The referenced consultant report that recommended

this study also pointed to reasons why state DOTs would benefit from the template framework, noting that "Although the lack of written project-level air quality guidelines or varying stages of development of written guidance does not seem to be hindrance to DOTs in completing environmental studies for their projects, having written procedures is good practice. With a DOT's having written guidance, staff (especially new staff) will know how to proceed etc. with an analysis, and to what depth of analysis, when and if a need should arise for a project-level analysis." (Syn.537, p.25)

Submitted By:

Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A

Comments:

Consider including active transportation elements as contributors to air quality improvements.

Submitter Response for 2023-B-24

From:

[email: Tim.Hill@dot.ohio.gov]

Comments:

B-24: Rank 8

Response to FHWA:

RESPONSE: We appreciate the positive feedback from FHWA and agree with their suggestion to use the term "framework" (or a similar term) instead of "guidance." to avoid confusion with federal guidance.

Response to NCHRP:

RESPONSE: We appreciate the suggested increased budget and timeframe. We also agree with the need to avoid confusion with federal guidance and clearly delineate NCHRP research from the development of guidance, and would use the term "framework" as suggested by FHWA, or a similar term.

In response to other comments:

* Future updates to the framework may be needed, most typically in response to incremental changes in federal guidance. However, such updates tend to be minor and state DOTs may prefer to do these in-house on their state-specific versions and not on the original master template framework. If there is a need to update the master template

in whole or in part in the future, various means are possible, including pooled fund efforts, FHWA funding, and possibly NCHRP funding .

* Contrary to the comment about lack of interest by state DOTs, this proposal was one of the highest ranked by state DOT members of the AASHTO Air Quality, Climate Change and Energy Subcommittee this year. The referenced consultant report that recommended this study also pointed to reasons why state DOTs would benefit from the template framework, noting that "Although the lack of written project-level air quality guidelines or varying stages of development of written guidance does not seem to be hindrance to DOTs in completing environmental studies for their projects, having written procedures is good practice. With a DOT's having written guidance, staff (especially new staff) will know how to proceed etc. with an analysis, and to what depth of analysis, when and if a need should arise for a project-level analysis." (Syn.537, p.25)

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Review Date:

2/4/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-25

Problem Title Environmental Effects of Roadway Lighting on Ecosystems

Background Information and Need for Research

Roadway lighting has been shown to measurably reduce fatal nighttime crashes. Yet roadway lighting can negatively impact insects and animals through attraction and disorientation or by disrupting their natural habitats. Transportation agencies are facing growing opposition to the use of nighttime lighting as a countermeasure to improve roadway safety. Local, state, and federal agencies, as well as members of the public are expressing a growing concern over consequences of nighttime lighting on the environment.

For example, the Federal Highway Administration, Federal Railroad Administration, and Federal Transit Administration in cooperation with the U.S. Fish and Wildlife Service have developed a programmatic consultation for transportation impacts to the endangered Indiana bat (*Myotis sodalis*) and the threatened Northern Long-Eared bat (NLEB) (*Myotis septentrionalis*). As a result of such actions, roadway lighting designers at DOTs across the country are beginning to encounter new challenges when planning routine lighting projects and are facing increasingly restrictive lighting regulations.

While it is known that lighting has a negative impact on some species, it is not well understood whether those impacts can be minimized or otherwise mitigated by directional shielding, changing light levels or altering the spectral content of the light source. Therefore, there is a need to investigate the effects of artificial light to determine best practices which will allow designers to continue to provide essential lighting for driver safety while minimizing its negative impacts.

The expected results of this research will support at least four goals of the AASHTO Committee on Design. Specifically, they are Goal 2, Goal 4, Goal 5, and Goal 6. In addition, Goal 2 and Goal 3 of the Committee on Environment and Sustainability will be supported as well as Goal 2 of CES Natural Resources.

Literature Search Summary

There is a growing body of literature documenting the negative impacts of artificial light at night (ALAN) on an ever-increasing list of species in both the plant and animal kingdoms. A search of ALAN on the National Institutes of Health's PubMed.gov search engine through the United States National Library of Medicine's National Center for Biotechnology Information brings up dozens or even hundreds of references and abstracts, depending on the key words used in the search. Many scholarly works now make it impossible to deny or ignore the direct relationship between ALAN and the

negative consequences it has on the environment. A significant area of emphasis has developed around the study of ALAN's influence on sleep, circadian rhythms, and human health.

At the same time, limited research is available on the impacts of roadway lighting on flora and fauna. Recently, the effects of roadway lighting on soybeans were studied in Illinois which proved that typical roadway lighting levels will adversely impact this important cash crop unless trespass light is managed properly (Palmer, Gibbons, Bhagavathula, 2018). An article by Fraser, Collins, Longcore and Vickers (2020) summarizes literature regarding the effects of ALAN as well as traffic noise on animal behavior and occupancy. In an article which references various studies, the authors suggest ALAN, is impinging on plant and animal behavior in regards to foraging, orientation, migration, seasonal reproduction, colonization and more (Falcón J, Torriglia A, Attia D, Viénot F, Gronfier C, Behar-Cohen F, Martinsons C, Hicks D., 2020). Another article describes ALAN's impact on plant-pollinator interactions (Giavi S, Fontaine C, Knop E., 2021), while yet another article addresses the response of bat populations to ALAN (Seewagen CL, Adams AM, 2021).

For many roadway lighting designers, this information is extremely disturbing and yet no clear guidance on how to mitigate these impacts is readily available to them in published lighting standards. While sufficient evidence exists to raise concern, there is still much to be understood about the mechanisms and ways to eliminate or reduce the effects of ALAN on the nighttime environment.

Research Objective

The Natural Sounds and Night Skies Division of the U.S. National Park Service (NPS) achieved International Dark Sky Park certification for Grand Canyon National Park and many other national parks in cooperation with the International Dark-Sky Association (<https://www.nps.gov/subjects/nightskies/practices.htm>). According to the NPS article, this was accomplished at Grand Canyon NP by converting a majority of existing fixtures within the park to a correlated color temperature (CCT) of 2,400K. The threshold of 3,000K or less seems to have become the de facto standard for safeguarding the environment from ALAN. However, current research is suggesting CCT in the range of 4,000K results in improved roadway safety through longer detection distances (NCHRP 05-22A).

CCT has often been used in conversation to characterize ALAN's impact. However, CCT is better used to define appearance than impact. "Blue light" with a higher CCT value has been identified by some as bad lighting. The term "blue light" has been used in connection with LED fixtures since they have an increased short wavelength content in their spectrum compared to legacy light sources. Spectral content better defines the impacts to orientation, migration, reproduction, and other mechanisms within various species of light impacted organisms. Therefore, actinic spectrum (Longcore et al) shall be used for this research, unless a more robust calculation method becomes available, to measure the potential impacts of ALAN.

This research will serve as a beacon to inform the work of researchers currently working independently by bringing together both ecological and lighting team members to pioneer solutions. To keep the scope of work manageable, the species shall be prioritized by level of impact with the highest priorities being addressed first. To stay within funding, the list shall be abbreviated as needed. Furthermore, species that are impacted in similar ways by the more common spectrum, light levels, and designs of roadway lighting can be grouped together as needed. Should it be necessary to further limit scope, flora shall be subordinate to fauna.

This research shall attempt to answer the following questions and make the following determinations;

- 1) Continue to expand and try to define a comprehensive list of species threatened by ALAN.
- 2) Determine the degree of endangerment for each specie.
- 3) Determine whether dimming or part-night lighting will sufficiently mitigate or resolve the impacts on threatened ecosystems, while maintaining a safe visual environment for motorists.
- 4) Determine whether roadway luminaire style and orientation (limit the amount of uplight) will sufficiently mitigate or resolve the impact on various species.
- 5) Determine the spectral content (using commercially available LED fixtures) that sufficiently mitigates or eliminates environmental concerns, while maintaining a safe visual environment for motorists.
- 6) Develop a map so lighting designers across the country know exactly where ALAN is a concern. The map will provide a geographic model (like wind maps) with zones of influence for all species of concern.
- 7) Develop a point system, such as a scale of 1 to 10, that defines the relative importance of ecological safety for the various ALAN affected species. Provide this information as a map layer so it can be overlaid on the map defined in objective #6 above, thus allowing lighting designers to identify areas of greatest concern.

The information derived from spectral response once assigned to each species group will most likely offer a broad array of potentially conflicting solutions. In other words, the spectrum adjustments needed to mitigate impacts on one may be impossible or impractical to achieve in a normal roadway lighting application. Furthermore, what may resolve impacts for one specie may intensify the problem for other species. Therefore, the array of possible practical solutions will be identified along with a best fit solution or solutions for current roadway lighting practice which is based on current roadway lighting techniques and technology.

Finally, this research shall build the framework and develop a roadmap to detail any future research needs through which environmental impacts of roadway lighting are fully identified and addressed in order to safeguard ecosystems. For this research objective, a final report will be sufficient as the end product.

Urgency and Potential Benefits

The urgency of this research has already been verified by the DOT representatives currently serving on the technical review panel for NCHRP 05-22A, Gaps and Emerging Technologies in the Application of Solid-State Roadway Lighting. Environmental impacts of roadway lighting have been identified as an emphasis area for that research work and this study will build upon NCHRP 05-22A.

Currently DOTs and municipalities around the country are rapidly converting legacy light sources to LED. The U.S. Department of Energy's (DOE's) Office of Efficiency and Renewable Energy estimates in their August 2020 report, Adoption of Light-Emitting Diodes in Common Lighting Applications that of the almost 50 million street and roadway lighting systems installed in the U.S. in 2018, almost half are now LED products. Furthermore, they estimate this is an increase of approximately 20% in just 2 years (since 2016).

If these DOE estimates are accurate, then LED lighting will continue to replace legacy light sources on the nations interstate highways, roadways and streets at a staggering rate. This makes a better understanding of what is environmentally safe especially important and may help guide the deployment of outdoor LED fixtures throughout the country that are optimally tuned to the needs of the environment.

Implementation Considerations

DOTs may use the proposed research results to update their roadway lighting design guidelines and guidelines for species impact evaluations. In addition, individual project managers, biologists and roadway lighting design engineers may use the research directly to support individual projects.

The AASHTO Joint Technical Committee on Roadway Lighting will use the research results to consider making changes to the AASHTO Roadway Lighting Design Guide, which is referenced by many state DOTs and other agencies responsible for roadway lighting. Besides AASHTO, other national and international lighting organizations (such as the Illuminating Engineering Society, IES) may consider the report in future updates to their guidelines. Key AASHTO Committees and other organizations would likely be interested in the research results and could help support implementation:

- AASHTO Joint Technical Committee on Roadway Lighting, Mark Luszc, Chair, 302-760-2356, mark.luszc@delaware.gov.
- AASHTO Committee on Environment and Sustainability, Margaret Anderson-Kelliher, Minnesota DOT.
- Federal Highway Administration, Daniel Buford, 202-366-8168, daniel.buford@dot.gov
- U.S. Fish and Wildlife Service, Catherine Liller, 303-236-4318, catherine_liller@fws.gov

Recommended Research Funding and Research Period

\$450,000 over 24 months

Problem Statement Author(s)

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Kris Gade, Arizona DOT, Co-Chair, NRC for AASHTO CES. kgade@azdot.gov, (602) 292-0301

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Person Submitting the Problem Statement

Tim Hill, Ohio DOT, Vice Chair, AASHTO CES, Tim.hill@dot.ohio.gov, (614) 644-0377

NCHRP Review of B-25Reviewed By:

Ann M. Hartell

ahartell@nas.edu

Comments:

This research could produce needed information on a design issue that likely goes un- or under-considered for most highway projects. The problem statement authors note that one reason for urgency is the current conversion underway to LEDs. It might be that this research could focus on the effects of this one type of lighting. Without a series of field trials and monitoring, it will be difficult to create robust information on the effectiveness of potential mitigation strategies (orientation, dimming, part-night lighting, spectral content, etc.) for a range of species. If the guidelines and a roadmap for future research could be developed based on a review of literature and in consultation with active researchers, a budget of \$350,000 is sufficient. If field trials or monitoring are needed, a significantly larger budget is required.

Review Date:

12/15/2021

FHWA Evaluation of B-25Reviewed By:

Buford/HEPE-30

Comments:

The proposed research into the effects of artificial lighting is important and has broad utility, but several of the 7 proposed tasks are not practicable, as written. Task 1 could include most species in the plant and animal kingdoms. Task 2 is ambiguous--it's not clear whether that's supposed to represent a species T&E status or its known vulnerability to night lighting. Task 6 is impracticable and task 7 should probably be categories instead of a point system. Tasks 3, 4, and 5 would be useful.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-25

Submitted By:

Tim Hill

Vice Chair

AASHTO Committee on Environment and Sustainability

Priority #: 12

Comments:

Response to FHWA: We believe that the selected panel will define the scope of the project as needed and may alter the specific tasks to focus the scope of work. Given the time sensitivity of gathering this knowledge before more light standards are develop

Submitter Response for 2023-B-25

From:

[email: Tim.Hill@dot.ohio.gov]

Comments:

Rank 12

Response to FHWA: We believe that the selected panel will define the scope of the project as needed and may alter the specific tasks to focus the scope of work. Given the time sensitivity of gathering this knowledge before more light standards are developed and deployed, we believe this project should move forward.

Response to NCHRP: This project is intended to collect available information on effects and types of mitigation and point to needs for future research. We believe the budget of \$350,000 is appropriate.

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Review Date:
2/4/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT OUTLINE

Problem Number: 2023-B-26

Problem Title: Evaluating the Role of the Transportation System in Food Supply Chain Resiliency

Background

The transportation system moves agricultural products from the farm to downstream processors, and from processors to downstream retailers and final consumers. Disruptions at any point in the food supply chain can affect the costs of market participants (upstream and downstream) and can ultimately result in food product shortages.

Food product supply chains may be more sensitive to transportation disruptions than other types of products for two reasons; they are often (1) perishable, and (2) produced seasonally. Therefore, when the transportation system experiences peak-load times a disruption in transportation supply or a deterioration in service quality can be directly tied to higher costs or a reduction in food product quality. The transportation system's ability to deal with disruptions in order to maintain system capacity and service quality can be evaluated in terms of *resilience*. Transportation system resilience will depend on the type of disruption, which transportation system components are impacted, and the magnitude of the disruption.

This research will assess transportation system risk to food supply chain resiliency, identify best practices to mitigate risk and ensure agricultural transportation system redundancy, as well as identify key indicators that can be monitored to assess transportation system risk to food supply chain resiliency.

Literature Search Summary

Supply chain resilience broadly defined means the ability to withstand a disruption, or the ability to recover to a previous state or move to a more desirable state quickly (Spiegler et al. 2012). A large body of literature is available that address the topic of transportation resiliency. Examples include:

- National Cooperative Highway Research Program (NCHRP) Report 750: Strategic Issues Facing Transportation, Volume 2: Climate Change, Extreme Weather Events, and the Highway System: Practitioner's Guide and Research Report .
- National Cooperative Freight Research Program (NCFRP) Report 50: Improving Freight Transportation Resilience in Response to Supply Chain Disruptions .
- NCHRP Report 20-117: Deploying Transportation Resilience Practices in State Departments of Transportation.
- NCFRP Report 39: Freight Transportation Resilience in Response to Supply Chain

Disruptions

- NCFRP Report 30: Making U.S. Ports Resilient as Part of Extended Intermodal Supply Chains.
- Transportation Research Record Paper: Building Resilience into Freight Transportation Systems: Actions for State Departments of Transportation.
- University of Wisconsin-Madison Theses: Freight Resiliency Performance Measures: Hudson-to-Beloit Corridor.
- Transportation Research Board Annual Meeting Presentation: Evaluating Freight Transportation Resilience on a Highway Corridor
- International Transport Forum (ITF) Report: Balancing Efficiency and Resilience in Multi-Modal Supply Chains.
- Federal Emergency Management Agency (FEMA), U.S. Environmental Protection Agency (EPA), and Metropolitan Transportation Commission/Association of Bay Area Governments (MTC/ABAG) Report: Regional Resilience Toolkit.

However, research is needed to understand the role of the transportation system in food supply chain resiliency. For example, as transportation demand is derived demand, the entire agricultural transportation system must transition to a new state in the wake of certain global disruptions. Global disruptions are disruptions that are widespread in geography. The widespread U.S. protein shortages due to meat processing bottlenecks and consumer panic buying resulting from the 2020 coronavirus pandemic required more frequent deliveries to prevent out-of-stock situations and higher prices. Global disruptions can therefore translate to new shipping patterns (changing infrastructure use) and different volumes of services provided within freight subsectors (changing capital use) to ensure the resiliency of the food supply chain.

On the other hand, local disruptions are limited in geography and can be caused by weather events such as hurricanes. These supply and demand shocks are often felt regionally, in the form of shortages or higher food prices, but not nationally. The impact of shortages and higher food prices on vulnerable communities becomes critical in the regional context. In the latter case, transportation systems and services will be critical for getting essential supplies to the region, though infrastructure (such as roads, railways, and ports) may be damaged. Finally, in addition to items needed for human health and consumption, the livestock industry relies on delivery of feed ingredients and veterinary supplies to reduce animal mortality during disasters.

Research Objective

The objectives of the proposed research are to:

- Assess and characterize transportation system risk to food supply chain resiliency.
- Develop a framework to evaluate the impact of external risk to the food transportation system and the resiliency of the food supply chain, as well as the impacts to vulnerable communities
- Identify best practices for state and local authorities to use when preparing for and recovering from disruptions to the agricultural transportation system.

- Identify key indicators that can be monitored and used to assess food-supply chain risks associated with the transportation system.

Urgency and Potential Benefits

Global and local disruptions are uncertain (not possible to predict when and where events will happen). What is clear is that disruptive events will continue to occur – possibly of greater magnitude and frequency. For example, climate models predict increased frequency and intensity of hurricanes (NOAA) and other natural disasters that will disrupt infrastructure (including transportation infrastructure). The need for a framework to understand and integrate transportation system risk to food supply chains are critical to ensure the availability and affordability of food.

Implementation Considerations and Supporters

The development of the framework, identification of best practices, and key indicators can inform transportation system investments, policies, and programs in support of resilient food supply chains. AT030 Agriculture and Food Transportation Committee supports this problem statement.

Other organizations that will be interested in the research include:

US Department of Agriculture

National and State Rural Development Councils

Recommended Research Funding and Research Period

\$300,000

18 months

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NCHRP Review of B-26

Reviewed By:

Camille Crichton-Summers
ccrichton-summers@nas.edu

Comments:

This topic is of interest to all industries given the recent compounding impacts of supply chain disruption during the COVID-19 pandemic, specifically in the area of the food supply chain. This should be coordinated with/build upon a current NCHRP project, NCHRP 23-13-(04) "Scoping Supply Chain Challenges and Solutions beyond COVID-19", although the objectives of this research are specifically related to effective practices and lessons learned during COVID-19. The budget and schedule should be increased to \$400,000 and 2 years given the interrelated challenges.

Review Date:

12/17/2021

FHWA Evaluation of B-26

Reviewed By:

Rob Kafalenos/HEPN

Comments:

This proposal looks useful. The resilience and vulnerability of national and local supply chains for food and agricultural products is not something that has gotten much attention. The proposal would be strengthened if it 1) talked more about what factors distinguish this specific supply chain from other national/local supply chains, and why it

should be examined separately; and 2) identified the range of risks that should be addressed. The proposal lists Covid and weather events, but ignores climate change, so it is incomplete.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-26

Submitted By:

Caroline Kieltyka
AASHTO Staff
Special Committee on Freight

Priority #: 6

Comments: N/A

Submitter Response for 2023-B-26

From:

[email: kelly.eagan@dot.ca.gov]

Comments:

Thank you so much for taking the time out of your schedule to review the AT030 Agriculture and Food Transportation Committee's Problem Statement 2023-B-26: Evaluating the Role of the Transportation System in Food Supply Chain Resiliency, and for providing thoughtful, insightful, and valuable feedback.

Distinguishing factors implied but not explicitly called out within the problem statement include (and are not limited to) access to food as an accessible good, trucking as the predominant mode for food transport, critical food supply chains (fresh produce, meat, dairy) that rely on cold chain/ refrigeration, evaluating complex logistical issues that in turn affect the need for sustainable infrastructure, understanding that rural and urban needs differ, acknowledging a lack of research on wholesale food movements. This research will also explore climate change impacts on food production geography and how this could affect access to the multimodal infrastructure that many agricultural products rely on for delivery.

Extraordinary challenges facing the agricultural industry include changes in consumer income and preferences that have resulted in more expensive supply chains. Modern supply chains are expanding to include many complex and innovative components (ex. big data, machine learning) and are controlled by numerous independent stakeholders (distributors, producers, state agencies) designed to serve diverse customer segments. For example, identity preserved (IP) commodities such as grains or organic meats and produce are increasing in popularity globally, including socioeconomically disadvantaged individuals seeking healthier dietary options. However, IP commodities require systems of

production, handling, documenting, certifying, marketing, and monitoring at all stages to ensure product quality and integrity, all of which result in additional costs. All the transactional information must be collected, coordinated, and distributed to the right people at the right time to trigger the right actions.

On the supplier side, food buyers are confronted with challenging decisions when placing food commodity orders. They can easily enter a "bullwhip effect" cycle in which their purchased produce spoils and they run out or run low, then they over-correct by over-ordering, and subsequently, that also produce spoils because it does not sell fast enough.

Examples of this effect are the ongoing market disruptions resulting from the Covid-19 pandemic on the global and U.S. food supply. Before the pandemic, food supply chains were very stable, and most perishables arrived at their destination just in time. However, as the pandemic grew, many customers started "panic buying", creating a spike in demand for certain goods followed by an extended and unexpected lull in supply. Further, plant worker illness and shutdowns in the food processing industry gradually created a bottleneck at packaging and processing plants, resulting in colossal food waste (euthanatizing oversized hogs, chickens, cattle) coupled with a subsequent shortage of meats despite the availability of livestock and increased demand at stores. In our review of 21 articles and reports on the topic, very little work has been done on evaluating the transportation challenges faced by wholesale food supply chains. Since most food consumed by Americans is moved by truck, and high-value foods such as meat, dairy, and fresh produce require cold chain movements, infrastructure placement is key to affordable logistics, especially for those independent businesses collaborating in supply chains. The latter remains a critical issue in addressing food access for rural, "frontier and remote areas," as documented in the Stevens et al. (2021) USDA-ERS report on rural food access.

This problem statement highlights the need for an analytical framework to evaluate agricultural supply chain performance as it evolves through exogenous disruptions like Covid. We face increasingly more frequent short and medium-term (less than ten years) disruptions that significantly affect global, national, regional and local economies as well as people's lives. While we agree climate change is of utmost importance, we would like to point out that climate change issues affect every aspect of this problem statement. Climate, weather, and agriculture are inseparable; therefore, as climate changes, regional food production may shift to regions where food and supporting transportation infrastructure is inadequate or simply unavailable.

We appreciate the connection with NCHRP 23-13-(04), and if funded, the NCHRP 2023-B-26 project team will coordinate and build upon the research as appropriate and apply it to the "agrifood" space. The team is also open to considering other relevant research, including the United States Department of Agriculture's Transportation Research Services study underway entitled, "Transportation Issues Affecting Fresh Food Distribution: A Comparison Study of Rural vs. Urban America," and can build off their methodology and findings. They worked closely with state departments of transportation to map data specific to wholesale food movements.

We initially suggested research funding of \$300K and a research period of 18 months; however, if funded, the project team will recommend increasing the research funding to \$400K and extending the research period to 24 months.

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Review Date:

February 1, 2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation
FY2023 NCHRP PROBLEM STATEMENT**

Problem Number: 2023-B-27

Problem Title: The Improving Container Availability for U.S. Agriculture Exports research provides solutions to the current global supply chain crises, improves rural agricultural access to national and international markets, improves the U.S. economy, reduces the U.S.- China trade imbalance, and reduces the chances of a global foods supply shortage.

Background Information and Need For Research - The United States (U.S.) is a leading global exporter of agricultural goods and leads the world in grain production: averaging 561 million tons between 2010-2016. The primary source of U.S. agricultural growth results from exports to middle-income countries like China and Mexico that account for the largest share of bulk exports like wheat, soybeans, barley, and rice. The five-year projections of grain productions and exports show a sustainable trend (Figure 1).

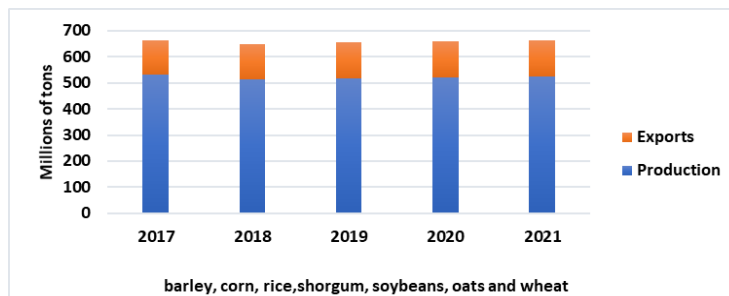


Figure 1. Total U.S. grain projections (productions and exports)
Source: USDA

Poor or incomplete export data impedes the ability to identify new inland grain export facilities replacement. The U.S. Census collects import/export data when a commodity export exceeds \$2,500 in value. While the data is reliable for manufacturing commodity origins, it is misleading for many agricultural exports and other products. For example, when comparing 2012 FAF and USDA corn export data (Figure 2), the FAF reports Louisiana, Washington, Texas, and Oregon in the top national corn and soybean export states, while those same states do not rank in the USDA's top ten grain exporting states. Also, a recent analysis for the Nebraska DOT showed that the state's grain exports were 450 percent higher than FAF reported.

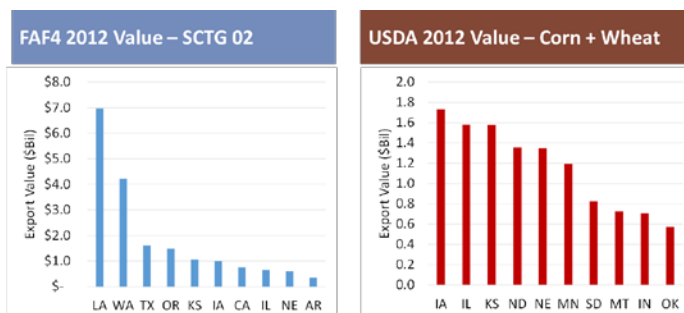


Figure 2. FHWA. and USDA

Intermodal movement of goods consists of transporting containers via multiple modes. Agricultural exports are primarily dependent on rail and truck involvement and are closely tied to the grain container exports analyzed here. Drayage is the service of transferring a container between loading and shipping sites. Drayage distance is a significant consideration to account for when assessing the economic viability of container transport costs. Transportation costs increase with distance; therefore, rail transport becomes vastly more cost-effective over long distances. Chicago, Illinois, has transformed bulk-grain facilities into container loading facilities with relative ease because they have a sizeable inland container pool available. To address the agricultural industry's transportation challenges, especially for inland state container transportation, we must examine the function of multimodal freight transportation within the industry. Without adequate, efficient transportation, state agriculture could not have become the backbone of our country like it is today.

According to a January 2021 CNBC report, the Ports of Los Angeles (POLA) and Long Beach (POLB) in California and ports in New Jersey and New York rejected 177,938 containers during the peak agricultural export season October and November of 2019. Further, in mid-October, carriers notified agricultural exporters they were prioritizing empty containers over agrarian exports. Port data provided to CNBC showed that the total export container deficit for the POLB and POLA was 136,392 TEUs. New York and New Jersey ports have an estimated shortage of 41,546 TEUs, resulting in a \$632 million total value loss in export trade.

Literature Search Summary

One Freight Policy Transportation Institute at Washington State University study¹ provided information and analysis focused on addressing the container availability challenges common to shippers in the Pacific Northwest U.S. The study includes recommendations to alleviate availability problems, including technology/operational improvements at ports, improved collective/bargaining for diverse agricultural shippers, and an inland container hub to reduce congestion (truck) at and near the ports. A follow-up study², "Assessing Feasibility of an Inland Container Terminal in the Pacific Northwest," offers an improved modeling approach to estimating container demand and site selection for choosing optimal locations for an inland container hub.

1Jessup, Eric, Suzette Galinato, Zhazira Alisheva and Bradley Eustice. "Pacific Northwest Container Availability Study: West Coast Container Traffic Analysis," http://ses.wsu.edu/wp-content/uploads/2019/08/Final_PNW_Container_Availability_Report.pdf

2Jessup, Eric, Maksud Rahman, You Zhou, and James Miller, "Pacific Northwest Inland Container Terminal Modeling Project: Assessing Feasibility of an Inland Container Terminal in the PNW" <http://ses.wsu.edu/wp-content/uploads/2020/08/PNW-Inland-Container-Terminal-Modeling-Project-Final-Report.pdf>

Research Objective Agriculture shippers have increasing difficulties accessing containers to export agriculture and other high-value commodities. The objectives of this research are:

- Identify and document the challenges of agricultural shippers gaining access to containers.
- Quantitative statewide analysis to identify optimal inland locations near the highways, railways, and marine access
- Economic evaluation for estimating the transportation infrastructure needs to build national heavyweight highway corridors to support new inland terminals and connect them to principal transload operations.
- Analytical and economic evaluation to incorporate the business and economic realities of participating entities and to address container access and availability issues

Urgency and Potential Benefits

The Current National Supply Chain Crisis, specifically at POLB/POLA, is making it harder to obtain empty containers because the port congestion impedes shippers' ability to send their empty containers back to Asia. Instead of sending them to inland farmers, shippers store them at the ports, warehouse, yards or abandon them in local neighborhoods.

Potential benefits include:

- Reduce shipping costs and improve port operations by identifying efficiencies, improving transloading times, and reducing the need to store empty containers.
- Improve national, regional, and local economies by increasing agriculture access to emptying containers rather than shipping the empty containers back to Asia.
- Improved efficiency and accessibility of rural agricultural industries to access domestic and international markets

Implementation Considerations and Support

This national research will be implemented through multistate, multijurisdictional partnerships between Coast and Inland State DOTs, logistic providers, port and railroad operators, intermodal terminals, etc. The research can be implemented at the POLA, number one in national container volume, and the POLB, number two in national container volume, comprises the largest North American container port. The research will be documented to assist decision-makers in developing national, state, regional, and local transportation policies, decisions, and investments. This research is supported by the Transportation Research Board's Committee on Agriculture and Food Transportation (AT030).

Recommended Research Funding and Research Period

- \$400,000
- 18 months.

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NCHRP Review of B-27Reviewed By:

Trey Joseph Wadsworth
 twadsworth@nas.edu

Comments:

The proposed research is timely provided the current supply chain issues and bottlenecks. However, improving the availability of shipping containers may be something that a state DOT's cannot influence, limiting the utility of this research to state DOTs. The intended audiences for this research appear to be private shippers, port operators, and entities other than state DOTs. However, there are elements

proposed within this problem statement that would have utility to state DOTs. For example, (1) improving the data issues identified in the background could help state DOTs with freight planning, and (2) the second bullet under the research objectives which would also help with freight planning. The research timeline and budget seem reasonable.

Review Date:

12/14/2021

FHWA Evaluation of B-27

Reviewed By:

Chandra Bondzie/HOFM

Comments:

Container issues are more complex than described in the background and research problem statement. It appears there is a focus on part of the solution to container issues being 'national heavyweight highways' before the research is complete. Of the research objectives listed, would suggest choosing just a single research objective to make a more sound and robust project. As currently written, the objectives delve into different topics for investigation and may not relate to each other.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-27

Submitted By:

Caroline Kieltyka

AASHTO staff

Special Committee on Freight

Priority #: 5

Comments: N/A

Submitter Response for NCHRP for B-27:

From:

[email: kelly.eagan@dot.ca.gov]

Comments:

Thank you for taking the time to review AT030 Agriculture and Food Transportation Committee's Problem Statement 2023-B-27: Improving Container Availability for U.S. Agriculture Exports, and for providing insightful and valuable feedback.

We agree that container availability issues are becoming increasingly complex, thus the need for the suggested research. What remains of interest to our committee is that container shortages have been a growing issue for value-added agriculture shippers for many years, long before the ubiquitous availability problems associated with the pandemic.

1. With regard to our national highways and the movement of freight – we are suggesting the opposite in many respects. Recent data and discussions with market participants indicate that many value-added agricultural shippers, especially in Midwestern states, are currently draying containers hundreds of miles to access intermodal yards for transshipment, the latter being located mostly in urban areas[1]. Our reference in the problem statement was in part a response to Congressional directives and guidance from the USDOT that States examine the sustainability of their heavy haul networks:

a. "In the case of roadways on which travel by heavy vehicles (including mining, agricultural, energy cargo or equipment, and timber vehicles) is projected to substantially deteriorate the condition of the roadways, a description of improvements that may be required to reduce or impede the deterioration." (Federal Register / Vol. 81, No. 199 / Friday, October 14. [Docket No. DOT-OST -2012-0168] Guidance on State Freight Plans and State Advisory Committees)

We agree with the referee that the objectives listed encompass many complex issues. If funded, the project team is open to modifying the primary objective to the following: "using quantitative and qualitative analyses to identify and document the challenges of agricultural shippers in gaining access to ISO containers for value-added exports; and further to identify potential policy, planning and operational strategies that can help address this problem."

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**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-28

Problem Title

Factors which determine the location and characteristics of logistics / manufacturing clusters – understanding the impact to the freight network and local land use

Background Information and Need For Research

The expectation of consumers for fast delivery has contributed to the emergence of fulfillment and distribution centers which are positioned closer to residential clusters. In addition, logistics clusters which are tied to ports and airports are being located throughout the nation, in some cases hundreds of miles from the seaport or airport.

The evolving interest in on- and near-shoring is expected to affect a diverse array of communities beyond those which have traditionally hosted manufacturing operations. Many communities have become the site of these clusters without the benefit of understanding the factors which are driving their emergence and understanding the impacts of these facilities on the surrounding communities' land use and transport infrastructure.

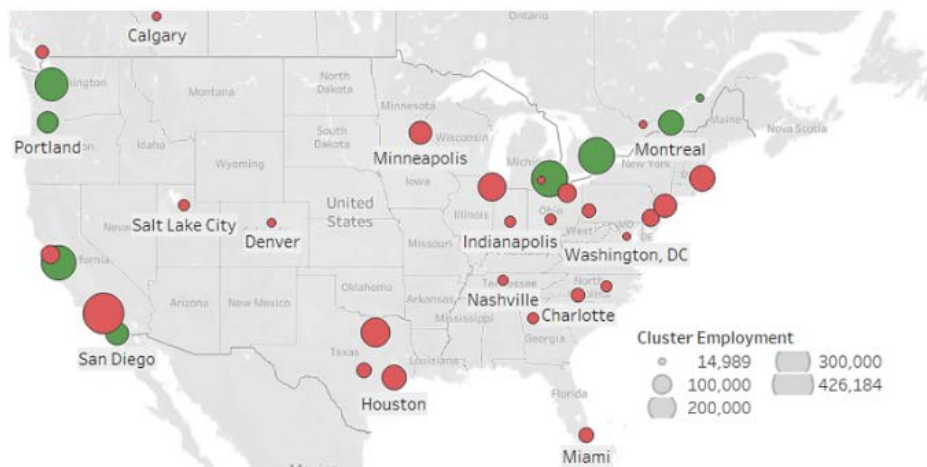
This project will study the emergence of several clusters from the perspective of the factors which are used to select the location, the development of the specific site, and the impact on the community in terms of changes to land use, the employment base of the community, and effects on the social and economic structure of the community.

The following map prepared by the Arizona State University International Logistics & Productivity Improvement Lab identifies the major logistics cluster platforms in the



United States.

A similar map below was prepared by the Economic Development Commission of Waterloo, Ontario, Canada identifies not only the location of, but also the employment levels associated with advanced manufacturing clusters in the US and Canada. As this map and the map above illustrate, the location of the clusters are not necessarily tied to traditional locations.



The clusters generate and receive significant flows of freight which are international, trans-border (being changed by the relatively-new North American “USMCA”: U.S. Mexico-Canada Agreement on trade), and domestic in nature. All modes of transport are employed in the move of shipments. The multi-modal nature of the freight flows requires an understanding of the unique operational aspects of each mode and their

interface requirements with the other freight transport modes.

Literature Search Summary

A cursory literature search has identified four reports which address logistics and manufacturing clusters. Reports are dated prior to COVID-19 and do not reflect significant and ongoing changes, which supports the need to comprehensively revisit the situation and update research findings.

- “Transportation and Logistics Cluster Competitive Advantages in the US regions: A Cross-Sectional and Spatio-Temporal Analysis”, I Kumar, A Zhalnin, A Kim, LJ Beaulieu - Research in Transportation ..., 2017 – Elsevier
- “Foresight Support Systems to Facilitate Regional Innovations: A Conceptualization Case For a German Logistics Cluster”, J Keller, C Markmann, A Heiko - Technological Forecasting and Social ..., 2015 - Elsevier
- “Absorptive Capacity, Cluster Linkages, and Innovation: An Evidence From Bengaluru High-Tech Manufacturing Cluster”, D Chandrashekar, BSM Hillemane - Journal of Manufacturing ..., 2018 - emerald.com
- “Research on the Synergetic Development between Manufacturing Cluster and Logistics Enterprises” [J], X XU, W CAO, C JIN, W GUO - Packaging Engineering, 2007 - en.cnki.com.cn
- Future Freight Flows (FFF) initiative launched as part of the National Cooperative Highway Research Program (NCHRP) Project 20-83(01)

Research Objective

A quick anecdotal review of logistics clusters near seaports and airports as well as inland ports, reveals a growing development of freight processing centers which work in concert with seaports and airports to shift certain freight processing off seaport and airport properties. The emergence of new manufacturing clusters, not always tied to traditional locations, is creating challenges for local land use planners, and regional transportation planners, and freight planning practitioners. This research will identify the parties involved in this evolution as well as the factors which lead to location and facility type decisions.

Urgency and Potential Benefits

Freight traffic related to the emergence and/or expansion of logistics structures and emerging manufacturing activities has numerous impacts on the local community. In many instances, local land use planners and regional transportation planners must respond to rather than pro-actively prepare for these developments. As a result, a wide array of impacts on the socio-economic-transportation fabric of the community emerge.

These impacts can spread beyond the precincts of the logistics structure. As a result of the research, planners will understand the factors employed to identify and select locations for the clusters and the direct and indirect impacts on the socio-economic-

transportation fabric of the community. The identification of the root factors and the consequential impacts will assist planners in proactively creating programs to strategically identify and recommend the location of the clusters and mitigate and/or minimize the adverse impacts of the clusters.

Implementation Considerations and Supporters

The research should lead to the development of a guidebook which outlines the identified locational factors and the impacts. The optimal presentation of this information would be in an interactive guidebook which includes explanatory scenarios.

The major components of the guidebook should include:

- How to identify and forecast freight flows employing innovative processes based on scenario constructs.
- Identification of the local and regional factors will attract and support the emergence and/or expansion of logistics and manufacturing clusters.
- Identification of impacts on the local community including on the transport infrastructure, land use, employment cohorts, disadvantaged communities, natural environment, educational facilities and programs, and political considerations.
- Best practices and examples of planning concepts and projects to accommodate the emergence and/or expansion of logistics and manufacturing clusters.

This research needs statement is supported by:

AASHTO Special Committee on Freight, Caroline Kieltyka (AASHTO Liaison),
ckieltyka@ashto.org, 202-624-8489

Recommended Research Funding and Research Period

The research and guidebook should be completed within 18 months. Suggested funding is \$450,000.

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

- Charles Edwards, Univ. of North Carolina at Chapel Hill,
chwedwards@gmail.com , (919) 215-0605
- Sushant Sharma, TTI, s-sharma@tti.tamu.edu, (314) 556-7363
- Tom McQueen, Georgia Department of Transportation tmcqueen@dot.ga.gov,
(404) 631-1785

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

The panel should be composed of a diverse group which represents community and regional and state DOT transportation planners, transport providers, and industrial developers.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Tom McQueen, AICP

Asst. Planning Administrator
Georgia Department of Transportation
tmcqueen@dot.ga.gov
(404) 631-1785

NCHRP Review of B-28

Reviewed By:
Trey Joseph Wadsworth
twadsworth@nas.edu

Comments:

The proposed research is timely as this is an emerging issue and has parallels to e-commerce logistics studies. However, the problem statement as proposed does not explicitly demonstrate the utility to state DOTs as it is focused on land use and regional planners, but refining the research focus could be addressed by the research project panel. The research timeline seems reasonable, but the budget may be too high. Recommend \$350,000.

Review Date:
12/14/2021

FHWA Evaluation of B-28

Reviewed By:
Millard/HOFM

Comments:

In general the problem statement is good. The primary recommendation is that economic development agencies are included as part of the potential beneficiaries and audience for this research. There may be opportunities for increased coordination between transportation and economic development professionals as a result of the research.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for B-28

Submitted By:
Caroline Kieltyka

AASHTO staff
Special Committee on Freight

Priority #: 9

Comments: N/A

Submitter Response for 2023-B-28

From:
Tom McQueen

Comments:

As submitted, the problem statement can be edited to highlight the value and importance of improved coordination between State (and more Local) Departments of Transportation and their corresponding partner Economic Development Agencies and stakeholders. I submit the following revision:

Proposed Changes:

Title: Identifying the factors which determine the location and characteristics of logistics / manufacturing clusters and understanding the value and processes of coordination between Transportation Planners and Economic Developers to optimize the impacts to the freight network and local land use

Implementation Considerations and Supporters

The research should lead to the development of a guidebook which outlines the identified locational factors and the impacts to be employed by State DOT as well as Metropolitan Planning Organization and local government transportation planners and their respective Economic Development Agency partners and business stakeholders. The optimal presentation of this information would be in an interactive guidebook which includes explanatory scenarios. The guidebook should include coordination processes.

The major components of the guidebook should include:

- How to identify and forecast freight flows employing innovative processes based on scenario constructs.
- Identification of the local and regional factors will attract and support the emergence and/or expansion of logistics and manufacturing clusters.
- Identification of impacts on the local community including on the transport infrastructure, land use, employment cohorts, disadvantaged communities, natural environment, educational facilities and programs, and political considerations.
- Best practices & examples of planning concepts & projects to accommodate the emergence and/or expansion of logistics & manufacturing clusters.

Contact Info:

Tom McQueen, GDOT [email: Tom_McQueen@outlook.com]

Review Date:

2/7/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation****FY2023 NCHRP PROBLEM STATEMENT TEMPLATE****Problem Number: 2023-B-29****Problem Title**

Reverse logistics – New freight flows create different challenges for land use and freight planning practitioners

Background Information and Need For Research

The trend of accelerated e-commerce adoption by consumers since the onset of COVID-19 is well documented; a July 2020 survey of 5,000 North American and European consumers found that 36% of respondents shopped online weekly, up from 28% pre-COVID-19.¹ According to the National Retail Federation, U.S. e-commerce sales accounted for \$565 billion (14%) of the total retail sales in the U.S. in 2020, of which \$102 billion was returned by the customer...overall, online returns more than doubled in 2020 from 2019 and are a major driver of the overall growth in returns.²

The rate of returns for e-commerce purchases are well above those from the brick-and-mortar stores' average of an 8.89% return rate³; in 2020, online purchases were returned at rate at up to three times those made at brick-and-mortar establishments⁴. E-commerce average return rates are close to 20% and the holiday season e-commerce average return rates hit around 30%.⁵ This has presented a financial challenge for business; the cost of handling returns is typically several times larger than the original dispatch costs. Part of this is driven by the relatively discrete quantities that are constantly entering the returns process for handling.⁶

Retail returns are a significant part of what commonly referred to as 'reverse logistics' supply chain, that contrasts with 'forward logistics' supply chain which describes steps associated with the production and ultimate delivery of goods to consumers. An overview of the reverse logistics supply chain is shown below: ⁷

¹ <https://medium.com/@AmericanPublicU/how-covid-19-is-affecting-reverse-logistics-processes-e9a052a9d4a6>

² <https://nrf.com/media-center/press-releases/428-billion-merchandise-retained-2020>

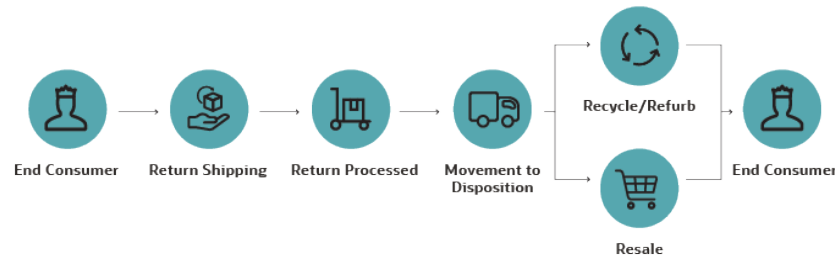
³ www.invespcro.com/blog/ecommerce-product-return-rate-statistics/

⁴ www2.deloitte.com/us/en/pages/consulting/articles/reverse-logistics-management-for-supply-chains.html

⁵ www.scmr.com/article/cbre_shares_post_holiday_reflections_on_supply_chain_returns_and_the_revers

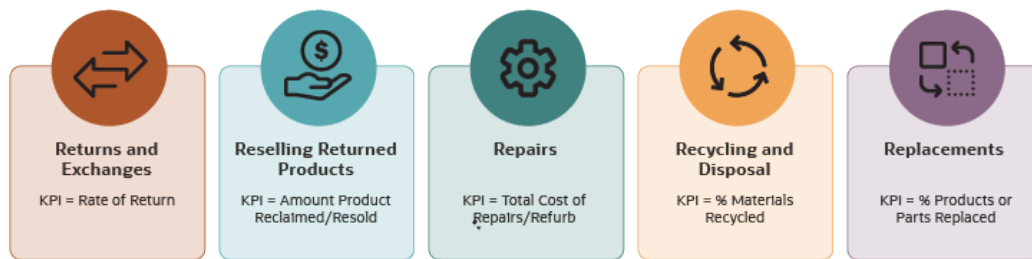
⁶ www.shdlogistics.com/reverse-logistics/new-reverse-logistics-challenges

⁷ www.netsuite.com/portal/resource/articles/inventory-management/reverse-logistics.shtml



With the rapid expansion of online business-to-business (B2B) flows, the volume of returns is also increasing for this segment of e-commerce and creating new business opportunities. Some forecasts suggest that U.S. B2B sales will be USD 1.8 trillion in 2023.

Another significant aspect of reverse logistics is what has been referred to as “the circular economy” which can be associated with recycling.⁸ The graphic below reflects it as well as others considered in the “five R” components of the reverse logistics ecosystem⁹:



Seasonality is an important facet of reverse logistics; for the 2021 holiday shopping season, e-commerce is projected to account for a record 18.9% of total retail sales.¹⁰ The increase in e-commerce utilization for consumer shopping results in a subsequent increase in return volume and rates; in fact, the 2019 holiday shopping season experienced a return rate 26% higher than the prior year.¹¹ As shown in the following figure, much is experienced around the holiday months with most e-commerce returns occurring in December, January and February¹². Proximity to major consumption centers helps retailers manage the transportation portion of reverse logistics and recirculates inventories faster.¹³ It should be researched and documented which transportation modes are most affected as well as what geographies (regions and/or areas of metropolitan regions and tangential rural areas) can expect to experience these freight flows on their corridors.

⁸

www.academia.edu/38456828/CIRCULAR_ECONOMY_APPLICATION_OF_REVERSE_LOGISTICS_IN_THE_RECYCLING_OF_URBAN_TRANSPORT_CAR_DS.pdf

⁹ www.netsuite.com/portal/resource/articles/inventory-management/reverse-logistics.shtml

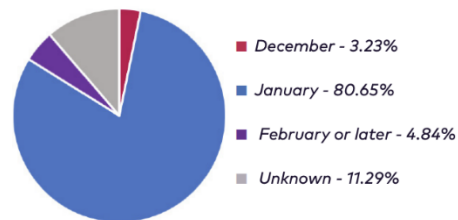
¹⁰ www.emarketer.com/content/how-retailers-start-planning-2021-holiday-season

¹¹ www.globaltranz.com/trends-in-reverse-logistics/

¹² www.shopify.com/enterprise/ecommerce-returns

¹³ www.forbes.com/sites/sharonedelson/2020/12/17/fueled-by-e-commerce-growth-industrial-leasing-continues-to-soar/?sh=7c84e3423061

When do you expect to receive the majority of returns?



The COVID outbreak has caused a rise in e-commerce and in turn, product returns.¹⁴ In addition to that industry sector, automotive industry product recalls and the pharmaceutical industry have been cited as contributing drivers of growth of the reverse logistics market¹⁵; as an example, between February 14 and March 11, 2013 (less than one month) the U.S. Food and Drug Administration mandated more than 40 recalls¹⁶. In response, businesses must consider adding workers and establishing separate internal departments to handle reverse logistics as well as increasing warehouse space¹⁷. Building on past consideration of consolidation centers¹⁸, industry experts consider this a growth opportunity for the industrial real estate market in the U.S., as the two most likely solutions to the reverse logistics problem both involve warehouse and distribution centers and will ultimately drive demand¹⁹; this is an important issue that should be investigated to the benefit of both land use planners and freight planning practitioners.

Specifically, the surge in digital orders has created a heightened demand for warehouse space in the U.S. so that retailers and delivery providers can handle all packages coming in and going out. As much as 400 M ft² of additional warehouse space could be needed in the next five years just to process returns.²⁰ Most of the square footage to handle returns come from older distribution centers which third-party logistics (3PL) providers and large retailers vacate for newer facilities to support forward logistics operations; this is significant because a reverse logistics supply chain requires an average of up to 20% more space and labor capacity than forward logistics.²¹ In addition, it is not uncommon for retailers to contract with 3PL's such as FedEx, UPS and many others for their returns management in order to free-up premium space for their forward logistics activities²². The anticipated land use change aspect is unique to this topic and should be investigated to the benefit of both land use planners and freight planning practitioners.

Return rates vary by product type (i.e. clothes/shoes, household products, electronics,

¹⁴ <https://locus.sh/documents/the-history-evolution-and-future-of-reverse-logistics.pdf>

¹⁵ www.openpr.com/news/2066006/impact-of-covid-19-outbreak-on-reverse-logistics-market-grow

¹⁶ www.supplychain247.com/article/why_reverse_logistics_needs_to_become_a_core_competency

¹⁷ www.shopify.com/enterprise/e-commerce-returns

¹⁸ <https://journals.sagepub.com/doi/abs/10.3141/2411-05>

¹⁹ www.supplychain247.com/article/reverse_logistics_in_the_age_of_entitlement/Reverse_Logistics

²⁰ www.cnn.com/2020/12/07/america-needs-more-warehouses-to-handle-record-holiday-returns-cbre.html

²¹ www.freightwaves.com/news/demand-for-reverse-logistics-warehouse-space-seen-rising-cbre-says

²² www.logisticsmgmt.com/article/leveraging_reverse_logistics_is_key_to_profits_this_year

etc.) and contribute to additional freight volumes moving in the multimodal transportation system. Each may produce varying effects on the system that is influenced by the unique characteristics / demands / needs of each. Example product category return rates are shown in the following table²³; after returned and processed, they may enter the domestic secondary retail market²⁴, or to another destination, but the net result remains of additional demand to once again move that freight through the multimodal transportation system – through the returns process as well as after that process completes and the product moves to its next market and ultimate destination.

Return Rate by Retail Category

Retail Category	Blended Return Rate ⁽¹⁾
Apparel	12.2%
Auto Parts	19.4%
Beauty	4.3%
Department Stores	11.4%
Drug/Pharmacies	1.6%
Footwear	9.1%
Hard Goods	3.8%
Home Improvement	11.5%
Housewares	11.5%
Sporting Goods	7.6%
Survey Average ^{(2) (3)}	10.6%

Additionally, some merchants with brick-and-mortar facilities may accept returns of online purchases at those facilities²⁵, while online-only channels may only accept via the vendor who initially delivered the product.

In this age of increasing e-commerce, there is important need to understand the characteristics of these flows and their impact on vehicle movements. For example, are there specific corridors/geographies or modes that bear a disproportionate burden now? What are projections and subsequent future impacts for those same questions?

Literature Search Summary

A cursory review indicates research on reverse logistics have been on specific commodities, products or industry-internal topics, many of which were focused outside of North America. Several may be germane but dated and do not reflect the recent rise and continued growth of e-commerce:

- “Reverse Logistics – A review of the Literature and Framework for Future Investigation” in the Journal of Business Logistics (1998);
- “The Who, What and Where of Reverse Logistics” (2003);
- “Emerging Supply Chain Management Trends and their Impact on Spatial Organization of Logistical Networks” (2002) presented at 2003 TRB Annual Meeting;
- “Multiproduct Distribution Network Design of Third-Party Logistics Providers with Reverse Logistics Operations (2007);

²³ www.shopify.com/enterprise/ecommerce-returns

²⁴ www.supplychain247.com/article/why_reverse_logistics_needs_to_become_a_core_competency

²⁵ <https://enterrasolutions.com/blog/the-impact-of-the-coronavirus-crisis-on-reverse-logistics/>

- “Reverse Logistics Retail Level Return” (2014),
- “Reverse Logistics in the Circular Economy” (2017);
- “Riding the Returns Wave: Reverse Logistics and the U.S. Postal Service” (2018);
- “Reverse Logistics in the Age of COVID-19” (2020); and
- “The History, Evolution and Future of Reverse Logistics” (2020).

Research Objective

□ The primary objective of the research will be to understand these unique freight volume flows, characteristics of their impact on the freight network and specific modal needs, and associated land use change trends related to industrial and warehouse/distribution developments in communities in across the nation.

□

The research will focus on 1) a thorough understanding of the commodities groups which are being moved, 2) the volume of goods moved and the characteristics of the traffic including seasonality, dominate destinations and mode of transport, 3) the characteristics of the origins of the return shipments including dispersion, frequency, etc., 4) likely land use development – and/or redevelopment – trends, and 5) the impact of these flows on truck operations including pick-up and line-haul.

Urgency and Potential Benefits

The recent expanded – and anticipated increasing – use of online (e-commerce) platforms has increased the volume of e-commerce related freight moving through the intermodal transportation system, and subsequently the consumer return shipments via the reverse logistics supply chain. The nature of these flows which have different characteristics in terms of origins and destinations, and day-time and seasonal characteristics can significantly affect the capacity of the local, regional and national freight system, as well as new demands for local land use developments for manufacturing and warehouse/distribution. Through the output of this research, local, regional and statewide land use planners and freight planning practitioners will be better informed to accommodate these flows in their planning mandates.

Implementation Considerations and Supporters

The output of the research should be in a format which planners can employ to estimate the volume and characteristics of return shipments and associated truck movements within the area of responsibility. The output should provide a process to identify the likely origins and associated volumes of return shipments, and the location of return shipment handling and processing centers.

This research needs statement is supported by:

AASHTO Special Committee on Freight, Caroline Kieltyka (AASHTO Liaison),
ckieltyka@aaashto.org, 202-624-8489

Recommended Research Funding and Research Period

The research project should be completed within 18 months. Suggested research funding amount is \$500,000.

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

- Charles Edwards, Univ. of North Carolina at Chapel Hill, chwedwards@gmail.com , (919) 215-0605
- Sushant Sharma, TTI, s-sharma@tti.tamu.edu, (314) 556-7363
- Tom McQueen, Georgia Department of Transportation tmcqueen@dot.ga.gov, (404) 631-1785

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

- Charles Edwards, Univ. of North Carolina at Chapel Hill, chwedwards@gmail.com , (919) 215-0605
- Sushant Sharma, TTI, s-sharma@tti.tamu.edu, (314) 556-7363
- Tom McQueen, Georgia Department of Transportation tmcqueen@dot.ga.gov, (404) 631-1785

Person Submitting the Problem Statement: Name, affiliation, email address and phone.

Tom McQueen, AICP
Asst. Planning Administrator
Georgia Department of Transportation
tmcqueen@dot.ga.gov
(404) 631-1785

NCHRP Review of B-29

Reviewed By:

Trey Joseph Wadsworth
twadsworth@nas.edu

Comments:

The background section of the proposed research does not clearly align with the research objective, though there are elements in both that would result in valuable research. Recommend combining elements of this problem statement with **2023-B-35** and reconsidering the budget accordingly. An eventual project panel would need to further refine the scope of work.

Review Date:

12/14/2021

FHWA Evaluation of B-29

Reviewed By:
 Pandey/HOFM

Comments:

This research can assist transportation agencies to better understand characteristics of reverse logistics within the context of e-commerce for supporting freight planning and programming activities. The problem statement and research objective are well defined. However, the proposal does not sufficiently describe data type, data sources, budget for data purchases if any, data challenges to conduct this research.

Review Date:
 December 17, 2021

AASHTO Committee Evaluation for B-29

Submitted By:
 Caroline Kieltyka
 AASHTO staff
 Special Committee on Freight

Priority #: 11

Comments: N/A

Submitter Response for 2023-B-29

From:
 Tom McQueen, GDOT

Comments:

Review suggestions for B-29 that made tangential references to problem statement 2023-B-35

<https://apps.trb.org/NCHRPBalloting/DocThread.asp?CandidateId=2618&clsbtn=on>

needed to clarify that B-35 focuses on the impact of *all* "pre-consumer receipt of product" e-commerce activities on travel (note that the reference to 'travel' is tightly related to freight transport) and land use. It should be noted that problem statement B-29 also looks at land use with a tighter focus on *reverse* logistics flows -- which is a very unique and rapidly growing "post-consumer receipt of product" aspect of the supply chain, that not only involves product returns, but also waste and product recycling streams; these starkly contrast with the more broadly defined perspective of B-35 which examines all e-commerce activity at a higher level.

As pointed out in the received suggestions/comments for B-29, it was noted that data will be a challenge; because this topic has not recently or significantly been investigated

by TRB, there is lack of familiarity with relevant industry groups working in the reverse logistics ecosystem. Resources are available and have increasing levels of visibility; for example, The Reverse Logistics Association are definitely a potential source of information. Consequently, I propose a suggested change to B-29 problem statement; specifically, please add a sentence that states that "The Reverse Logistics Association <www.rla.org>, which was established in 2002 and grew to a membership of over 150 companies by 2018, would a prime resource for pursuing the data and information that would support research in B-29."

Contact Info:

Tom McQueen [email: Tom_McQueen@outlook.com]

Review Date:

2/7/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2022 NCHRP PROBLEM STATEMENT

Problem Number: 2023-B-30

Problem Title

Aquatic Organism Passage in Rehabilitated Culverts

Background

Rehabilitation of culverts is widely used by State DOTs to extend the life of these structures, and to maintain adequate flow capacity when replacement would be cost-prohibitive. Culverts under deep fills on major highways can be at depths exceeding 50 feet. These structures would be extremely costly to replace and cause major traffic disruptions during construction. Unfortunately, there is little research to support DOT culvert rehabilitation designs that promote fish and another aquatic organism passage.

There is a growing amount of research on hydraulics for rehabilitated culverts, such as flow patterns and velocity for slip lining or baffles of various shapes. Research has been done on fish passage requirements but has focused primarily on new or replacement culverts. Few studies have focused on culvert rehabilitation features with fish in laboratory settings, including Olsen (2011) in Utah with trout in an HDPE culvert liner, and MacDonald and Davies (2007) in Australia who tested baffles with jollytails.

Researchers have noted the need for additional research to determine effective techniques to improve fish passage at culvert rehabilitations. This project will benefit State DOTs by studying fish behavior and developing specific measures to improve fish passage in rehabilitated culverts.

This research is consistent with the Strategic Research Plan for the AASHTO Technical Committee on Hydrology and Hydraulics (TCHH). For the calendar year 2021, the TCHH Plan includes seven Strategic Research Goals, of which three directly relate to this research proposal:

- *Decrease environmental and water quality impacts to natural watersheds and water bodies due to the construction, maintenance, or presence of transportation infrastructure*

Improved provisions for aquatic organism passage in rehabilitated culverts will reduce environmental impacts for these measures.

- *Reduce construction and maintenance costs for hydraulic infrastructure*
and
- *Increase hydraulic infrastructure asset service life*

Existing culverts which do not function well for aquatic organism passage, but which can feasibly be rehabilitated (at much less cost than total replacement) can allow for extended service life at reduced cost.

Literature Search Summary

A literature search was conducted in TRID (<http://trid.trb.org>), which includes the Research in Progress database (<http://rip.trb.org/>). The only reference cited was a 2007 study by Utah DOT. Other references were noted in a general review. Several sources state the need for further research to quantify fish passage effects of rehabilitated culverts along with testing methods to improve fish passage. Current guidelines for aquatic organism passage in culverts (FHWA HEC 26) provide information on new culvert installations, not rehabilitations.

Research Objective

The objective of this research is to determine culvert rehabilitation methods and site conditions that facilitate aquatic organism passage, with emphasis on non-salmonid fish species, and to develop design guidelines that will enable State DOTs to improve such passage at rehabilitated culverts.

- a. The desired outcome will be a report summarizing fish passage testing results, and presenting design guidelines, construction techniques and details of measures that facilitate aquatic organism passage in rehabilitated culverts.
- b. Major tasks to be performed include:
 - Perform a literature review and survey of State DOTs to determine widely used techniques for culvert rehabilitation, and existing methods for accommodating fish passage in them. Review previous research studies.
 - Develop a work plan and select several rehab techniques to evaluate, including slip lining, baffles and invert paving.
 - Review and summarize existing hydraulic performance data for rehabilitation and conduct limited flume and 1-, 2-, and 3-D numerical simulation to supplement existing data.
 - Select up to three species of fish and conduct flumes or lab testing of fish passage using selected culvert rehabs and baffles. Correlate swimming data with 3D CFD modeling of fish swimming and energy expenditure to extrapolate performance over a larger range of slopes, flows, life stages, low vs. high head, etc.
 - Correlate findings from numerical models and laboratory testing with FHWA HY-8 version 7.5 low-flow calculator for culverts, and with current two-dimensional algorithms or FishXing used for modeling fish physical capabilities

- Visit and document field locations at up to three culvert rehab sites as case studies for proposed fish passage enhancements, and/or existing rehabs with effective fish passage performance..
 - Prepare a final report summarizing analytical and fish passage testing results, with recommendations and guidelines for specific measures to improve fish passage. If the research develops information useful for passage of other aquatic organisms in rehabilitated culverts, this will also be summarized.
- c. Research results will be presented in the form of design guidelines.

Urgency and Potential Benefits

The benefits of this research to the majority of State DOTs will be the development of guidelines and a knowledge base to facilitate improved fish passage at rehabilitated culverts. Transportation agencies, faced with prohibitive costs to replace large diameter culverts under deep highway fills, and difficult maintenance of traffic needs, find culvert rehabilitation the only feasible option in many cases. Results will be applicable to a wide cross section of states by focusing research on non-salmonid fish species.

Negative consequences without this research include continued construction of culvert rehabilitations that may impede fish passage for years to come. Furthermore, if a culvert replacement is constructed due to the need to improve fish passage, the cost will be much higher than a culvert rehab based on the proposed guidelines.

Benefits of this research will accrue to: State DOTs (using cost-effective techniques to extend the service life of culverts) environmental resource agencies (construction of rehabilitations that can eliminate barriers to fish passage) and the aquatic organism community (increased diversity and upstream and downstream passage).

Implementation Considerations and Supporters

- Who within a state DOT will likely be responsible for using the research results: hydraulic engineers, environmental specialists, planning and programming managers.
- State DOTs can implement the research by adopting the proposed guidelines as policy for in-house and consultant -designed culvert rehabilitation projects.
- The proposed guidelines can be incorporated into existing DOT design procedures.
- Presentations and training workshops can build awareness and help implement research results. Besides State DOTs, likely participants include State fish and wildlife agencies and local transportation agencies (who maintain large numbers of culverts).

This research proposal is endorsed by the AASHTO Committee on Design and further recommended by The AASHTO Technical Committee on Hydraulics and Hydrology (TCHH). Other Committees focusing on environmental and construction issues may also have interests in this research. Contact person for AASHTO TCHH: Jeffrey E. Syar, P.

E. Chair, Ohio DOT Office of Hydraulic Engineering 614.275.1373
 Jeffrey.Syar@dot.ohio.gov

Others Supporting the Problem Statement: TRB Standing Committee on Hydrology, Hydraulics and Stormwater, AKD50. Contact Person: Beatrice Hunt, Chair Principal Hydraulic Engineer, AECOM 212-973-2946 Beatrice.Hunt@aecom.com

Recommended Research Funding and Research Period

The recommended research funding is \$500,000 to accomplish the research objective. This estimate includes lab or flume testing expenses, computer modeling, and travel to up to three sites. Of that total, \$80,000 is estimated for initial activities and to facilitate communication and implementation of research results.

The proposed time period is 27 months to complete the research, plus an additional 6 months to conduct communications activities in support of guideline implementation.

Problem Statement Author

Wayne Gannett, P.E., Senior Water Resources Engineer (for TRB AKD50)
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Potential Panel Members

- Charles Hebson, Ph.D., P.E., Manager Surface Waters Resource Division, Maine Department of Transportation, AASHTO TCHH, Phone (207) 557-1052, Charles.Hebson@maine.gov
- Matthew Lauffer, P.E., C.P.M., State Hydraulics Design Engineer, North Carolina Department of Transportation, AASHTO TCHH, Phone (919) 707-6703 Mobile (919) 621-0443, mslauffer@ncdot.gov
- Julie Heilman, P.E., State Hydraulics Engineer, Washington State Department of Transportation, AASHTO TCHH, Phone (360) 705 7262 Mobile (509)969 3223, heilmaj@wsdot.wa.gov

Person Submitting the Problem Statement

- Brad McManus, P.E. State Roadway Hydraulics Engineer, Georgia Department of Transportation, AASHTO Committee on Design, Technical Committee on Hydrology and Hydraulics. [Phone 470 848 2358](tel:4708482358), bmcmanus@dot.ga.gov

NCHRP Review of B-30

Reviewed By:

Edward T. Harrigan
eharriga@nas.edu

Comments:

This problem is solvable through research. A search in Google Scholar identified only one additional reference (Chelgren, N., Dunham, J., and Hansen, B., Evaluating the Effectiveness of a Culvert Replacement Program – An Approach Based on Sampling the Distribution and Abundance of Aquatic Organisms, International Conference on Engineering and Ecohydrology for Fish Passage, 2013); it describes a modelling approach to investigating the problem. As noted, the problem is consistent with the 2021 Strategic Research Plan of the AASHTO Technical Committee on Hydrology and Hydraulics. It is likely that the results of this research will be value to all the state DOTs.

The objective statement is clear and concise, and the scope is reasonable.

The suggested period of performance is 27 months is reasonable, but the suggested budget of \$500,000 should be increased to \$750,000 to accommodate the cost of the flume studies and the field projects.

Review Date:

12/9/2021

FHWA Evaluation of B-30
Reviewed By:

Buford/HEPE-30

Comments:

The research would be beneficial.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-30
Submitted By:

Patricia Bush
AASHTO staff
Committee on Design

Priority #: N/A

Comments: Endorsed by Committee on Design.

Submitter Response for 2023-B-30From:

[email: bmcmanus@dot.ga.gov]

I appreciate both FHWA's and National Academy of Sciences support of this problem statement. I especially appreciate and agree with Mr.Harrigan's advice to increase the funding recommendation of the problem statement.

Comments:

I agree with the suggestion to increase the budget from \$500,000 to \$750,000 to account for flume studies and field projects as suggested by Edward Harrigan (with the National Academy of Sciences) in his December 9th review.

Contact Info:

Brad McManus

600 W. Peachtree Street, Atlanta, GA 30308

Phone: 470 848 2358

Review Date:

Brad's December 30th comment supporting NAS December 9th review

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-31

Problem Title

Characterizing economically disconnected areas in the era of Artificial Intelligence.

Background Information and Need For Research

Transportation equity has long been a persistent issue that transportation officials have been trying to address for decades. While significant efforts have been made, achieving equity is yet a persistent challenge that may not always be easily realized. Equity in transportation could be related to mobility and accessibility, equal balance of cost and benefits, spatial distribution of costs and benefits, and/or creating opportunities for travelers to make travel decisions. Problems related to these equity aspects often result in creation of economically disconnected areas in cities around the world and in the U.S.

Recent advancements in transportation technologies have resulted in the ability to collect data with unprecedented variety and amounts (Big Data) which can be leveraged to improve mobility, safety, and the environment. Yet, whether and how such data could be best utilized to address the equity problem remains an unanswered question. For example, lack of transportation service in many areas, especially the suburban and rural areas, may lead to unintended biases when analyzing the transportation system behavior.

Advanced data analytics and artificial intelligence (AI) have offered ample opportunities to address data scarcity and associated equity issues. AI techniques can help to effectively extract and understand structure and patterns underlying the data and make robust inferences for future conditions and trends. With these capabilities, it is envisioned that AI can help analyze effects of previously implemented strategies to address a variety of equity issues related to transportation safety, mobility, accessibility, affordability, resiliency, and recreation. In essence, this research aims to address the following key questions:

- 1- What data is available that can be used to address the equity in transportation? What data gaps need to be addressed? What traditional and untraditional sources can

help close these gaps? What methodologies and techniques should be implemented to collect these data?

2- How can these data be used to identify economically disconnected districts?

What are the characteristics (socioeconomic, transportation system related, etc.) that should be used to identify these districts?

3- What system-wide strategies have been and should be implemented to close the gaps?

4- What tools could be used to empower economically disadvantaged groups to close the equity gap (provide more “personalized” resources) at the individual level?

5- What framework should be adopted to inform decision makers based on lessons learned from Question 3 above? How the public and private stakeholders could be effectively involved and collaborate within this framework? How could this framework be resilient and adaptable to mega-level events such as COVID-19 to ensure equitable access to diverse opportunities?

It is expected that the research team will leverage advanced analytical techniques and emerging AI technologies [data fusion of structured and unstructured data, predictive analytics, pattern recognition, etc.] to address the research questions above.

Addressing these questions will result in an effort that will align with the goals of the AASHTO Committee on Planning to “Promote a multi-disciplinary planning process that encourages State DOTs to define a long-term vision; establish a framework for system and project-level actions; integrate the perspectives of the many and varied stakeholders across modes, sectors, and jurisdictions; and promote an alignment between vision and program implementation”, and “Support State DOTs in the understanding and use of models, tools, analysis techniques, methodologies and professional development that are important in implementing a multi-modal transportation planning process”.

Literature Search Summary

Transportation planning decisions often have significant equity impacts. Particularly due to the emergence of new technologies and transportation services (such as transit, automated vehicles, electric vehicles and charging stations, ride-share services, and connected vehicle environments), transportation equity issues have brought a significant attention to policy makers. In fact, recent studies noted that the benefits from such consumer-facing technologies are usually not fairly distributed among population groups, leading to equity issues. A comprehensive review of literature on the TRID database and other databases showed that while significant efforts have been directed to address the equity issue, such efforts were mostly directed on the policy side. Whether other approaches were investigated, including extracting indicative measures using advanced data analytics and AI from past experiences, was not part of the driving

force for such policies. The National Academies Press's Report on the 2019 Critical Issues in Transportation identified equity as one of twelve areas with pressing needs. Additionally, the report indicated that artificial intelligence may offer an opportunity to "guarantee significant future changes and benefits". Therefore, the targeted research herein aims to investigate how AI tools can help guide an effective decision-making process to help address the transportation equity challenge.

Research Objective

The objective of this research is to develop a comprehensive framework that can be used by departments of transportation, metropolitan planning organizations and municipalities to address transportation equity issues in their jurisdictions. The framework should (I) provide science-driven methodologies to identify and diagnose the causes of transportation equity issues and characterize economically-disconnected districts in urban areas; and (II) provide a tested process that can be used by the different stakeholders to develop comprehensive plans to address transportation equity issues in their jurisdictions. Accomplishment of the project objective will require working on at least the following tasks.

Task 1. Provide a comprehensive literature review on transportation-related equity issues in urban areas and their adverse social and economic consequences. The survey is expected to provide a categorization of the different equity issues with respect to for example, mobility, accessibility, safety, environmental quality, and recreation. Additionally, the review should cover transportation system-based strategies (e.g., information systems, public transportation, toll subsidizing, carpooling, shared-economy mechanisms, etc.) that were successfully adopted to address transportation equity in urban areas.

Task 2. Develop science-driven methodologies to identify equity issues and characterize economically disconnected districts in urban areas. The task should identify data requirements and describe the sources and methods to collect this data.

Task 3. Validate the methodologies developed in Task 1 by demonstrating how they can be used to diagnose transportation equity issues and characterize economically disconnected district in at least two different urban areas.

Task 4. Develop an AI-based process that can be used by the stakeholders to construct a comprehensive plan that integrates a subset of the strategies identified in Task 1 to address transportation equity issues in their jurisdictions. The process is expected to account for possible synergies and conflicts among these strategies, their cost of deployment and how they contribute to equity goals defined for each jurisdiction.

Task 5. Demonstrate the application of the process developed in Task 4 for at least two different urban areas (testbeds) and illustrate - using appropriate predictive modeling techniques - the effectiveness of the integrated plans developed by this process.

Urgency and Potential Benefits

State and local DOTs are facing increasingly challenging problems in transportation operation, management, and safety. The recent literature shows that AI and ML tools present unique opportunities to address many of those complex problems and issues. AI research in transportation has advanced recently at an unprecedented rate and will continue to shape the future of transportation research by offering more effective solutions to unique transportation problems in many areas. Yet, as we brace for a new intelligence revolution wherein AI and ML will play a significant role in decision support systems, it is not clear to State DOTs what implications and opportunities AI will have on critical issues such as transportation equity, fairness, diversity, policies, workforce development, etc. This research needs statement highlights the importance and potential of addressing these issues with AI tools. This will ensure that State DOTs are well prepared for and have enough understanding of the potential implications of AI in the broad transportation domain.

Implementation Considerations

The planning divisions of state DOTs and MPOs will likely be the direct users of the results and products generated from this research. The goal of the project is to help state DOTs and MPOs to adopt practical data-driven procedures to incorporate due equity considerations into their long-range transportation planning process. The AI-based framework developed from this research is expected to be generic and flexible to capture equity aspects at different spatiotemporal scales to ensure transferability. This will help to facilitate adoption at the state level by considering the availability of data and computing resources, which may vary significantly across states. To guarantee successful implementation of the anticipated products from this research, state DOTs will need to identify and leverage their existing data sources. Data exchange and fusion from related divisions within state DOTs and MPOs are anticipated. Data sources from the private sector may be required depending on the desired level of sensitivity.

Recommended Research Funding and Research Period

Consistent with other recent framework development efforts under the NCHRP program, the recommended research fund to perform this research is \$650,000, including \$635, 000 for accomplishing the research objectives and \$15,000 for online surveys required to collect the data required for the research. The recommended research period is 36 months.

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Person Submitting The Problem Statement: Name, affiliation, email address and phone.

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NCHRP Review of B-31

Reviewed By:

Jennifer L. Weeks
jlweeks@nas.edu

Comments:

NCHRP has several ongoing projects related to identifying and documenting equity needs by the industry that will benefit this project. There is substantial overlap with that part of the scope that is focused on identifying inequities. AI and ML are not part of any current NCHRP equity-related research.

One thing that should be considered by this research are efforts to solicit the perspective of leaders of national, state and local organizations on the definition of equity as well as indicators of equity (or lack thereof) that could inform this research. This type of "self-reported" data collection would ensure that the perspectives of the targeted populations are appropriately identified and reflected in the research that is conducted and the processes, procedures, etc that come from it for implementation.

The problem statement assumes that AI and ML will be good tools for facilitating equity in transportation decision making, but that should perhaps be a foundational issue to address; determining if AI has its own built in inequities should be considered. If these issues are addressed as a precursor to the research being proposed, this smaller project could be accomplished for \$300,000 in 24 months.

Review Date:
12/15/2021

FHWA Evaluation of B-31

Reviewed By:
Faith Hall/HEPH-10

Comments:

We see benefit in this research. The effort could benefit from changes to the scope and a reduction of funding commensurate with borrowing substantially from other literature reviews focused on "equity analysis." The proposal makes a potentially valuable connection in ensuring that "equity analysis" has a place at the AI/ML table. It is important to explicitly include an equity perspective and considerations of bias as we develop and test new analytical tools. It would be helpful to include a tangible example of how AI/ML techniques have been applied to improve decision making in a different sector.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for B-31

Submitted By:
Chad Baker
Research Subcommittee Chair
Data Management and Analytics

Priority #: 12

Comments:

The research is actually focused on bias in approach of assessing transportation equity and not on use of AI.

Submitter Response for 2023-B-31**From:**

[email: Julius.codjoe@la.gov]

Comments:

Response to FHWA comment: We agree with the reviewer's suggestions to reduce the scope and evaluate funding needs accordingly. Past and ongoing relevant projects can be referred to in the final version of this problem statement if approved for funding. Additionally, the issue of equity in AI, or ethics in AI relevant to the transportation equity application, is a focus in this work that can be further pointed out along with examples from different sectors in the final version of the statement.

Response to NCHRP comment: We agree with the reviewer with the detailed assessment. We plan to address these comments in a final version of the statement as follows: (1) a task can be added to request researchers to perform a detailed survey/review of current NCHRP work relevant to equity as well as AI, such as the AI roadmap work; (2) a task will be added to request conducting a well-designed survey to engage key stakeholders and solicit their input to guide the proposed work better; and (3) the statement could have a task to explore ethical issues in AI which has long been under research in many sectors other than transportation.

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Review Date:

2/8/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

Problem Number: 2023-B-32

NCHRP Problem Statement Title:

Improving Supply Chain Visibility for Agricultural Commodities Using Artificial Intelligence

Background

The movement of agricultural products is a critical international, national, statewide, regional and local multimodal transportation sector. Agricultural commodities originate from local farms and travel across state boundaries destined for domestic and international markets to supply diverse demands. The supply chain management of agricultural commodities is increasingly complex because fresh food is perishable, demand is highly variable, and lead times are uncertain. Furthermore, these commodities depend on stochastic environment factors such as climate conditions, transportation modes, processing methods, along with packaging, transportation, and storage conditions.

Other extraordinary challenges facing the agriculture industry include changes in consumer income and preferences that have resulted in more expensive supply chains. Supply chains are expanding to include many complex and innovative components (ex. big data, machine learning), controlled by numerous independent stakeholders (distributors, producers, state agencies), and designed to serve diverse customer segments. For example, identity preserved (IP) commodities such as grains organic meats and produce are increasing in popularity with global populations, including socioeconomically disadvantaged residents seeking healthier dietary options. However, IP commodities require systems of production, handling, documenting, certifying, marketing, and monitoring at all stages to ensure product quality and integrity that results in additional costs. All the transactional information must be collected, coordinated, and distributed to the right people at the right time to trigger the right actions. Manually performing these complex, time-sensitive interactions is inefficient, unfeasible, and can be better facilitated using ‘smart contract’ blockchain technology and artificial intelligence (AI). These state-of-the-art technologies can be utilized to improve efficiency and smoothen the flow of grain at each point in the supply chain.

Buyers are perpetually confronted with challenging decisions when placing food commodity orders and often enter a vicious “bull-whip effect” cycle in which their produce spoils and they run out or run low, then they over-correct by over-ordering, and that produce also spoils because it does not sell fast enough. AI coupled with blockchain technologies can assist in calculating more accurate forecasts and compute economic order quantities resulting in orders placed for the right amount or number of commodities at the right time.

Examples of this effect are the market disruptions resulting from the Covid-19 pandemic on the global and U.S. food supply. Before the pandemic, the food supply chains were more stable, and produce arrived at its destination just in time. However, as the pandemic commenced, customers started “panic buying,” creating a spike in demand for certain commodities followed by an extended and unexpected lull in demand. Further, plant worker illnesses and plant shutdowns in the food processing industry created a bottleneck at the packaging and processing plants resulting in colossal waste (euthanatizing oversized hogs, chickens, cattle) and a shortage of meat despite the availability of livestock and the increased demand at stores.

A sensing system based on blockchain technology provides supply chain visibility solutions that can help connect and synchronized the food supply chain to track the cause of waste, while also assisting buyers in monitoring transportation processes to predict realistic shelf-life based on data, determining the optimum condition for the food, and ensuring lead-times are adequate to get the commodity to the consumer.

Food storage and transit also present supply chain challenges as conditions must be continuously monitored and maintained at favorable conditions. Artificial Intelligence with IoT and blockchains can enhance quality assurance by monitoring and controlling parameters while in storage and transit, such as humidity, light exposure, ventilation, and temperature to maintain agricultural commodity shelf-life, food safety, and ensure that the commodities reach the end-user in a satisfactory state.

Improving Supply Chain Visibility for Agricultural Commodities Using Artificial Intelligence research includes database and expert system development for optimal grain storage and will result in transparent supply chain management and optimization of trucking drayage and railroad contracts that can be utilized by other agricultural commodities including fresh food. Advanced machine learning algorithms can be designed to quantify the effects of available train frequency and velocity, truck and rail drayage data, demand changes at grain elevators, and price of grain in domestic and international markets. This research is vital for assisting stakeholders in choosing the right market and right time to sell their commodities. Therefore, the resulting expert systems designed with the support of AI will monitor all factors that affect the quality and condition of the grain and other commodities during the entire supply chain.

Current Status of the Technology

Alarming Statistics:

Dallas-based technology company Symphony Retail AI has revealed.

- 43 percent of grocers are challenged by lack of real-time inventory visibility
- 48 percent of grocers rate their forecasting technology from very poor to average
- 43 percent of retail supply chain professionals say their technology can't keep up with business demands
-

There are additional challenges with food exports and its tractability when shipped overseas.

Literature Search Summary

An online web search for “Agriculture Supply Chain Visibility Using Artificial Intelligence” resulted in several reports and articles regarding the technology developments and benefits of AI for supply chain visibility using. AI has been shown to improve supply chain visibility and transports good more efficiently. However more research is needed for effective implementation.

In a report of data-driven agriculture supply chains, the findings found that information collection and sharing is highly valuable and beneficial for a supply chain to remain competitive, address challenges of food perishability, demand-supply variations, safety, and sustainability (Kamble et al 2020)²⁶. This is dependent on accessibility to high quality data.

There has not been significant research on the efficient implementation of a digitized supply chain across an agricultural market to improve supply chain visibility. According to a white paper by Frost & Sullivan, in partnership with IBM,

- 84% of Chief Supply Chain Officers stated that “lack of visibility” across their supply chain was the “biggest challenge” they are currently facing.

Research Objective

1. Summarize existing AI technology for improved supply chain visibility for agricultural commodities
2. Identify challenges/barriers to implement AI in supply chains and distinguish between:
 - a. Urban and rural challenges including equity
 - b. Challenges for small farmers
 - c. AI for producers vs. consumers vs. distributor
3. Assemble case studies to identify transport efficiency gains and business savings of successful implementation of AI for supply chains, including the use of blockchain technology and IoT.
4. Utilizing AI, IoT, and blockchain to develop the supply chain of the future
5. Develop recommendations for effective implementation of AI for interstate agricultural transportation markets including:
 - a. Resiliency for emergency events including Covid-19
 - b. Congestion and bottlenecks at various stages of the supply chain
 - c. Rural and Urban

Urgency & Potential Benefits

The urgency for improving freight supply-chain efficiency is extremely high, particularly given widespread challenges in the U.S. that have negatively impacted producers, shippers, manufacturers, and consumers everywhere. Many of the challenges being experienced today and over the past 1.5 years could be mitigated with better information systems and visibility, to allow improved decision-making by participants throughout the supply-chain. The potential benefits include:

²⁶ http://agri.ckcest.cn/file1/M00/0F/A7/Csgk0F4oCMeAbz3xABM8_eyy10o901.pdf

- Reduced delivery times
- Improved equipment utilization
- Reduced energy utilization, increased environmental benefits (air quality)
- Lower transportation cost
- More effective planning and coordination with public transportation system
- Improved safety
- Improved system performance

Estimate of Problem Funding and Research Period

- **\$400,000**
- 18 months

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NCHRP Review of B-32

Reviewed By:

Camille Crichton-Summers
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Comments:

Research related to the use of artificial intelligence with IoT and blockchains in transportation is emerging. New goods tracking technologies that can increase agricultural goods transport efficiency, minimize truck delivery conflicts, increase safety, and aid in system resilience post disruption are needed. This topic will be of interest to a diverse group of stakeholders involved in agricultural goods movement especially given the supply chain disruptions during COVID-19. The budget is reasonable but the project timeframe should be increased to 24 months.

Review Date:

12/17/2021

AASHTO Committee Evaluation for B-32

Submitted By:

Caroline Kieltyka
AASHTO staff
Special Committee on Freight

Priority #: 10

Comments: N/A

Submitter Response for 2023-B-32

From:

[email: scott.luekenga@itd.idaho.gov]

Comments:

Per NCHRP comments, increase of project time frame from 18 to 24 months is acceptable.

Contact Info:

Scott Luekenga

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Freight Program Manager

Highway Development Planning Service

Idaho Transportation Department

Review Date:

December 22, 2021

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-33

Problem Title

Improving Resilience to Multiple Interacting Crises and Cascading Failures

Background Information and Need For Research

In 2020 and 2021, we faced many short-term and extreme weather driven natural disasters (e.g. wildfires, drought, hurricanes, heavy rains, floods, heat, strong winds, and cold snaps), while dealing with the COVID-19 pandemic and long-term effects of climate change. These frequent drivers for multiple interacting crises can disrupt transportation systems potentially leading to interacting and cascading inter-modal and supporting infrastructure failures (e.g. electric grid, telecom, cyber-security, water supply). The impacts of these weather crises and near-system failures impacted all levels of government (Federal, state, regional, and local) rippling nationally through populations, communities, and supply chains. For example, in 2020-21, COVID-19 inhibited hurricane evacuation necessitating non-congregate sheltering and longer, riskier, and more expensive evacuee relocations. Western wildfires closed roads disrupting travel and supply chains, inhibiting fire-fighting equipment fueling, impacting regional air quality, and setting-up for future landslides.

Complementary research is needed to identify, understand, and provide recommendations for how to improve transportation asset management and planning in the context of long-term risks that climate change and weather are driving across intertwined systems. Additionally, the post-COVID-19 context has altered social, economic, and policy behavior. Research is needed to 1) determine key points of failure among and between critical infrastructure, transportation modes, and supporting systems; 2) understand feedback loops from local to state to regional scales, especially among dependent systems and for supply chains; 3) find entry points for interventions to reduce key weather and climate vulnerabilities between and across assets and systems; and 4) learn how to plan and prepare in advance to prevent or mitigate cascading failures that climate and weather events may cause. Using analysis of post-COVID-19 and supply chain impacts also could provide a vehicle for understanding specific systemic issues applicable to needed near-term responses. In sum, the goal is increasing overall systems resilience through understanding system interconnections incorporating new conceptualizations of systems resilience and interactions that may not have been previously explored.

This research aligns with scope of the AASHTO Committee on Transportation System Security and Resilience (CTSSR), which covers preparation for and response to both natural and human-made threats, shocks and stressors to the transportation system, and the TRB AMR50 Standing Committee on Extreme Weather and Climate Change

Adaptation, which “addresses issues and hazards related to extreme weather and climate change. The committee works with all modes of transportation through policy, planning, research and technology innovation, and rethinking current transportation infrastructure development, operations, and maintenance.”

Literature Search Summary

A cursory search found a limited amount of literature, especially for transportation. TRID shows about 10 related articles. Some research groups and Federal grant programs are pursuing this topic, particularly focused on systems and risk modelling (e.g. the Resilient Infrastructure as Seas Rise (RISeR) project, supported by the National Science Foundation (NSF) Critical Resilient Interdependent Infrastructure Systems and Processes (Critical Resilient Interdependent Infrastructure Systems and Processes 2.0 FY18 (CRISP 2.0) (nsf18523) | NSF – National Science Foundation).

This RNS touches on common themes from other completed and active NCHRP studies with objectives of improving transportation resilience, including operations and planning, intermodal and systems interdependencies, emergency and risk management, climate and all-hazards resilience, and integrating research into practice, also focusing on climate and hydrology, asset management, project design and delivery, recovery, and supply chains.

However, this RNS complements and builds on these other active or anticipated resilience studies. It pulls together a different and needed focus on multiple crises and cascading failures, and intermodal and dependent systems. It also focuses on a longer-term climate perspective, slicing these problems in unique ways—including linking extreme weather and climate timescales; incorporating deeper climate impacts knowledge and spatial-scales into long-term planning; blending planning, O&M, and asset risk management; and looking at systemic interactions of modes, dependent systems, and multiple crises as an antidote to cascading failures.

Research Objective

The research objectives are as follows:

- Identify, understand, and provide recommendations for how transportation systems can increase capacity to manage and respond to extreme weather and climate crises occurring simultaneously or in conjunction with other crises (e.g. COVID-19);
- Determine points of criticality among and between modal assets and supporting systems (e.g. electric grid, cyber and telecom, supply chains);
- Identify feedback loops from local to state to regional scales of impacts and crisis that may cause cascading failures across populations, communities, and supply chains; and
- Determine entry points for interventions to reduce key vulnerabilities via policy, planning, operations, and maintenance.
- Analyze Covid-19 and supply chains as vehicles for exploring systemic vulnerabilities, potential failures, and interventions.

The desired outcomes and expected final products are as follows:

- increased consideration and interaction of AASHTO and TRB Committees on this topic – including annual Policy Forum topic, and possibly new ad hoc group, or standing committee
- improved understanding by the transportation community of climate and weather observations, data, modeling, and decision support tools available from the climate research community
- compendium of current research and best practices, especially applying systems risk management from other sectors (e.g. electric grid)
- illustrative analysis and case studies from representative regions, states, or agencies
- development of methodologies and guides

Major tasks or activities the research contractor will likely have to perform toward successfully conducting the research include the following:

- Literature review and compilation, including from past/active TRB studies and reports
- Series of interdisciplinary Committee Workshops and interviews across modes to compile expert judgement, including from outside the transportation community who manage interdependent systems on which transportation relies (e.g. electric grid), public health (e.g. COVID-19 and COVID-19 response expertise), perform disaster preparedness and recovery, and model complex adaptive systems
- Compendium production, including developing any useful case studies
- Potential to focus cases (and overall report) regionally covering specific climate and weather hazards specific to particular parts of the country instead of nationwide
- Climate and weather information and decision support guidance and training for the transportation sector

Research results may be presented in forms that may include, but are not limited to, guidance or guidelines, a test method, equipment, a tool, specifications, a manual, a new or revised process. Products may include reports, guidance, best practices, decisions support tools, guides, trainings, webinars, and workshops.

Urgency and Potential Benefits

Given the interdependencies and complexities of current transportation systems and modes nationwide, coupled with COVID-19 limits on safe responses with constrained resources, and the arrival of climate tipping points driving extreme weather events, the time is now to explore this topic for all DOTs, especially in a post-COVID--19 environment experiencing new supply chain vulnerabilities that COVID-19 and weather and climate related natural disasters have highlighted.

Failure to explore this topic means that DOTs will be less prepared for these emerging crises, to prevent cascading failures that inevitably will arise, and opportunities will be missed to improve overall systems resilience.

Besides proving the value of current investments in preparedness leading to avoided future costs, and the benefits of improving decision making for system risk management, increasing overall systems resilience has advantages both measurable and intangible.

Implementation Considerations

Although valuable across multiple modes and business units, planners, asset managers, risk managers, and policy decision-makers likely will benefit the most. However, it is essential to involve operations and maintenance personnel to bridge short and long-term management scales in developing agency-wide policies.

States with emerging resilience positions and programs will be best able to pursue and take advantage of this research, so building this capacity across all DOTs should be part of the backdrop to the research process.

Various DOTs including, but not limited to California, Colorado, Florida, Hawaii, Michigan, Maryland, Massachusetts, Minnesota, New York, North Carolina, Pennsylvania, Texas, and Virginia, are pursuing resilience planning and preparedness statewide or in their transportation agencies. State-level transportation organizations like AASHTO also are beginning to emphasize the importance of systems resilience with a plethora of studies completed or going forward at this time. Additionally, system resilience, especially in the face of climate change is becoming a priority for numerous organizations including built infrastructure, electric grid, telecom, cyber-security, water, and transportation and supply chain professionals, among others who are “asking the climate [or resilience] question”.

Likely products could include systems models supporting general and ad hoc decision support tools. Dissemination and training on these tools could follow.

This research project has the support of the AASHTO Committee on Transportation Systems Security and Resilience (CTSSR) and TRB AMR50: Standing Committee on Extreme Weather and Climate Adaptation, and both committees can be avenues for implementing research results.

Recommended Research Funding and Research Period

Research Funding:

- \$25,000: Literature review and compilation
- \$100,000 (remote or in-person): series of interdisciplinary Committee workshops and interviews across modes to compile expert judgement, including experts from outside the transportation community who manage interdependent systems on which transportation relies (e.g. electric grid), perform disaster preparedness and recovery, or model complex adaptive systems
- \$50,000: compendium guide production
- \$75,000: developing research-based case studies
- \$100,000: trainings

TOTAL = \$350,000

Research Period: 24 months

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

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Maryland Department of Transportation

Office of Environment, HQ

Committee on Transportation System Security and Resilience

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Maryland Department of Transportation

Office of Environment, HQ

Committee on Transportation System Security and Resilience

NCHRP Review of B-33

Reviewed By:

Leslie C. Harwood

LHarwood@nas.edu

Comments:

The objectives of the research are clear and the timeline is appropriate to conduct the proposed project. As one outcome is to produce method(s) and guide(s) with regard to climate and weather information and decision support, the proposed budget for production of the compendium/guide seems low and therefore I suggest that the budget be increased to \$400,000. I agree with the commenters from FHWA that there may be

confounding issues surrounding COVID-19 which could overshadow infrastructure-related dependencies and, if funded, the researchers will need to be careful that there is not an over-emphasis on those particular simultaneously-occurring crises.

Review Date:
12/17/2021

FHWA Evaluation of B-33

Reviewed By:
Rebecca Lupes, Rob Kafalenos - HEPN-30

Comments:

This is a timely and useful study. We would caution against putting too much weight on analysis of post-COVID-19 and supply chain impacts lest freight issues overshadow the broader critical infrastructure-related dependencies of this research related to electric grid, telecom, cyber-security, and water supply and concurrent events and stressors including natural disasters and climate change.

Review Date:
December 17, 2021

Submitter Response for 2023-B-33

From:
[email: jfooster@mdot.state.md.us]

Comments:

I want to thank reviewers for their comments. I agree including Covid and supply chain analysis may dilute the study. Covid topic was included not only because of timeliness and to differentiate study from others, but also because the Covid pandemic has sufficiently reshaped our notions of national and global resilience (climate too) that some acknowledgement and assessment of changed context seemed merited, especially long-term impacts. Perhaps a short exploration or case study component would cover issue adequately? I also agree supply chain issues may also dilute study. Again, topic was included because of timeliness and differentiation. But also because author thought supply chain could be used to unify, explore, and reveal certain systemic challenges and to pin-point key points of failure among and between systems impacting resilience using a topic combining critical infrastructure, mobility and modes, and role of human capacity. Again perhaps a brief exploration or case study would cover the topic sufficiently? Author concurs that study would benefit from an increase in budget to \$400,000 which other informal reviewers also advised. Thanks, Josh

Contact Info:

Josh Foster
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Review Date:
12/22/2021

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-B-34

Problem Title

Quantifying deer-vehicle collision rates in response to vegetation management.

Background Information and Need For Research

Nationally, deer vehicle collisions have a significant impact upon roadway safety with fatalities, property damage, and other collateral damage occurring each year. An average of 148 fatalities have been reported nationally each year attributed to deer vehicle collisions (and 6 deaths/year in NYS alone). In relation to property damage, an annual average of 65,000 collisions with white-tailed deer in NYS alone resulted in an average cost of \$4,300 per deer-vehicle collision (DVC). With the significant negative outcomes from DVCs, it is important to know and best control for any changes to design and operations which could affect DVC incident rates.

Many DOTs are implementing altered vegetation management practices within their Rights of Way (ROW) to provide pollinator habitat for declining populations, reduce energy demands, improve stormwater quality, maintain grassland bird nesting habitats, reduce spread of invasive species, and to achieve a myriad of other environmental objectives. To accomplish this, mowing practices are being altered to provide early successional stages of flowering vegetation along the ROW by implementation of 1) rotational mowing so that certain areas are mowed at intervals less frequent than once per year; and/or 2) mowing outside of grassland bird nesting and monarch rearing seasons and per Best Management Practices (BMP)s for these habitats. These practices are expected to result in greater vegetation heights and other differing conditions at these locations certain times of the year.

The initiatives to promote early successional habitats within highway ROW have attracted attention from maintenance staff, traveling public, and resource agencies as to the potential effect of increased vegetation heights on potential DVCs. The true effect of altered vegetation practices upon DVCs has not been significantly researched. This study will quantify DVC rates in relation to vegetation management and vegetated conditions along the roadside. The objective of the research is to determine if there are negative, positive, or no impacts of these practices and conditions on DVC rates. The research is needed to assist DOTs in directing and implementing effective vegetation management practices that best ensure safety objectives to the traveling public and support environmental objectives. The research will assist in effective communication to the public, resource agencies, and DOT staff the effects of altered vegetation management (mowing) on DVC rates.

This problem statement supports the strategic goals of TRB AKR20, Roadside Operations Committee involving roadside maintenance practices and safety and stewardship objectives. The problem statement also supports the objectives of TRB Committee on Environmental Analysis and Ecology (AEP70), and TRB Committee on Landscape and Environmental Design (AKD40).

Literature Search Summary

- Data from Pagany et al. (2020) identifies an absence of wildlife-vehicle collision studies in the northeastern U.S. Guyton et al. (2014) posits that deer were observed most frequently in mowed, lowland areas near streams. However, this study took place in Mississippi and did not quantify the number of DVCs associated with vegetation management practices. Stapleton et al. (2019) linked driving conditions and roadway alignments to frequency of DVCs. From the literature mentioned and included below, there is an apparent need to quantify the effects of vegetation management and environmental factors on DVCs.
- Pagany, R. 2020. Wildlife-vehicle collisions – influencing factors, data collection, and research methods. *Biological Conservation* 251.
- Stapleton, S.Y., Ingle, A., and T.J. Gates. 2019. Factors contributing to deer-vehicle crashes on rural two-lane roadways in Michigan. *Transportation Research Record* 2673(10): 214-224.
- Guyton, J., J. C. Jones, and E. Entsminger. 2014. Alternative Mowing Regimes' Influence on Native Plants and Deer. Report No. FHWA/MDOT-RD-14-228.
- Effect of Reduced Roadside Mowing on Rate of Deer-Vehicle Collisions, Transportation Research Board 92nd Annual Meeting, 2013, 12 p).
- Normandeau Associates, Inc. Deer-vehicle crash, ecological, and economic impacts of reduced roadside mowing – final report. May, 2012. Federal Highway Administration, Washington D.C. 2012.
- Federal Highway Administration. Wildlife-Vehicle Collision Reduction Study: Report to Congress. Report No. FHWA-HRT-08-034. August, 2008.

Research Objective

The objective of this research is to quantify the frequency of DVCs under two primary vegetation management treatments:

- 1) Control - where vegetation is maintained by conventional practices with mowing at least once per year and no timing constraints; and
- 2) Experimental – where vegetation is managed as an “adopted area” with conservation measures including:
 - o Conservation Mowing only outside of monarch development and bird nesting seasons and per Best Management Practices (BMP)s for these habitats
 - o Rotational mowing at intervals less frequent than once per year

Other factors that may influence the DVC rates will also be considered and could include but are not limited to: plant species composition within the ROW; distance of forested area to DVC; roadway infrastructure/design; landcover; and/or any other features identified to affect the relationship of the vegetation management practices and

the rate of DVCs. Data will be collected year-round to evaluate the effects of seasonality as an additional co-variate for vegetation management.

Upon completion of the project, peer-reviewed journal articles, a final report, and guidance for vegetation management as it relates to DVCs will be provided.

Major tasks for completion of the research project include:

- Engaging a research team and developing a detailed scope, schedule, and budget
- Identifying sampling locations that should include multiple states with varying climate/vegetation conditions. Research locations would include “Control” areas with traditional vegetation management practices (conventional mowing) and “Experimental” areas with altered practices during the period of study.

Urgency and Potential Benefits

Deer-vehicle collisions pose significant safety risks to drivers with an average 148 deaths nationally and 6 deaths/year in NYS. Many DOTs are implementing altered vegetation management practices within their ROWs to provide a myriad of environmental objectives. The effect, if any, of increased vegetation heights along the roadside (e.g. pollinator habitat) on DVCs is a critical and urgent concern for state DOTs and other highway agencies to best understand, implement, and communicate their programs to the public, resource agencies, and DOT staff.

Currently, there are few studies quantifying the effects of vegetation management - consistent with early successional habitats - on the frequency of DVCs. Conducting this research will enable DOTs to make informed decisions regarding the implementation of environmentally supportive vegetation management practices, define any safety aspects related to these practices and DVCs (positive or negative), refine practices (if needed), and have information that supports their decisions.

Implementation Considerations

This research will inform DOTs about the potential risks (or benefits) associated with early successional vegetation management practices as it relates to DVCs within our ROWs and provide for best practices for determining the placement of conservational measures at locations along the roadside. This research supports the strategic goals and objectives of TRB standing committees AKR20, AEP70, and AKD40. These technical committees may aid implementation efforts as the study unfolds. Maintenance and environmental staff will primarily be responsible for implementation following the results of this research. State DOTs will implement the information from the results of this research through the development of guidance and policy. Existing collector applications for roadkill (for example, <https://roadkillapp.com/>) may be used to aid DOTs recording deer collisions within study areas. State police accident reports may also be used to supplement data collected by DOT staff.

Recommended Research Funding and Research Period

Research Funding: \$2,000,000 to accomplish the research objective. This estimate includes development of the research process for collection of DVC data by the state DOTs for the research locations, identification, and evaluation of the conditions within the control and experimental areas, evaluation of results, development of conclusions and report, and development of guidance identifying the results and any recommendations for refinements to practices based on the results.

Research Period: 48 months to complete the research, plus an additional 1 year to conduct communications activities in support of results and subsequent publication(s) and guidance.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Christopher Standley, NYS Dept. of Transportation, christopher.standley@dot.ny.gov, 518-485-0367

Laura Greninger, NYSDOT, laura.greninger@dot.ny.gov, 518-457-4469

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Christopher Standley, NYS Dept. of Transportation, christopher.standley@dot.ny.gov, 518-485-0367

State DOT representatives (potential members/friends of AKR20 and AEP70)

FHWA Representative

Pollinator Specialist with Monarch Venture or Xerces

Others TBD

Person Submitting the Problem Statement: Name, affiliation, email address and phone.

Christopher Standley, NYSDOT, christopher.standley@dot.ny.gov, 518-485-0367

NCHRP Review of B-34

Reviewed By:

Ann M. Hartell

ahartell@nas.edu

Comments:

The proposed research addresses a topic applicable in most if not all regions of the country. As written, the project would rely on a number of state DOTs to collect DVC data, with an NCHRP contractor designing the research protocol, conducting the analysis, developing a report and guidelines, and subsequent dissemination. Note that NCHRP research projects are typically 3 or at the most 4 years in duration and data collection at field sites is the responsibility of the contractor. The significant role of state

DOTs coupled with the scope and scale of the proposed research suggests this might be better addressed through a Transportation Pooled Fund study.

Review Date:
12/15/2021

FHWA Evaluation of B-34

Reviewed By:
Bufurd/HEP; Satterfield, Mookherjee/HSA; Brinkly/RC SHD; Tan/HRSO

Comments:

Buford - The research could be beneficial but is too simplified as written. There are many factors that influence DVC and the authors simplify the investigation to roadsides with and without conservation management for pollinators. A more thoughtful approach to DVC is to identify where they occur, evaluate the causes, and develop countermeasures.

Satterfield, Mookherjee, Brinkly, Tan - The research concept has merit, but the scope needs to be broadened beyond deer to wildlife, and possibly beyond mowing to other maintenance practices. The cost needs to be reduced, taking into account available sources and using a phased approach to reduce the risk. The recently enacted BIL directs the Secretary of Transportation to conduct a study of the state of the practice of methods to reduce collisions between motorists and wildlife (23 USC 172). This is due before the panel is convened, so it can serve as the synthesis of practice. Other efforts that overlap, like Rural Safety Center Roadkill Observation and Data System (ROaDS) and NPS activities, should be explored to determine an effective scope, preferably national. We suggest a phased approach with the first step being a pilot that looks at available data (maintenance logs, crash records) to establish feasibility of the larger project. \$250K sounds like a reasonable initial cost.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for B-34

Submitted By:
Kelly Hardy
AASHTO staff
Safety

Priority #: N/A

Comments:

Relatively low priority.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-35

Problem Title

Impacts of E-Commerce on Travel and Land Use Patterns

Background Information and Need For Research

E-commerce (electronic commerce) generally refers to the buying and selling of goods and services over an electronic network, primarily the internet. In other words, it primarily refers to the processes involved in storing and shipping inventory for an online store or marketplace, including inventory management and the picking and shipping of online orders. These transactions occur either as business-to-business (B2B), business-to-consumer (B2C), consumer-to-consumer or consumer-to-business. In 2019, Amazon delivered more than 2.5 billion packages in the U.S. which is approximately 20 packages for every household. As per U.S. Census Bureau, e-commerce retail sales as a percentage of total sales increased from 4.7% in Quarter 1 of 2011 to 13.7% in Quarter 1 of 2021. Of these purchases, an estimated 5 percent are same-day deliveries, which may increase to 15 percent within 5 years. E-commerce retail sales increased from \$46 billion in 2011 to \$215 billion in 2021.

The rapid growth of e-commerce trends seems likely to have transformational impacts on land use and transportation in settings ranging from small cities to intensely urban and large cities. Some of the identified potential direct impacts include environmental risks, safety risks, travel behavior pattern changes, congestion growth and evolving freight demand. Similarly, potential indirect impacts may include changes of land use patterns (locations of warehousing, distribution, and intermodal transfer facilities and jobs), personal travel behavior shifts (commuting, shopping, and recreation), evolving supply chain logistics and property value changes. Other unaccounted externalities might be truck parking shortages, competition for curb space, impacts to brick and mortar retail and policy considerations like local tax revenue streams. With more people choosing same-day or next day shipping, requiring more vehicles and less optimized distribution/routing, the transportation system is being pushed towards technological innovation like drones and automated deliveries as well.

With these trends growing by the day, it is imperative that State departments of transportation (DOTs), metropolitan planning organizations (MPOs), local government authorities, and other public-sector decision makers are increasingly confronted with questions of how to consider the potential consequences that e-commerce may have on urban/regional economic activity, land use, and transportation demand; and how to manage public investments in transportation facilities and services to maintain economic vitality and high quality of life.

The high level of growth and uncertainty in long-term urban e-commerce travel is the biggest challenge. Hence, a comprehensive research approach is needed to identify impacts of e-commerce on the transportation system and land use and strategies to address them. This study is expected to answer how can e-commerce travel trends be incorporated by state DOTs and other public-sector agencies in transportation and urban freight planning, design, and operations.

Literature Search Summary

E-commerce has been well-defined and studied from the private sector point of view. But e-commerce definitions are still not clear for public-sector planning for transportation as well as urban planning and design. Similarly, e-commerce needs to be classified for transportation, economic activity and land-use needs. A comprehensive literature review on this subject will be the foundation of this research. Many studies have speculated the direct and indirect impacts of e-commerce on transportation systems. But, it has been a challenge to quantify them with lack of sufficient data. A meta-analysis of studies on this topic will benefit public-sector agencies to outline areas of improvements in their decision-making. E-commerce is contributing heavily towards changing the personal and freight travel behavior patterns. Normally, revealed, or stated preference household travel surveys and commodity flow freight surveys are the best solutions to gauge these behavior patterns. The study will identify if there are any local or regional surveys being conducted to understand e-commerce impacts and will provide robust recommendations on how we can leverage existing survey mechanisms to bolster our understanding of e-commerce. Other data sources like probe datasets and commercial proprietary sources will be reviewed as well.

Research Objective

Across various other studies and contexts, there is a growing recognition that trends in e-commerce can have tremendous transportation and land use impacts. The current state of practice in transportation lends itself to the conclusion that advances in e-commerce research need to be integrated into planning, design, and operation norms to help account for unforeseen negative externalities. To this effect, research comprising a literature review, survey of stakeholders, and evaluation framework should be undertaken to advance the development of methodologies to plan for e-commerce growth.

1. Define e-commerce and identify types of e-commerce travel; jobs and land use types supporting e-commerce.
 - Survey of existing practices and datasets (land-use, commodity flow and others).
 - Conducting a comprehensive literature review.
 - Standardizing definitions and classification schemes to characterize e-commerce from perspective of transportation and land-use.
2. Identify and examine direct as well as indirect impacts of e-commerce on transportation.
 - Survey of existing practices and conducting stakeholder engagement to identify different impacts. Relevant stakeholders include (but not limited to) residential and

commercial interests, as well as municipal authorities who can speak to e-commerce impacts.

- Standardizing approaches to quantify direct and indirect impacts which can be seamlessly integrated in urban transportation/freight planning and design studies.

3. Development of a theoretical and methodological framework to evaluate e-commerce impacts on transportation and land-use

- Data Needs and Assessment for statistical analyses and evaluations.
- Stakeholder Inputs for empirical evidence.
- Identifying gaps in literature.
- Developing a comprehensive framework or solutions toolbox useful for federal, state, and regional as well as local agencies.

Urgency And Potential Benefits

E-commerce and its supporting technological innovations have drastically changed our daily lives, mostly enhancing our quality of life. However, it is an urgent need for state DOTs and other public agency decision-makers to integrate this reality in transportation planning, operations, and design. Continuing to apply older planning and design guidance, without taking account of major changes due to e-commerce trends, will leave state and local agencies unable to fully respond to negative externalities and unintended impacts of these transportation activities.

Implementation Considerations and Supporters

Any official, such as within a state or city DOT, who is responsible for modeling freight transportation trends or developing and applying policies to mitigate externalities, would benefit from the proposed research results. If this research results in a fully developed framework or solutions toolbox, as proposed above, it can be immediately applied to relevant planning and forecasting activities.

Adoption and implementation of this research would further benefit from training workshops for affected state DOT practitioners and training or peer exchange with city officials to learn about the major findings and how to use the framework/solutions toolbox.

This research needs statement is supported by:

- AT025 - Standing Committee on Urban Freight Transportation, Bill Eisele (Chair), b-eisele@tti.tamu.edu
- AASHTO Special Committee on Freight, Caroline Kieltyka (AASHTO Liaison), ckieltyka@aashto.org, 202-624-8489

Recommended Research Funding and Research Period

Recommending \$400,000 for 24 months of study, toolbox development, and dissemination of findings.

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Makarand Gawade, HDR Inc., (402) 617-5398, Makarand.Gawade@hdrinc.com
 Matthew Reiter, University of California - Berkeley, (512) 627-0952,
 matthew.reiter@berkeley.edu

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Makarand Gawade, HDR Inc., (402) 617-5398, Makarand.Gawade@hdrinc.com
 Matthew Reiter, University of California - Berkeley, (512) 627-0952,
 matthew.reiter@berkeley.edu
 Casey Wells, Texas Department of Transportation, (512) 423-8986 ,
 Casey.Wells@txdot.gov

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Casey Wells
 Statewide Planning Branch Manager
 Texas Department of Transportation
 Casey.Wells@txdot.gov
 (512) 423-8986

NCHRP Review of B-35

Reviewed By:

Trey Joseph Wadsworth
 twadsworth@nas.edu

Comments:

The proposed research is timely would be valuable to state DOTs. Elements of 2023-B-29 should be incorporated. Any workforce or equity considerations should defer to NCHRP 23-13(06) *Assessing the Equity and Workforce Mobility Implications of the Expansion of E-commerce and Direct-to-Consumer Delivery Services*. The research timeline is reasonable. If **2023-B-29** is added, the budget should be increased to \$450,000. If **2023-B-36** is combined into this project as well, budget should be increased to \$750,000. Combining these scopes would prevent duplication of effort and produce a very useful product.

Review Date:

12/14/2021

FHWA Evaluation of B-35

Reviewed By:

Brian Gardner/HEPP; Tamiko Burnell/ HOP

Comments:

Brian Gardner - Regarding time horizon and scale, "planning, design, and operation norms" could cover long term land development, travel forecasting, near term traffic impact analysis, etc. Also, the current scope is vague regarding if the research need(s) are household focused, business-business focused, or freight/warehousing/logistics focused.

Tamiko Burnell - This is a good research statement. As E-commerce continues to grow in urban areas, it is important that new tools be developed to help evaluate the impact of urban freight on communities. The impact of E-commerce on transportation decisions is still a very new area of study and requires research. This research also has the potential to be a catalyst for future tools that can be developed. No recommended edits to the research statement.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-35
Submitted By:

Kyla Elzinga
AASHTO staff
AASHTO Committee on Planning

Priority #: 6Comments: N/A

Submitted By:

Caroline Kieltyka
AASHTO staff
Special Committee on Freight

Priority #: 1Comments: N/A

Submitter Response for 2023-B-35
From:

Casey Wells
Makarand Gawade
Matthew Reiter

Comments:

FHWA commenter noted that the scope is somewhat vague. It is our intention that this research would provide broadly applicable background knowledge for a variety of specific planning needs, including long term land development, travel forecasting, near term traffic impact analysis, and more. Similarly, the scope would cover a wide range of e-commerce processes. The primary intended audience is envisioned to be state and local DOTs seeking to understand freight/warehousing/logistics land use impacts, including those resulting from business-to-consumer (household focused), business-to-business, and potentially consumer-to-business (reverse logistics) freight flows. With this generality in mind, we do not agree with the NCHRP idea to combine this proposal with B-29 or B-36. The present proposal envisions a broad typology of e-commerce types and impacts, while B-29 focuses much more narrowly on a specific freight flow and B-36 addresses one of many possible land use applications.

Contact Info:

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Matthew.Reiter@berkeley.edu

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-36

Problem Title

Land Use Impacts of Storefront Micro-distribution Hub for Freight Logistics

Background Information and Need For Research

- Rapidly evolving e-commerce trends, such as the increased use of urban and suburban storefronts as micro-distribution hubs, is leading to a completely different real estate and land use environment. In addition to affecting cities and local governments, which need to consider how to address these changes, this shift impacts neighboring residences and businesses. The traffic patterns, congestion levels, mode usage, and even parking near existing land uses may change significantly due to this new pattern.
- Focused research on this topic would help to quantify how many locations are finding this new double use, how much freight traffic has changed in the vicinity, the extent to which modes have shifted as a result, and who is most directly or severely impacted. While to a large degree this is a local concern, understanding these patterns will help to inform more accurate regional and statewide freight models.
- These effects are more dramatic in the era of Covid-19. E-commerce has increased significantly, leading to more micro-hubs and other types of innovative freight-related facilities. In addition, an increase in suburban population as residents seek space and access to outdoor amenities has further complicated the freight landscape. Research into these trends is needed.

Literature Search Summary

Existing research already describes trip generation and distribution, including freight generation, for a wide range of land uses. However, given the segregation of land uses that has been the norm for decades, a retail storefront that also doubles as a small-scale distribution center is an unconventional use, and it is unclear how to classify it for purposes of trip generation estimates. Moreover, the perception of the people towards the micro-hub (e.g. increase of activity due to the micro-hub may create disturbance for the people living in the neighborhood) is absent in the literature, which is essential to select the proper place for establish a new micro-hub in an area. The proposed research would add to the existing knowledge by adding guidelines to determine what category such a facility would fit into and how many trips predictions will be generated from the facility.

Research Objective

The objective of this research is to identify the defining characteristics of a storefront/micro-hub facility; specify a methodology for estimating freight trip generation for such a facility; and describe case studies illustrating how these trips impact surrounding residential and business uses.

Major research tasks for this project may include the following:

- Conduct a survey of stakeholders to understand freight patterns
- Conduct observational count of freight or commercial vehicles associated with various sizes and locations of micro-hubs, including any innovative modes such as e-scooters or bicycles
- Data analysis to develop estimated trip generation parameters
- GIS or similar analysis to identify trends regarding location choice of new micro-hubs. Do they tend to be in business or residential areas? What are the demographics of these locations?
- Conduct a survey of people who live near a micro-hub to understand the perception of developing a new hub

Research results should be presented as a proposed new trip generation table, comparable to those that already exist for standard land uses in Institute of Transportation Engineers (ITE) manuals. This should be accompanied by a narrative describing case studies that illustrate current trends and validate the proposed methodology. Ideally these case studies will highlight any relevant distinctions, for example between small and medium-sized hubs, or between urban and suburban locations.

Urgency and Potential Benefits

The emergence of these innovative freight facilities has both local and state-level impacts. This research will help state DOTs to understand evolving freight flows, including identifying locations of likely congestion and environmental impacts. Ignoring this problem is likely to lead to an increasing number of freight movements that are poorly understood and unreliably accounted for, thus harming the ability of state DOTs to correctly model freight in large regions of their states.

Primary beneficiaries of this research, in addition to academics who wish to understand emerging freight trends and DOTs that are modeling freight movements, will be residents and businesses near emerging micro-hub land uses. A better understanding of current and emerging freight-related impacts will help to mitigate externalities facing these residents.

Implementation Considerations and Supporters

The most immediate opportunity to implement these research findings would be within a large-scale freight model, so the modeling group is the most immediate candidate to use the results of this research. Some findings may be directly usable as inputs to an updated freight model. Alternatively, the research findings would spell out how state DOTs can collect information related to micro-hubs to make their own updates to existing freight models.

Because this is an important local issue, coordination with city and county level agencies would also be highly beneficial, for example via training workshops or data sharing arrangements. This would enable municipalities to incorporate the research methodology into their local models and mitigate block- or corridor-level congestion and environmental

externalities. In turn, these localities could share their findings back to the state DOT to improve high-level freight modeling as real-world conditions continue to rapidly evolve.

This research needs statement is supported by:

- AT025 - Standing Committee on Urban Freight Transportation, Bill Eisele (Chair), b-eisele@tti.tamu.edu
AASHTO Special Committee on Freight, Caroline Kieltyka (AASHTO Liaison), ckieltyka@ashto.org, 202-624-8489

Recommended Research Funding and Research Period

Recommending \$350,000 for a 24-month period.

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Matthew Reiter, University of California - Berkeley, (512) 627-0952, matthew.reiter@berkeley.edu

Limon Barua, University of Illinois - Chicago, (312) 292-7191, lbarua2@uic.edu

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Please contact Caroline Kieltyka at ckieltyka@ashto.org for potential panel member contact information.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Casey Wells
Statewide Planning Branch Manager
Texas Department of Transportation
Casey.Wells@txdot.gov
(512) 423-8986

NCHRP Review of B-36

Reviewed By:

Trey Joseph Wadsworth
twadsworth@nas.edu

Comments:

The proposed research could be valuable to state DOTs. However, this topic seems to be a sub-topic of what is proposed in 2023-B-35 and would be best addressed if both were combined with 2023-B-29 for a single project. This would prevent duplication of effort since they are highly related to each other.

Review Date:
12/14/2021

FHWA Evaluation of B-36

Reviewed By:
Burnell/HOFM

Comments:

This is a good research statement. The increase and change in freight flows has a direct impact on how transportation decisions are made. Therefore, it is important that transportation decisions be supported by the most current data and models. No recommended edits to the research statement.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for B-36

Submitted By:
Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A

Comments:

Relevant resource: Urban Freight Lab launches sustainable last-mile delivery project | UW Civil & Environmental Engineering (washingtton.edu)
<https://www.ce.washington.edu/news/article/2021-06-24-zero-emissions-delivery-pilot>

Submitted By:
Caroline Kieltyka
AASHTO staff
Special Committee on Freight

Priority #: 3

Comments: N/A

Submitter Response for 2023-B-36

From:
Casey Wells

Matthew Reiter
Limon Barua

Comments:

FHWA comment:

We would like to express our gratitude to the respected reviewer for his/her overall positive view of our research statement.

NCHRP Review of B-36:

We thank the reviewer for the suggestion. We agree that the problem statement 2023-B-35 is linked to this research statement. However, research on the Storefront Micro-distribution Hub is still in its early stages and would benefit from more focused research attention. Some of the Micro-distribution Hub concerns may be separate or different from traditional e-commerce issues. If the two problems are studied individually, it may benefit each project. The present research proposal could achieve more detailed knowledge of one very narrow strategy, that of Storefront Micro-distribution Hub, while 2023-B-35 would provide a broader overview of how this connects to other e-commerce issues. Insights that aid in the effective merging of the two topics can be discovered by working in parallel on these subjects.

Contact Info:

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Review Date:

2/2/22

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-37

Problem Title

Methodologies and Measurements of Urban Freight Resiliency Under Emerging Next Normal

Background Information and Need For Research

Resiliency refers to the rate of action in implementing countermeasures in response to disruptive events, which could be due to natural events or man-made, and of which we could have some forecast of or none. To this effect, in urban freight transportation, it often relates to developing strategies to mitigate its short-term and long-term impacts on the economy and population of a region. This requires transportation planners and policymakers to identify and understand the leading indicators of freight movement to develop strategies to mitigate its impact. Resilience, however, means nothing without being able to identify problems in real time and acting on them quickly. Quick and responsive assessments of supply chain are becoming necessary. While short-term fixes are a necessity, the “New Normal” will be established in the long term and is the biggest challenge. Therefore, a comprehensive research approach is needed to address urban freight resiliency over the long term in presence of high degree of uncertainty. This study will contribute to past research on freight disruptions by focusing on new methodologies and measurements of urban freight resiliency.

Literature Search Summary

Recent studies on improving freight resiliency during disasters have revealed how thinking beyond resilience creates opportunities for smarter supply chain and logistics decisions in the new normal. According to the U.S. Department of Labor, 43% of freight-related businesses experiencing disasters never reopen. Further, approximately 29% of businesses that are able to reopen after a disaster go out of business within two years. As a result, business resumption is a major issue in resilience management. Historically, the focus has been on examining the immediate concerns rather than the complete picture of all the factors that keep a business in operation. The above statistics further reinforces the need to look beyond the immediate impacts, importantly it calls for understanding the differential impacts across businesses, commodities, transportation mode. These aspects could be valuable inputs to the development of resilience strategies, which might not necessarily be confined to planners and policy makers but could as well include other stakeholders.

In this context, urban and regional economists, planners and engineers work with state and federal transportation agencies on periodic disruptions to the urban freight systems from a range of inevitable natural and human-caused events (Renne, et al. 2020). However, the vulnerabilities of economic and technological systems are not yet

completely understood. This is because, freight disruptions have far reaching consequences and affects a diverse array of stakeholders. It is often difficult to define and quantify the impact from such adverse events across them both in the short term (e.g.: lack of access to commodities) as well as long term (e.g.: business closures). Ninety-two percent of the states (Flannery, Pena, and Manns, 2018) reported having no specific resilience metrics in place for freight transportation. This being said, select urban transportation entities have working definitions of resilience, and few have resilience metrics as well. A variety of possible metrics have been suggested and tested (Parkany & Ogunye, 2016, NAP 2016; NCHRP 20-125; NASTRB, 2021) aligned along the four components of resilience outlined by robustness, redundancy, resourcefulness, and rapidity.

Research Objective

There are several areas that require additional research. First is to undertake a survey across agencies to understand the extent of resilience measures and preparedness for unforeseen disruptions. This is of utmost importance given the growing rate of disruptions resulting from natural and man-made disasters. The second objective is to evaluate the state of the practice, in terms of the strategies, tools and intelligent transportation system (ITS) technologies to assess and respond to immediate needs versus optimization plans to mitigate its impact over the long term. Across various other studies and contexts, there is a growing recognition that lack of resilience can have grave socioeconomic consequences, especially in the context of disruption of interconnected infrastructure. The current state of practice in transportation planning lends itself to the conclusion that advances in resilience research need to be integrated into planning norms to help account for uncertain events and emerging risks. To this effect, this statement outlines the following research tasks to be undertaken for advancing the development of methodologies and measurements of urban freight resilience.

Research Tasks:

1. Define Urban Freight Resiliency
 - ☐ Similarities and differences – large, medium, small metropolitan areas
 - ☐ Resilience assessment framework and evaluation methodologies
2. Identify & Examine Challenges to Resiliency
 - ☐ Interdependencies among Stakeholders
 - Best practices of freight resiliency measures at state highway and transport facilities.
 - Best ITS technologies for automation, connectivity, and freight resiliency.
 - ☐ Economic Implications of Lack of Resiliency (Do Nothing Scenarios)
3. Develop an integrated framework linking freight network disruptions and resiliency measures to quantify economic impacts.
 - ☐ Short term resiliency: Responding to incidents (such as disruptions to State DOT infrastructure and(or) function)
 - ☐ Long term resiliency: Secondary effects of disruptions resulting in adverse economic effects (such as loss of business, employment etc.) for an urban area.
4. Model Implementation and Evaluation

- ☐ Performance Assessment Metrics (by mode, commodity, geography)
 - ☐ Data Collection – Existing data, surveys, focus group interviews
 - ☐ Case Studies of immediate impact and long-term impacts from disruptions and effectiveness of resilience measures.
5. Policy Recommendations

Urgency and Potential Benefits

This study will integrate resilience models for freight transportation networks with economic models. Past studies have shown that travel delay resulting from disruptions in transportation networks result in non-trivial economic impacts. The economic outcome of disruptions cannot be predicted by a simple incremental change of velocity-related parameters (VMT, VHT). The research will demonstrate that economic models must also be paired with structural network models and analysis in order to best reflect the impact of disruptions on economically important freight movements and processes.

Implementation Considerations

The outcome of this research will be a guidebook on “Methodologies and Measurements of Urban Freight Resiliency” to better address future challenges under the new normal. The state DOTs and the Metropolitan Planning Organizations (MPOs) would benefit from the research results of best practices for implementation and evaluation of resiliency measures. The economic impacts of “do nothing” scenarios could be used to justify investment in infrastructure and functions within state transportation facilities. This research could bridge the knowledge gap through innovative data analytics and spatial visualization of urban freight disruptions and resiliency measures for improved communication with policymakers.

This research needs statement is supported by:

- AT025 - Standing Committee on Urban Freight Transportation, Bill Eisele (Chair), b-eisele@tti.tamu.edu
- AASHTO Special Committee on Freight, Caroline Kieltyka (AASHTO Liaison), ckieltyka@ashto.org, 202-624-8489
- Carole Delion, Division Chief & CAV Program Manager, Maryland Department of Transportation. Email: cdelion@mdot.maryland.gov; Phone: (702) 530-7719.

Recommended Research Funding and Research Period

\$400,000 for 24-month period.

Problem Statement Author(S): For Each Author, Provide Their Name, Affiliation, Email Address And Phone.

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Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.
 Please contact Caroline Kieltyka at ckieltyka@ashto.org for potential panel member contact information.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.
 Casey Wells
 Statewide Planning Branch Manager
 Texas Department of Transportation
 Casey.Wells@txdot.gov
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 - U.S. Department of Transportation, Federal Highway Administration, “FHWA Order 5520: Transportation System Preparedness and Resilience to Climate Change and Extreme Weather Events,” webpage, December 15, 2014. As of August 5, 2019:
-

NCHRP Review of B-37

Reviewed By:

Trey Joseph Wadsworth
twadsworth@nas.edu

Comments:

Because of its focus on urban areas alone, the proposed research would be valuable to only a subset of state DOTs; Resiliency issues exist in rural areas, too. As the literature review section of this problem statement points out, 92% of states did not have metrics on resilience for freight. Why then only focus on urban freight? If the scope could be expanded to examine rural issues then it would be valuable to all state DOTs. The research timeline seems reasonable and the budget too, even if rural areas are included in the scope.

Review Date:

12/14/2021

FHWA Evaluation of B-37

Reviewed By:

Burnell/HOFM

Comments:

Urban freight resiliency is still a very new area of research and requires study over the next few years.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-37Submitted By:

Caroline Kieltyka

AASHTO staff

Special Committee on Freight

Priority #: 8Comments: N/A

Submitter Response for 2023-B-37From:

Casey Wells

Amlan Mitra

Comments:

We agree with the comments of the evaluators. Therefore, our revised problem statement (attached) has expanded the scope of the research to include both urban and rural freight resiliency. Thank you for giving us the opportunity to resubmit.

NOTE: The submitter provided a revised problem statement. It has not been provided because it could not be re-reviewed by AASHTO committees or FHWA and NCHRP staff.

Contact Info:

Casey.Wells@txdot.gov

mitraa@purdue.edu

Review Date:Feb 2, 2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-38

Problem Title

Transportation Planning and Public Health Outcomes: How State DOTs Collect and Integrate Public Health Data into Transportation Planning Prioritization & Decision Making

Background Information and Need For Research

Transportation is an important social determinant of health as it impacts many aspects of a person's overall quality of life. Access to adequate transportation infrastructure and services are fundamental to healthy communities, including access to healthcare services, mitigating exposure to environmental risks, creating opportunities for physical activity, and allowing for the ability to socially connect with others. Transportation planning can help boost community health through healthy transit options.

There is a growing consensus that to improve health outcomes in the United States, stronger partnerships must be established between public health and transportation. NCHRP Research Report 932 (2019), A Research Roadmap for Transportation and Public Health, provided an overview of what research is needed to better understand the intersection of transportation and public health. Within this report, a multidisciplinary team identified under-researched topics by way of categorizing research gaps and needs in transportation and public health. With further extensive research and analysis of which health data is collected and reviewed as part of a state DOT's transportation project planning process, transportation planners and engineers will be better equipped to consider a health perspective in their decision making. Furthermore, community health may be improved if transportation practitioners receive public health training to grow their knowledge and skills in how transportation planning decisions can positively or negatively impact health outcomes. A better understanding of current public health training opportunities within state DOTs can facilitate improved transportation planning, programs, and policy.

This project will inform state DOTs interested in further understanding what impacts transportation has on public health outcomes in their state, what health data can and should be considered when proposing transportation projects, and what public health related training opportunities are provided to staff to improve transportation planning decision making.

Literature Search Summary

There is robust research on the impacts that transportation has on air quality (environmental), safety, and noise; however, there are gaps in research in how transportation affects other areas of health outcomes; active transportation, access to community services and resources, equity, and social connections. This research will

build upon the body of literature and assist state DOTs to integrate healthy design methodologies into existing planning processes to improve health outcomes within each state.

1. Lyons, William; Morse, Lindsey; Nash, Logan; Strauss, Rachel. "Statewide Transportation Planning for Healthy Communities." National Transportation Library, John A. Volpe National Transportation System Center (U.S.), Federal Highway Administration, 1 Apr. 2014.

This report includes five state DOT case studies that chose to integrate public health considerations into their transportation planning and decision-making. This report builds upon the project's team previous white paper, Metropolitan Area Transportation Planning for Healthy Community (2012).

2. Christofa, Eleni, et. Al. "Public Health Assessment of Transportation Projects." University of Massachusetts Amherst, Massachusetts Department of Transportation, Federal Highway Administration. Feb. 2020.

This report conducted a review of publications and interviews with state DOTs, state departments of public health, and metropolitan planning organizations. Research investigated general health assessment methods, tools, and datasets utilized to assess health-related criteria. Information gathered led to the development of eight new criteria that were recommended for incorporation in the Massachusetts Department of Transportation highway project scoring process.

3. Fan, Yingling. "Transportation Research Synthesis: The Health and Transportation Nexus: A Conceptual Framework for Collaborative Health and Transportation Planning." University of Minnesota, Humphrey School of Public Affairs, Minnesota Department of Transportation, Research in Progress.

Research is currently underway by MNDOT Sustainability and Public Health Division to conduct a Health and Transportation Field Scan to understand how other U.S. DOTs are prioritizing and institutionalizing public health.

Research Objective

Public health data such as, but not limited to, obesity rates, air quality, crashes/injuries, and access to public transit, healthcare, and healthy food sources should be considered when proposing long-term transportation projects. Individual and community health could be improved if transportation planners have more knowledge of how transportation planning decisions can positively or negatively impact the health of people, particularly those among vulnerable populations within each state such as the elderly, disabled, and low-income individuals.

The objectives of this research are to:

1. Identify public health data that state DOT's collect, review, and apply as part of their long-term transportation planning efforts.
2. Identify health data tools that state DOT's use as part of their transportation planning decision-making.
3. Identify training focused on public health concepts offered to state DOT transportation planners as part of their professional continuing education.
4. Develop a framework, guidance documents, and a suite of tools that support the consideration of health data for transportation planners to utilize in state transportation planning processes.
5. Develop a model curriculum that includes public health concepts to be shared with transportation engineering faculty members to consider including in course materials.

The contractor should conduct a research review, to include, but not limited to: project survey, structured interviews with state DOTs, state health departments, USDOT, CDC, and other identified public health agencies, academic review, and grey literature to assess what type of health data is collected and considered as part of the screening process for proposed transportation projects. Information gathered shall identify what types of health data state DOTs now consider and which additional methods and health data sources would be desirable in the project planning process. In addition, this research should include what internal and external factors influence a state DOT to incorporate or not incorporate health data in the screening process.

Urgency and Potential Benefits

The COVID-19 pandemic brought to light the importance of transportation's role in public health, particularly in showing the many inequities and the limited access to critical services among vulnerable populations such as the elderly, disabled, and low-income communities. For state DOTs, this is a critical moment to explore innovative ideas to ensure that vulnerable populations have a reliable transportation infrastructure to access critical services such as healthcare. In addition, state transportation planners have an opportunity to positively impact health for those families who reside in lower economic areas as well as those families who live in rural areas. By conducting this research, state DOTs can learn from each other how health data is collected and utilized in the planning of transportation projects and a more people-focused approach can be adopted to improve individual and community health for all.

Implementation Considerations

The target audience to use the research results will be state DOT transportation engineers and transportation planners. Additionally, transportation engineering faculty members could benefit from this research to further improve planning and design curriculum to educate future engineers of the importance of considering the impact projects will have on the health of people within the transportation system they are building. State DOTs could implement the research from this project in their long-term transportation planning efforts by knowing what public health data tools are available and applying related indicators in decision-making.

Recommended Research Funding and Research Period

Recommended funding: \$300,000 with a research period of 24 months.

The funding level recommended above would cover the following expertise and related costs for the principal investigator, research team, public health officials, public health faculty members, transportation engineering faculty members, public health advocates/community health advocates, technical writer, and travel expenses.

The research period includes research objectives listed above and initial communication of research to state DOTs for state consideration and implementation.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Mrs. Arlin Alvarez, Texas DOT, Wellness Program Administrator, arlin.alvarez@txdot.gov, 512-645-5896

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

1. TRB Transportation and Public Health Committee (AME70) members such as Dr. Daniel A. Rodriguez, Committee Research Coordinator for TRB's Standing Committee on Transportation and Public Health (AME70). Dr. Rodriguez is the Associate Director of the Institute for Transportation Studies & Professor of City and Regional Planning, UC Berkley, danrod@berkeley.edu, 510-642-3111.

2. State DOT transportation planners.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Arlin Alvarez
Texas DOT
Wellness Program Administrator
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512-645-5896

NCHRP Review of B-38

Reviewed By:

Jennifer L. Weeks
jlweeks@nas.edu

Comments:

This would be useful to state DOTs. Additional potential research products could include training modules, but also other tools and procedures for achieving public health outcomes at a local level through transportation planning. The relationship

between land use planning and equity of access to healthy food, parks and green space, could be considered. The project will require a lot of data gathering and interactions with state agencies. This usually takes more time and effort than expected. For this reason, the budget should be increased to \$400,000 and the duration to 30 months.

Review Date:

12/15/2021

FHWA Evaluation of B-38

Reviewed By:

Victoria Martinez/HEPN-10; Spencer Stevens/HEPP

Comments:

Victoria Martinez - We see the benefit of this effort and support the effort to help State DOTs identify and collect health outcomes/impact data, use these tools to analyze the data and implement these in program and project delivery. Training would help take this even further. The funding level seems reasonable. .

Spencer Stevens - The strong points include a project that looks at ways to inform State DOTs interested in further understanding what impacts transportation has on public health outcomes in their State, and what health data can and should be considered when proposing transportation projects. This includes strong Equity considerations. In addition, it uses our original MPO Planning for Healthy Communities (Volpe) report as a resource and could build on that research. The draw backs could potentially put a strain on MPO's and State DOTs with the added time and costs of collecting Health related data and being an obstacle for good timely Transportation Planning.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-38

Submitted By:

Kyla Elzinga

AASHTO staff

AASHTO Committee on Planning

Priority #: 7

Comments: N/A

Submitted By:

Bud McDonald

AASHTO staff
Agency Administration Managing Committee

Priority #: N/A

Comments:

Support with comment: recommend including an equity disparity analysis.

Submitted By:
Bud McDonald
AASHTO staff
Committee on Civil Rights

Priority #: N/A

Comments:

Support with comment: recommend including an equity disparity analysis.

Submitted By:
Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A

Comments:

Recommend looking at adult physical activity, which is also captured in public health data, as the more direct outcome affected by access to active transportation or barriers created by large-scale vehicular projects. Someone walking or cycling receives health benefits regardless of their body size. Consider including information from school systems on rates of students walking/bicycling to school as another data set related to healthy activity. Consider including an equity disparity analysis.

Submitted By:
Chad Baker
Research Subcommittee Chair
Data Management and Analytics

Priority #: N/A

Comments:

Merge with B-05?

Submitted By:
 Kelly Hardy
 AASHTO staff
 Safety

Priority #: N/A

Comments:

A synthesis could address the bulk of the work described.

Submitter Response for 2023-B-38

From:
 Arlin Alvarez [email: Arlin.alvarez@txdot.gov]

Comments:

Thank you, Victoria, Spencer and Jennifer, for your review and feedback to this problem statement.

I would agree with Victoria and Jennifer's feedback in that training could take this research further with a final deliverable being workforce training across interested state DOTs. If it is determined that funding is available to support the design, development, and implementation of training, I would concur with Jennifer in her review that the budget and duration should be increased to \$400,000 over at least a 30-month period. In addition, I recommend the following update be made to the research objectives. See #5 below.

The objectives of this research are to:

1. Identify public health data that state DOT's collect, review, and apply as part of their long-term transportation planning efforts.
2. Identify health data tools that state DOT's use as part of their transportation planning decision-making.
3. Identify training focused on public health concepts offered to state DOT transportation planners as part of their professional continuing education.
4. Develop a framework, guidance documents, and a suite of tools that support the consideration of health data for transportation planners to utilize in state transportation planning processes.
5. ~~Develop a model curriculum that includes public health concepts to be shared with transportation engineering faculty members to consider including in course materials.~~

Replace with: Develop training curriculum, training objectives, proposed training modules, and proposed training implementation strategies.

Spencer noted that a drawback may be the time and cost it may take for state DOTs and MPOs to collect health-related data. While this is a valid concern, this is why it is imperative for the selected research team to conduct a very thorough review. By establishing a solid research foundation, the research team will be in a strong position to recommend efficient and effective guidance for how state DOTs can and should include health data when proposing transportation projects. Just like other established analysis tools/methods used today, establishing a best-practice toolkit/scorecard for collecting and utilizing appropriate public-health data may take some time to transition to become standard practice (such as state DOTs and MPOs having an environmental justice strategy).

Lastly, as we heard in committee meetings and lecture presentations throughout the TRB Annual Meeting and in Secretary Pete Buttigieg's keynote address, one of the six strategic goals the U.S. Department of Transportation will be focusing on in FY 2022 - 2026 is equity. While still open for public comment at this time and is subject to change, the equity goal includes a focus on "reducing transportation-related disparities, adverse community impacts, and health effects." The U.S. DOT has noted that this can be achieved through "the planning, development, and implementation of all transportation investments." Equity includes 'health equity', where all individuals are given an opportunity to be as healthy as possible and transportation can either positively or negatively impact individual and community health. This research could help state DOTs develop projects that improve health equity goals.

Thank you again for the feedback and for the opportunity to provide a response.

Contact Info:

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Phone: 512-645-5896

Review Date: 1/18/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-B-39

Problem Title

Volunteer Driver Programs (VDPs) Serving Rural and Low Density Communities

Background Information and Need For Research

Volunteer driver programs (VDP) can be an effective means to accommodate the unmet mobility needs of older adults and other transportation-disadvantaged people in rural and low density communities where transit, paratransit and taxi services are limited or cost prohibitive. There is considerable potential for these programs to be implemented or expanded on a coordinated basis to provide low-cost and accessible transportation in underserved or unserved rural communities; however, there is limited understanding of what makes a successful, sustainable and replicable VDP.

The collective body of knowledge surrounding VDPs is case-study or anecdotal in nature, with little, if any, research-based exploration of the operational, organizational and human factors which differentiate them from transit, paratransit or taxi voucher program. There is no authoritative body of work from a U.S. federal transportation agency providing technical guidance in the assessment, development, demand forecasting and deployment of car-based VDPs as a mobility option in meeting transportation needs, in particular for older adults or in rural areas.

This has led to a lack of understanding of the potential for success and the scalability and replicability of VDPs to meet the growing demand for specialized transportation services, along with successful recruiting and retention of volunteer drivers. Without a clear systematic understanding of VDPs as a mode of transportation, it is difficult for state DOTs, public transit and human services agencies, or regional transportation authorities to estimate the programs' potential, determine prospective costs and benefits, and identify where and when VDP models will be successful and sustainable. This limits the ability of rural public transit agency staff, mobility managers, and transportation planners to consider, plan, implement, and sustain VDPs among a continuum of transportation services (ranging from transit and paratransit to on-demand services) where planning metrics and demand estimation may be better defined.

Given that many prospective rural VDP would fall under the purview of organizations with limited resources for surveys and research, a forecasting tool would be an efficient means for rural or small transit agencies and other entities to evaluate the potential of the service. Recent research suggests that such guidance is both possible and of considerable interest for delivering transportation services in rural or low density areas. In addition, the extension of car-based VDP into more rural and low-density areas is limited by the understanding of how VDP develop and evolve (a bottom-up, community-

driven approach vs. a top-down planning approach), funded and sustained, and how to assess the demand for such services and supply of volunteers.

A research project is therefore needed to assemble detailed VDP data (similar to that in Freund, et al (2020)) at a national level, viewed through a transportation engineering and planning lens (as described by Hanson and Goudreau (2019)) and aligned with quantifying organizational practices associated with stages of VDP development (or maturity, as described in Goudreau and Hanson (2018)). A resulting NCHRP publication that combines these elements with accompanying an forecasting tool would provide critical planning resources for mobility development by agencies engaged in rural public transportation and other organizations looking to complement public transportation with VDPs.

Literature Search Summary

Existing research on VDPs shows a need for improvement of mobility in rural and underserved areas. Many people in North America are facing a future where the health effects of aging may compromise their ability to independently meet their needs as a driver with a personal automobile. The U.S. Census Bureau projects that the population of adults aged 65 years and older will nearly double from 49 million in 2016 to 95 million in 2060, representing 25% of the population (Vespa, Armstrong, & Medina, 2020). The projections are also pronounced for Canada, where the senior population is expected to rise from 6 million in 2014 to 9.5 million 2030, representing 23% of the population (Wong, 2014). While aging itself does not compromise driving ability, the health effects of aging can make driving difficult or impossible over time, and for an automobile-dependent society (which typifies much of rural North America), this will leave many without an alternative to driving themselves.

The data already demonstrate a move away from maintaining a driver's license with age; in 2018, approximately 90% of Americans aged 65-74 years maintained a driver's license, while 62% of those 85 years and older maintained a license. While licensing rates are relatively the same between men and women younger than 50 years, a higher proportion of men than women maintain their licenses with age; by the time they are 85 years and older, 78.5% of men and only 50% of women maintain a license (U.S. Department of Transportation, 2019) . It is not clear to what degree this is a gender-effect or a cohort-effect, but suggests the importance of maintaining a gender lens in the consideration of driving alternatives.

When it comes to alternatives to driving, older adults tend to seek it from friends and family first (Coughlin, 2009), (Donorfio, Mohyde, Coughlin, & D'Ambrosio, 2008) (Hanson and Hildebrand 2011), (Taylor & Tripodes, 2001). A confluence of demographic and other factors in North America, which includes smaller family sizes, dispersed families, centralizing essential services, are likely to make it more difficult for older adults to rely exclusively on friends and family, and by extension, a society that implicitly relies on the ability of older adults to secure their own transportation to access services such as healthcare.

Existing research reports from the National Academy of Sciences address practices in rural transportation, though none have an explicit focus on VDPs. TCRP Research Report 223 (2021) focuses on non-emergency medical transportation (NEMT) and cites VDPs as a mobility option for reimbursement for Medicaid NEMT service and a resource for community 211 services to connect riders to drivers. This report cites case studies of health organizations and consortiums in rural areas of Colorado, Oregon, Missouri, New York, Kentucky, and Vermont utilizing volunteer drivers as part of their mobility options for riders. NCHRP Research Report 861 (2017) alludes to VDPs as a subtype of specialized transportation services which provide scheduled rides in rural areas where distances will not adequately support fixed routes. This report mentions Central Community Transit in Minnesota as an example of a transit agency providing service volunteer drivers through support from a state grant. TCRP Report 136 (2009) includes some discussion of VDP in rural areas and smaller counties as demand-response transportation and discusses impacts of VDPs on performance data. TCRP Report 101 (2004) includes an entire chapter on the use of volunteers in rural transportation and case studies in California, Oregon, Washington, and Idaho (including as drivers for demand response transportation), also citing previous work from The Bevelly Foundation on the subject. TCRP Report 99 (2004) also includes a similar case study on Washington and Idaho.

As outlined in the TRB “Critical Issues in Transportation 2019 Policy Snapshot”, providing mobility for populations with limited transportation options is a growing need in North America, compounded by the aging demographics and limited accessible, on-demand transportation programs (National Academies of Sciences, Engineering, and Medicine, 2018).

VDPs are featured prominently within the suite of topics within the National Center for Mobility Management (<https://nationalcenterformobilitymanagement.org/by-topic/>), (NCMM), National Aging & Disability Transportation Center (NADTC) and research would be consistent with the NADTC and NCMM national technical assistance role.

Research Objective

The objectives of a national research effort are to support the elaboration of a seminal publication that would review, summarize, and build on the following dimensions:

- Identify existing VDPs in North America, particularly in rural or low density areas, and available resources on these programs, including tools for planning services or monitoring and dispatching volunteers
- Identify the types of metrics and methods for monitoring performance that would be valuable for transportation planning and aligned with the VDPs capacity to provide service and improve equity of available mobility options
- Create an organizational complexity model (also known as maturity model) tool that quantifies success factors and best practices of VDPs in rural or low density areas
- Identify criteria/factors for program success based on population and geography size to identify ideal places for VDPs and appropriate sizing of programs based on local suitability

- Create a tool based on organizational complexity and operational metrics that transportation agencies and existing or prospective VDPs can use to help them assess or self-assess potential areas for improvement
- Identify sustainable funding sources and mechanisms for VDPs in rural or low density areas based on agency size and trip types
- Quantify the potential for VDPs into a viable transportation resource in rural or low density areas (which may include areas of long travel distances or otherwise difficult and expensive to serve) to provide additional transportation options for seniors, persons with disabilities, and other travelers as well as improve the equity of available mobility options

Urgency And Potential Benefits

The expected payoff of this research lies with its potential:

- To help transit agencies, human services agencies, and mobility managers serving rural or low density communities implement and sustain VDPs as a cost-effective solution to meeting unserved and underserved populations.
- To improve the potential for organizing and delivering transportation in low-density or hard to serve environments that would otherwise not be possible due to cost or level of service.
- To provide replicable VDP templates for specific applications in hard to serve communities, and to provide the tools needed to understand such programs, thereby increasing sustainability, success rates and mode viability.
- To enhance the societal benefits of enhancing mobility options for non-drivers and drivers in transition.

This project can lead to improved safety by helping to provide the environment for the development of mobility solutions that facilitate a transition of driver to non-driver at a point where the health effects of aging may make driving difficult or impossible. The project can make better use of existing infrastructure by leveraging an existing pool of drivers and vehicles to support meeting the transportation needs of older adults. The study outcome contributes to the development of innovative practices and accountability by making planning and forecasting data a central theme.

The growing population of older and more diverse drivers in rural communities in particular, including notable difference in licensing rates among older women and men, presents challenges and opportunities that require immediate action. The largest challenge is that the health effects of aging can make driving difficult or impossible over time, yet few alternatives exist in rural communities where older individuals who want to age in place tend to hold on to their driver's licenses longer than their urban counterparts. VDPs appear to have many elements which can appeal to older adults and the potential to be a feasible provision of special transportation services in an aging society. However, extensive and systematic research on what makes VDPs successful has been limited. The proposed study will produce a critical reference and tools for the development and enhancement of VDPs.

VDPs have many elements which can appeal to older adults that transition from driving (and that currently rely on friends and family for mobility), while replicating the friends and family experience. There is considerable potential for VDP to be a systematically deployed asset of special transportation services in an aging society, though such deployment requires a better technical understanding of the elements that make VDP successful. While older adults are not the exclusive clientele of VDP, they can be expected to be a major beneficiary of expanded VDP operations.

VDP research is needed as the widespread adoption of Autonomous Vehicles still remains a long-term goal and primarily urban pursuit. It also remains unclear whether these technologies can be as effective in addressing the types of assistance required by non-driving older adults, and the degree to which the “human connection” contributes to program success. Nevertheless, new technologies and operational models are emerging that are serving and supporting rural and low-density areas, such as ITN Country (extension of the ITN America model to rural areas) (ITN Country, 2020) and Feonix-Mobility Rising and its “Freedom Driver” concept (Feonix - Mobility Rising, 2020) which are bringing the Mobility-as-a-Service (MaaS) concept to these areas.

Implementation Considerations

State DOT divisions that will be responsible for making use of and/or disseminating the research results would most likely be those in public transportation programs/divisions or work in rural and tribal transportation. The research will be a value tool in state DOT's toolkits for providing technical assistance to the transit agencies and specialized transportation providers within their states, particularly if state DOT's sponsor informational or training sessions based on the proposed research.

Recommended Research Funding And Research Period

Recommended Funding: \$200,000 to \$300,000

Research Period: 24-36 Months

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Leadership in developing this problem statement from Dr. Trevor R. Hanson, Associate Professor, University of New Brunswick, Canada, Committee Research Coordinator, Transportation Research Board Standing Committee on Accessible Transportation and Mobility. Support from this problem statement includes the following group: Carrie Diamond, Assistant Director of the National Aging & Disability Transportation Center at Easterseals, Inc., Todd Hansen, Associate Research Scientist at the Texas A&M Transportation Institute; Dimitra Pyrialakou, Assistant Professor, West Virginia University.

- Dr. Trevor Hanson, University of New Brunswick, thanson@unb.ca, 506-453-4521
- Carrie Diamond, National Aging & Disability Transportation Center, cdiamond@easterseals.com, 312-405-2248
- Todd Hansen, Texas A&M Transportation Institute, t-hansen@tti.tamu.edu, 713-613-9205

- Dr. V. Dimitra Pyrialakou, West Virginia University,
dimitra.pyrialakou@mail.wvu.edu, 304-293-9927

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Some of the transit agencies and DOT staff that participated in the following studies may be willing to participate on the panel for the proposed research:

- TCRP Research Report 223
- NCHRP Research Report 861
- TCRP Report 136
- TCRP Report 101
- TCRP Report 99

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

N/A

NCHRP Review of B-39

Reviewed By:

Jennifer L. Weeks
jlweeks@nas.edu

Comments:

The research addresses an identified need in rural areas throughout the country. The objective is clear. The budget should be \$300,000 and the duration 30 months.

Review Date:

12/15/2021

FHWA Evaluation of B-39

Reviewed By:

Spencer Stevens/HEPP

Comments:

We support evaluating VDP and further developing a CMM so agencies can improve their on-demand strategies, specifically for older adults and other transportation-disadvantaged people in rural and low density communities.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for B-39

Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: N/A

Comments:

This would help address some of the older driver safety concerns in rural areas.

Research Field C

DESIGN

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation****FY2023 NCHRP PROBLEM STATEMENT TEMPLATE****Problem Number: 2023-C-01****Problem Title:**

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 and demographic information 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 fulfill 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 a few of the 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 feet within CBD's and urban mix contexts, between 500-1000 feet along residential and commercial corridors, between 750-1,500 feet in suburban areas and between 250-750 feet in rural areas (ODOT, 2020). 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 optimal 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, demographics, 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 and targeted follow up 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, demographics, 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 optimal pedestrian crossings, including type and minimum and maximum spacing based on context, demographics, 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. Additional benefits include improved transit access and permeability of arterials or similar roads, which can support walking and bicycling on neighborhood streets. Agencies can use this guidance to provide additional crossing opportunities that improve pedestrian safety.

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.

Recommended Research Funding and Research Period

\$500,000

36 months

Problem Statement Author(s)

Sirisha Kothuri, Portland State University

Chris Monsere, Portland State University

Jeremy Chrzan, Toole Design Group

AASHTO Council on Active Transportation

Potential Panel Members

N/A

Persons Submitting the Problem Statement

Toks Omishakin, Caltrans Director, and Chair of the Council on Active Transportation

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. [lon](#)

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>

NCHRP Review of C-01

Reviewed By:
 Zuxuan Deng
 zdeng@nas.edu

Comments:

The objective is not well-defined. As an optimization problem, what is the objective function and what are the constraints? Can any constraints be loosened? And what factors can be controlled? Isn't pedestrian crossing desire line largely driven by land use and roadway network configurations? Will marked crosswalk give false sense of security to crossing pedestrians? Even if an optimal distance between crosswalks can be determined, how to implement it given the existing roadway conditions? Will it be any different from the NYSDOT and ODOT examples as being considerably wide ranges?

Review Date:
 12/15/2021

FHWA Evaluation of C-01

Reviewed By:
 Eisert/HRSO

Comments:

The budget for this submission roughly makes sense for essentially a literature review and a couple studies, and the tasks laid out are all feasible and would be helpful. The timeline might need to be shortened a little.

Review Date:
 December 17, 2021

AASHTO Committee Evaluation for C-01

Submitted By:

Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: 5

Comments: N/A

Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: N/A

Comments:

This research should look at the question from both the perspective pedestrian willingness to walk to a comfortable crosswalk in various contexts but also driver expectation and adherence to stopping at crosswalks based on spacing.

Submitter Response for 2023-C-01

Comments:

- Recommend combining with **G-08: Pedestrian Crosswalk Spacing and Placement Guidance to Improve Safety**, submitted by the Safety Committee.
- The objective of this research is to take a holistic look at pedestrians' crossing experience to provide guidance for agencies on optimal 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, demographics, transit stops, facility type, speed limit, geometry, and vehicle and pedestrian volumes.
- Appropriately located and designed crosswalks are essential to completing the network; examining the "along" without addressing the "across" will fail to establish actual minimum thresholds for connectivity and safety.
- The outcome of the research would be a recommend process for determining spacing under different contexts. The ranges will likely vary depending on the contexts.

- The research would provide an opportunity to refine and reexamine NYDOT and ORDOT- existing guidance and develop guidance that better addresses active transportation needs. Guidance and consistency is needed.
- Through NCHRP 20-123, a research Roadmap was developed to assist the Council on Active Transportation implement the research components of its 2018 Strategic Plan. To identify and define research priorities, the team reviewed existing and on-going research; conducted a survey of practitioners, including AASHTO councils and committees, TRB committees, state DOTs, and ITE, APBP, and NACTO members; and conducted a series of practitioner workshops. The Roadmap contains active transportation research that will address the most important needs of state DOTs. The priority level of research identified in the Roadmap 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. Of the 110 research topics identified, this was the #5 priority for CAT.

Contact Info:

Bud McDonald

bmcDonald@aathto.org

Review Date:

2/3/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-C-02

Problem Title

Determination of barrier deflections for lower speeds

Background Information and Need For Research

Deflection of permanent and temporary barrier systems often influence the design of the surrounding roadside. Utility poles and other fixed objects may have to be relocated to avoid the zone of intrusion for W-beam guardrail, free-standing portable concrete barriers, etc. Additional construction phases may need to be added to account for portable concrete barriers that would otherwise be located too close to a drop-off condition. These scenarios, and ones like them, contribute to added costs and delays to construction.

Minimum offset requirements are typically based upon crash test results. MASH testing criteria requires TL-3 tests to be performed at 62 mph and TL-2 tests at 44 mph. However, there are many instances where vehicles may be expected to travel at speeds that are lower than what was crash tested, so the offset requirements from the MASH testing may be overly conservative. Furthermore, most of the commonly used barriers are not tested for the lower-speed TL-2. The behind-the-barrier offset requirements for the barriers are based on testing at a much higher 62 mph impact speed. Understanding what the deflection would be at lower speeds will help DOTs to make more informed decisions and could ultimately reduce construction costs by minimizing utility relocations, changes to roadside design, and potentially eliminating unnecessary construction phases.

Literature Search Summary

Roadside Design Guide's (RDG) Zone of Intrusion (ZOI) guidelines were developed using results of NCHRP Report 350 testing with longitudinal barriers. These guidelines provide zones on top and behind the barrier, where an impacting vehicle or the barrier may intrude into during a crash. Ongoing NCHRP Project 22-34 has been tasked to update the ZOI guidelines using the MASH testing criteria. However, the research effort to update the ZOI guidelines is significantly different from the one being proposed under this problem statement. ZOI research is focused primarily on Test Level 3 or higher, which is suitable to high-speed roadways. Furthermore, in addition to flexible or semi-flexible barrier systems, ZOI related research and guidance is influenced by inclusion of rigid or nearly rigid barriers such as bridge rails, permanent concrete barriers, etc. These barriers have close to zero maximum dynamic deflection. In contrast, typical W-beam guardrail or free-standing portable concrete barriers have several feet of dynamic deflection, which can be significantly reduced for lower speed impacts.

Research performed by Weiland et al. (MwRSF Report TRP-03-314-15) focused on determining the working width and maximum dynamic deflection of the MGS guardrail

system for MASH TL-2 and TL-1 impact conditions using simulation analysis. This research can be expanded further to include other barrier systems. Furthermore, while the MASH testing standard specifies impact speeds of 62 mph (TL-3), 44 mph (TL-2) and 31 mph (TL-1), in many situations, roadside barriers are placed on roadways with intermediate or lower design speeds. There is currently not much information on the working width or barrier deflection for these lower and intermediate speeds. This new problem statement proposes to research and provide this missing information, which will be of significant benefit in reducing the minimum offset requirements behind the barriers on low-speed roadways.

Research Objective

This research should result in guidance on the required distance needed behind different types of MASH compliant barriers, based on the roadway design speed. The design speeds should range from 25 mph to 62 mph. The research activities should involve the following major tasks in developing this guidance.

- The research should perform a thorough literature review of the different barrier types that have been crash tested to MASH TL-3, but are also used on lower-speed roadways, and it would be beneficial for state DOTs and user agencies to know their clear offset requirements for lower-speeds. Examples of such systems are W-beam guardrail, free-standing portable concrete barrier systems, etc. The literature review should also include any MASH testing performed on such barrier systems at lower test levels (TL-2 or TL-1) of MASH.
- To develop the guidance for lower-speed impacts, the research team should identify MASH TL-3, and whenever possible, MASH TL-2 crash tests performed on these barrier systems. The research team should develop detailed finite element models of the selected barrier systems and perform impact simulations using MASH TL-3 and/or TL-2 test impact conditions. The results of the simulations should be compared to the test results to establish the validity of the models. In doing so, the research team should use the verification and validation methods described in NCHRP Web Only Document 179. Validation should be established for the barrier's dynamic deflection, permanent deflection, and the MASH work width of the system.
- Once the barrier system models have been adequately validated using previously available MASH TL-3 and/or TL-2 crash test data, the research team should perform additional impact simulations with lower impact speeds. The research team should use these lower-speed impact simulations to establish the MASH working width and dynamic deflection of the various barrier systems.
- Results of the simulations with lower speeds should then be used to develop the desired guidance for barriers installed on lower-speed roadways.

Urgency and Potential Benefits

All State DOTs take barrier deflection into consideration during the design and placement of both permanent and temporary roadside barriers. On low-speed roads, additional and sometimes unnecessary work may be required to accommodate these deflections that are based on high-speed testing. Conducting this research may allow states to reduce

costs and time associated with overly conservative decisions associated with the limited knowledge about deflection that exist today.

This research is ranked number 4 out of 5 by the AASHTO Technical Committee on Roadside Safety. This research is endorsed by the AASHTO Committee on Design.

Implementation Considerations

The State DOT Highway, Roadside Design, Traffic, and/or Work Zone engineers will benefit from these research results. Using this new data, states may be able to update design manuals and construction drawings. Furthermore, AASHTO Roadside Design Guide can include more guidance emanating from this research for installation of barriers on lower speed roadways.

Recommended Research Funding and Research Period

The recommended research funding is \$350,000.

The recommended research period is 2 years.

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

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Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

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Person Submitting The Problem Statement: Name, affiliation, email address and phone.

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NCHRP Review of C-02

Reviewed By:

David M. Jared
djared@nas.edu

Comments:

This higher-priority research (per AASHTO) would complement previous MASH-related studies and could provide new material for the AASHTO Roadside Design Guide. Even if full-scale crash tests are not part of the scope, I think that the budget should be higher, and certainly if crash testing is included.

Review Date:

12/2/2021

FHWA Evaluation of C-02

Reviewed By:

Roadway Departure

Comments:

Having information for the deflection of barriers at lower speeds would be useful to highway agencies and could be included in the AASHTO Roadside Design Guide. It is possible that this could be accomplished quicker through the Pooled Fund Program rather than an NCHRP project.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for C-02

Submitted By:

Patricia Bush

AASHTO staff
Committee on Design

Priority #: N/A

Comments:

Endorsed by Committee on Design.

Submitted By:

Kelly Hardy
AASHTO staff
Design-Technical Committee on Roadside Safety

Priority #: 4

Comments:

TCRS ranked this research its #4 priority (of 5 submitted).

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-C-03

Problem Title

Development of MASH Full-Scale Test Matrices for Additional Roadside Safety Devices

Background Information and Need For Research

The Manual for Assessing Safety Hardware (MASH) has developed test matrices for various hardware based on a philosophy of the “worst practical conditions”. This philosophy intends that to select the worst, or most critical conditions when defining a test matrix. Tests within a matrix need to evaluate range of different vehicle types, impact conditions, failure types, and evaluation criteria. A matrix also needs to allow multiple design alternatives for a roadside feature.

Test matrices must also be practical such that roadside features evaluated through the test matrix are cost effective and provide increased safety benefit without being a financial burden to end users. It is difficult for TCRS or other agencies to determine if vehicle type, impact condition, or evaluation criteria is impractical.

While MASH has matrixes for most roadside features, several devices lack a matrix, or a matrix needs clarity. Some of the devices that fall into this category are Treatments for Intersection Roadways/ Short Radius Guardrail, Buried-in-Backslope Terminals, Attenuation Nets, Gates, Longitudinal Barriers Placed Adjacent to Slopes.

There are no formal procedures to develop or evaluate a new matrix. There are no procedures to evaluate or update an existing matrix. This lack of procedure makes it difficult for AASHTO's Technical Committee on Roadside Safety (TCRS) to balance safety, cost, and practicality.

If there is not an agreed upon matrix for a device, is the device MASH compliant? If there is no agreement on evaluation criteria, is a device crashworthy? At what point does vehicle type, impact condition, or evaluation criteria become impractical?

Literature Search Summary

There is little formal documentation about the development test matrices. The most recent example of a test matrix being developed would be for cable median barriers in various ditch designs for MASH 2016. TCRS, Midwest Roadside Safety Facility (MwRSF), and the Texas A&M Transportation Institute (TTI) worked together to develop two cable barrier test matrices. The development of the matrices reviewed existing crash test results, crash data data, cable median barrier designs, and evaluation of vehicle trajectories. While this effort was successful, documentation of the effort is spread across several sources. Some of the sources are:

Stolle, C.S., Sicking, D.L., Faller, R.K., and Reid, J.D., Cable Median Barrier Failure Analysis and Remediation Phase II, Final Report to the Midwest State's Regional Pooled Fund Program and MidAmerica Transportation Center (MATC), Transportation Research Report No. TRP 03-319-13, Project No.: TPF-5(193) Supplement #44, Project Code: RPFP-12-Cable-1 & RPFP-12-Cable-2, MATC TRB RiP No. 28495, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, Nebraska, June 30, 2013.

Schmidt, T.L., Meyer, C.L., Lechtenberg, K.A., Faller, R.K., Bielenberg, R.W., Stolle, C.S., Sicking, D.L., and Reid, J.D., Energy Analysis of Vehicle-To-Cable Barrier Impacts, Final Report to the New York State Department of Transportation, Transportation Research Report No. TRP 03-283-13, Project No.: TPF-5(193) Supplement #130, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, Nebraska, June 11, 2013.

Stolle, C.S. and Sicking, D.L., Cable Median Barrier Failure Analysis and Prevention, Final Report to the Midwest State's Regional Pooled Fund Program and Mid-America Transportation Center (MATC), Transportation Research Report No. TRP 03-275-12, Project No.: MATC WBS: 25-1121-0001-428, Project Code: MATC TRB RiP No. 28495, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, Nebraska, December 17, 2012.

Mongiardini, M., Faller, R.K., Rosenbaugh, S.K., and Reid, J.D., Test Matrices for Evaluating Cable Median Barriers Placed in V-Ditches, Final Report to the Midwest State's Regional Pooled Fund Program, Transportation Research Report No. TRP-03-265-12, Project No.: TPF-5(193) Supplement #44, Project Code: RPFP-12-Cable1&2 Year 22, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, Nebraska, July 13, 2012

Stolle, C.S., Reid, J.D., and Lechtenberg, K.A., Update to Cable Barrier Literature Review, Final Report to the Midwest State's Regional Pooled Fund Program, Transportation Research Report No. TRP-03-227-10, Project No.: TPF-5(193), Project Code: RPFP-09-01 - Year 19, Midwest Roadside Safety Facility,

University of Nebraska-Lincoln, Lincoln, Nebraska, August 12, 2010.

Thiele, J.C., Bielenberg, R.W., Faller, R.K., Sicking, D.L., Rohde, J.R., Reid, J.D., Polivka, K.A., and Holloway, J.C., Design and Evaluation of High-tension Cable Barrier Hardware, Final Report to the Midwest State's Regional Pooled Regional Pooled Fund Program, Transportation Research Report No. TRP-03-200-08, Project No.: SPR-3(017), Project Code: RPFP-01-05, RPFP-04-01, RPFP-06, and RPFP-08-02 - Years 11, 14, 16, and 18, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, February 25, 2008.

Research Objective

Given the wide variation of roadside devices, it is not practical to review all devices previously listed as lacking a test matrix, provide clarification to a test matrix, or address all other issues discussed in this problem statement. What is needed is a research project to:

- Review existing research looking for information on how existing test matrixes were developed or modified
- Conduct interviews of experts in the field of crash testing for information on how existing testing matrixes were developed and modified.
- Summarized the existing research and interviews on the development of existing matrixes, modification to matrixes and how issues of practicality were addressed.
- Develop potential methodologies and procedures to evaluate the development of new matrixes.
- Develop potential methodologies and procedures to evaluate the modification of a test matrixes.
- Select one or two of the devices mentioned previous and use the developed methodologies and procedures to develop or modify a test matrix.

Urgency And Potential Benefits

Development methodologies and procedures for developing matrixes will improve effectiveness of roadside features, increase efficiency in developing and maintaining matrixes, and provide a consistent and defensible roadside hardware evaluation process.

This research is ranked priority number 3 out of 5 by the AASHTO Technical Committee on Roadside Safety. This research is endorsed by the AASHTO Committee on Design.

Implementation Considerations

After review by TCRS, this research could be implemented in the next version of MASH. TCRS would likely seek input from researchers, manufacturers, and other states before implementing this research.

Recommended Research Funding and Research Period

3 years

\$400,000

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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NCHRP Review of C-03

Reviewed By:

Richard A. Retting
rretting@nas.edu

Comments:

MASH full-scale test matrices for additional roadside safety devices is an important highway safety issue. The problem statement provides strong background information and documents the need for research; a good literature search summary; and clear research objectives. The recommended funding seems reasonable for the stated research objectives, but may not accommodate all of the types of devices listed in the problem statement that lack a MASH matrix or for which a MASH matrix needs clarity (Treatments for Intersection Roadways/ Short Radius Guardrail, Buried-in-Backslope Terminals, Attenuation Nets, Gates, Longitudinal Barriers Placed Adjacent to Slopes). It might, thus, be useful to prioritize these types of devices based on the greatest safety need (e.g., estimated number of devices across the highway network; estimated prevalence of fatal and serious injuries associated with the various types of devices).

Review Date:

11/30/2021

FHWA Evaluation of C-03

Reviewed By:

Roadway Departure

Comments:

This is of great importance and has been a topic of great debate. It is surprising the project is not focused on a particular type of device but instead will be coming up with a generic method for determining/updating the testing matrix. If this study is conducted, other studies would then need to be conducted to use the results so that the actual matrices are updated.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for C-03

Submitted By:

Patricia Bush
AASHTO staff
Committee on Design

Priority #: N/A

Comments:

Endorsed by Committee on Design.

Submitted By:

Kelly Hardy
AASHTO staff
Design-Technical Committee on Roadside Safety

Priority #: 3

Comments:

TCRS ranked this research its #3 priority (of 5 submitted).

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-C-04

Problem Title

National Guidance for Defining Acceptable Roadside Hardware Field Performance through In-Service Performance Evaluations (ISPEs)

Background Information and Need For Research

One reoccurring theme in each re-writing of crash test and evaluation procedures over the last 40 years is the recommendation to conduct in-service performance evaluations (ISPEs) of roadside safety features. Michie et al. recommended ISPEs in the National Cooperative Highway Research Program (NCHRP) Report 230 crash test and evaluation procedures published in 1981. The importance and need for ISPEs was reiterated by Ross et al. in NCHRP Report 350 as well as by AASHTO in the Manual for Assessing Safety Hardware (MASH).

The laboratory performance of roadside safety hardware is tested and evaluated using criteria published in MASH. The site location and installation of roadside safety hardware is guided by criteria published in the AASHTO Roadside Design Guide (RDG). In-Service Performance Evaluation (ISPE) criteria has only just now become available under NCHRP Project 22-33. Guidance is needed, at the national level, for defining acceptable field performance.

National guidance which defines acceptable field performance, for each of the evaluation criteria developed under NCHRP 22-33, will provide States with the ability to establish crashworthiness without having to conduct endless crash tests. Furthermore, the performance thresholds established by this research could be used to determine when (if) updates to MASH are necessary rather than simply updating MASH when the vehicle fleet changes.

This research is supported by the Technical Committee on Roadside Safety's (TCRS) Strategic Plan. The objective of the Strategic Plan is to "critique and improve the underlying assumptions within the RDG and MASH through the analysis of field performance and assessment of available data."

The AASHTO/FHWA joint implementation plan called for MASH testing to be required for the development of new hardware beginning January 1, 2011. As these MASH systems are placed into service, adequately planned and conducted in-service performance evaluations (ISPEs) will allow determination of field performance of roadside safety hardware. The performance thresholds established under this research will facilitate in the development of actionable conclusions for each ISPE conducted.

Literature Search Summary

There are several research projects which are currently underway or were recently completed which will directly contribute to this effort in one way or another. A few of the more important projects have been highlighted here, including: TRB and FHWA pilot studies of data collection, NCHRP 22-33, and NCHRP Project 22-44. A TRB special study was completed which includes "... exploratory work in selected states" on collecting data for ISPEs. The FHWA office of Safety Research and Development recently completed a pilot data collection program which documented good practices for real-time crash data collection and interagency communication.

Past ISPE criteria for data collection and analysis were published under NCHRP Report 490. State funded ISPEs have been ongoing for more than 40 years. These various studies are too voluminous to list here. In addition to ISPEs, some states have begun developing mobile data collection apps for the purpose of asset management and/or assessing the field performance of roadside hardware. Examples of these states include Texas, Iowa, and Minnesota.

NCHRP Project 22-44, "A Transportation Agency Data Collection Practice for Use with In-Service Performance Evaluations (ISPEs)" is progressing to Phase II and is scheduled to complete on June 30, 2023. NCHRP Project 22-44 will provide nationally standardized ISPE data collection techniques. NCHRP Project 22-33 developed national ISPE evaluation criteria. NCHRP Project 22-33 has just finished a pilot test and the final report is anticipated this year. These national ISPE data collection protocol and evaluation criteria are two major steps toward realizing the long-sought goal to conducting ISPEs. The research proposed under this effort would provide the final piece for the conduct of national ISPEs to establish crashworthiness.

Research Objective

The objective of this research is to develop national guidance which defines acceptable field performance thresholds for roadside hardware. Performance thresholds defining acceptable performance should be developed for each of the evaluation criteria established under the NCHRP 22-33 ISPE Guidance Document. Guidance for the use of ISPEs for establishing or updating existing guidelines and for establishing crashworthiness should be developed. The following tasks are proposed:

- a. Assemble ISPEs conducted using the NCHRP 22-33 criteria;
- b. Recommend additional hardware to be evaluated using the NCHRP 22-33 criteria;
- c. Through consultation with the panel and based on a review of available data, determine which additional ISPEs should be conducted;
- d. Conduct additional ISPEs;
- e. Tabulate the results of the available and newly conducted ISPEs. Using the tabulated results, recommend national thresholds for acceptable performance which can be implemented across the states; and
- f. Develop recommendations for the use of ISPEs:

- to establish and/or update existing guidance on the crash testing and placement of roadside hardware.
- to establish the crashworthiness of existing hardware such that new crash testing is not required for federal-aid eligibility.

Urgency And Potential Benefits

Urgency – MASH was published in 2009. The AASHTO/FHWA joint implementation plan called for MASH testing to be required for the development of new hardware beginning January 1, 2011. Without in-service performance evaluations of roadside safety hardware it will not be possible to determine how well crash test performance translates into field performance. Making informed decisions about future crash testing requires that in-service performance evaluations be performed. National criteria which establishes acceptable field performance will provide a mechanism for agencies to assess field performance, establish crashworthiness of existing hardware, and establish federal-aid eligibility rather than continually updating to the latest crash testing standard.

Potential Benefits – The primary payoff is a means to better understand and more consistently evaluate the field performance of roadside hardware. This information can be used in updating existing standards and to establish the crashworthiness of roadside hardware absent of crash testing. The cost of this research is a tiny fraction of what a whole-sale technology replacement would cost if a particular device type proved unacceptable in a single crash test.

This research is ranked number 5 of 5 by the AASHTO Technical Committee on Roadside Safety. This research is endorsed by the AASHTO Committee on Design.

Implementation Considerations

This research would result in an improved understanding of the field performance of roadside hardware. A portion of the project should be dedicated to disseminating the results to interested agencies. It is anticipated that the improved guidelines would better support state DOT personnel charged with maintaining

State standards. Outreach to the TRB AKD20 committee and AASHTO TCRS is recommended.

Recommended Research Funding And Research Period

48 months and \$400,000

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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NCHRP Review of C-04

Reviewed By:

David M. Jared
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Comments:

Complements work in NCHRP 22-33, "Multi-State In-Service Performance Evaluations of Roadside Safety Hardware" nearing completion and in NCHRP 22-44 well underway. Seems like a good idea to initiate this research in parallel with 22-44, "A Transportation Agency Data Collection Practice for Use with In-Service Performance Evaluations (ISPEs)".

Review Date:
12/2/2021

FHWA Evaluation of C-04

Reviewed By:
Roadway Departure

Comments:

This is an important project. Currently there is no national guidance for conducting ISPE. Developing national guidance for conducting ISPE and establishing crashworthiness through ISPE will be helpful to highway agencies to determine crashworthiness of hardware without depending on crash tests for each individual variance in the field. This research can possibly contribute information to MASH updates in the future.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for C-04

Submitted By:
Patricia Bush
AASHTO staff
Committee on Design

Priority #: N/A

Comments:

Endorsed by Committee on Design.

Submitted By:
Kelly Hardy
AASHTO staff
Design-Technical Committee on Roadside Safety

Priority #: 5

Comments:

TCRS ranked this research its #5 priority (of 5 submitted).

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-C-05

Problem Title

Safety Risks of Occupant Compartment Damage During Crashes

Background Information and Need For Research

Each year, there are significant numbers of road departure crashes that result in serious injuries and fatalities. Many of these crashes involve impact events with roadside safety hardware and features. Since the early 1960s, there has been an evolution of safety performance guidelines used to evaluate the crashworthiness of roadside features.

The American Association of State Highway and Transportation Officials (AASHTO) uses the Manual for Assessing Safety Hardware (MASH) to crash testing and evaluation of roadside features. Quantifying intrusion and deformation of the occupant compartment is part of deciding if a roadside feature is crashworthy. The evaluation criteria states that the test article should not show potential for penetrating the occupant compartment. It is believed that more clarity is required within MASH to address the potential of penetration.

Although test article penetration is partially addressed, the MASH 2016 impact safety criteria does not clearly address the potential risks when vehicle components penetrate the occupant compartment. In some crash test scenarios, vehicle components may penetrate further into the occupant compartment than that for components of test articles. Therefore, there exists a need to address whether vehicle component penetration into the occupant compartment should be considered similarly to test article penetrations.

Currently, it is proper to re-examine the MASH limits for occupant compartment deformation and the risks associated with test article penetration. It may be necessary to decide if vehicle component penetration poses similar risks to occupants and propose limits for vehicle component penetration.

Ideally, an objective crash data from police reports would be used to develop deformation and penetration limits. There are concerns that crash reports lack details on penetrations and occupant compartment deformation.

In recent years, there has been an increase in electric vehicles (EVs) in the United States. Limited real-world crash data has already shown potential fire risks for EV crashes. In the future, penetration and deformation criteria may be more critical.

In summary, this research study will focus on improvements and clarifications to the MASH guidelines as they pertain to deformations of and penetrations into the occupant compartment.

Literature Search Summary

Below is a sampling of crash tests where there has been penetration by test article, penetration by vehicle components, or excessive occupant compartment crush.

Sample Literature:

Faller, R., Rosenbaugh, S., Bielenberg, R., Lechtenberg, K., Holloway, J., Stolle, C., Schmidt, J., Reid, J., and Pajouh, M., Investigation and Mitigation of Post Penetration into Floor Pan of 1100C Small Cars, Transportation Research Board, Transportation Research e-Circular No. E-C220, First International Roadside Safety Conference, San Francisco, California, June 2017. [Numerous post penetrations through the floor pan areas of small passenger vehicles were encountered during the development of cable barrier systems.]

Bielenberg, R.W., Asselin, N.M., and Faller, R.K., MASH TL-3 Evaluation of Concrete and Asphalt Pin Tied-Down Anchorage for Portable Concrete Barrier, MwRSF Research Report No. TRP-03-386-19, Performed for the Wisconsin Department of Transportation, Performed by Midwest Roadside Safety Facility, University of Nebraska-Lincoln, April 12, 2019. [Left-front wheel pushed open left-side lower side panel and floor pan/toe pan, resulting in rim penetration into occupant compartment.]

Polivka, K.A., Faller, R.K., Sicking, D.L., Rohde, J.R., Bielenberg, B.W., Reid, J.D., and Coon, B.A., Performance Evaluation of the Free-Standing temporary Barrier – Update to NCHRP 350 Test No. 3-11 (2214TB-1), MwRSF Research-Report No. TRP-03-173-06, Performed for the National Cooperative Highway Research Program (NCHRP), Performed by Midwest Roadside Safety Facility, University of Nebraska-Lincoln, October 11, 2006. [Left-front wheel was dislodged, became pinched between concrete barrier and vehicle, then contacted and shattered left-side driver's window.]

Rasmussen, J., Faller, R., Lechtenberg, K., Sicking, D., and Holloway, J., Safety Investigation and Guidance for Work-Zone Devices in Freight Transportation Systems Subjected to Passenger Car and Truck Impacts with New Crash Standards, MwRSF Research Report No. TRP-03-225-10, MATC-UNL Report No. 100, Performed for the Mid-America Transportation Center and the Smart Work-Zone Deployment Initiative, Performed by the Midwest Roadside Safety Facility, University of Nebraska-Lincoln, March 1, 2010. [Components of 350-approved WZTCDs penetrated passenger vehicles under MASH TL-3 testing.]

Research Objectives

For this research study, several objectives are expected:

1. Review and standardize the MASH language for deformation, intrusion, and penetration of test vehicles.

2. Review and document historical research on deformation limits for the MASH impact safety guidelines/standards.
3. Examine whether the existing deformation limits and areas of concern are suitable, and recommend changes to the deformation limits, as needed. Clarify or develop protocols for handling boundaries between regions with varied deformation limits.
4. Review the types, locations, and extents of occupant compartment penetrations, and the potential for penetration, by roadside safety features into passenger vehicles and heavy trucks.
5. Review the types, locations, and extents of occupant compartment penetrations, and the potential for penetration, by vehicle components into passenger vehicles and heavy trucks.
6. Propose methods for investigating and deciding motorist risks from occupant compartment penetrations, such as through biomedical analysis, computer simulation, component testing, full-scale crash testing, review of crash tests, real-world crash data, etc.
7. Investigate and classify the risks associated with roadside safety feature penetrations into the occupant compartment of passenger vehicles and heavy trucks.
8. Investigate and classify the risks associated with vehicle component penetrations into the occupant compartment of passenger vehicles and heavy trucks.
9. Considering motorist risks, decide efficacy of existing MASH penetration guidance. Determine potential changes to MASH penetration guidance. Compare and discuss the motorist risks associated with existing and suggested vehicle penetration guidance and the associated safety benefits.
10. As needed, develop recommendations for consideration to update the deformation limits and penetration guidelines in MASH.
11. As needed, prepare a list of future research needs identified in this project and note the estimated funding needs, anticipated tasks, and program periods.

Urgency and Potential Benefits

There is a need to review and clarify existing penetration and occupant deformation criteria. There may be some low-risk penetrations that may be acceptable (e.g. a bolt head that has penetrated a windshield with little risk of injuring vehicle occupants). MASH needs to address vehicle component penetration into the cab and the risk of occupant injury. MASH may need to consider risks to EV and crashes into roadside hardware.

This research is ranked priority number 2 out of 5 by the AASHTO Technical Committee on Roadside Safety. This research is endorsed by the AASHTO Committee on Design.

Implementation Considerations

Results from this research study will be forward to the AASHTO Technical Committee for Roadside Safety (TCRS) for consideration in a future update to the MASH safety performance guidelines. There exists a high potential for these research findings to be implemented and result in the use of improved and more effective roadside safety feature across U.S. highways and roadways.

Recommended Research Funding and Research Period

\$750,000

3 years and 0 months

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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NCHRP Review of C-05

Reviewed By:
 Richard A. Retting
 rretting@nas.edu

Comments:

The problem statement provides solid background information, documents the need for research, and provides clear research objectives. Rapid growth in the prevalence of EVs – and potential fire risks associated with penetration of EVs – seems important and worthy of research. The problem statement does not mention any potential implication regarding rapid growth in the prevalence of SUVs, and potential implications for penetration. One thing to keep in mind when considering prioritizing this research topic over other problem statements is the contained provision in the recently-passed Infrastructure bill that mandates anti-drunk driving technology in new vehicles, which is projected to prevent thousands of drunk driving deaths annually. Vehicles equipped with the new technology will start rolling off assembly lines as early as 2026. Approximately 40% of drivers killed in fixed-object crashes have blood alcohol concentrations (BACs) at or above 0.08 percent. That technology should significantly reduce exposure to penetration associated with roadway departure crashes. In terms of the suggested funding of \$750,000, if that amount proves insufficient to support the stated research objectives consideration can be given to eliminating (or de-emphasizing) heavy trucks from the proposed research given the substantial height of the passenger compartments in heavy trucks, which reduces the risk of penetration compared to passenger vehicles. It is not even clear that heavy trucks are exposed to significant risk of passenger compartment penetration under existing MASH testing criteria.

Review Date:
12/4/2021

FHWA Evaluation of C-05

Reviewed By:
Roadway Departure

Comments:

With changes to the vehicle fleet there will need to be a reassessment of what is considered to be acceptable occupant compartment damage. We are not sure that this needs to happen now, but as times goes by and vehicle fleet is updated, its importance will be greater.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for C-05

Submitted By:
Patricia Bush
AASHTO staff
Committee on Design

Priority #: N/A

Comments:

Endorsed by Committee on Design.

Submitted By:

Kelly Hardy

AASHTO staff

Design-Technical Committee on Roadside Safety

Priority #: 2

Comments:

TCRS ranked this research its #2 priority (of 5 submitted).

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-C-06

Problem Title

Impact of Flooding and Inundation on the Resiliency of Pavements

Background Information and Need For Research

The resiliency of pavements after inundation by flooding will gain greater significance in the foreseeable future. For many years, transportation agencies have dealt with the aftermath of flooding from major storm events, but the threat of sea level rise from global climate change now looms more ominously. During the 20th century, the sea level rose 15-20 centimeters (roughly 1.5 to 2.0 mm/year), with the rate accelerating towards the end of the century.

Climatological projections predict an even faster sea level rise in the 21st century. For example, the Southeast Florida Regional Climate Change Compact is estimating the SE Florida region will experience an increase between 9 and 24 inches in the next 50 years. To help mitigate some of the impacts, the region has already implemented \$400 million worth of mitigation/adaption projects of to construct 2 pump stations to in part to keep the roads from flooding.

FHWA Technical Brief on Climate Change and Pavement Sustainability (FHWA-HIF-15-015) provides an introduction on how pavements may be fortified against climate change impacts due to extreme conditions, such as longer heat waves and severe flooding, and explains how these changes will accelerate the deterioration of highway pavements. However, it recognizes that the state of the practice is largely limited to general observations and is lacking with regards to specific adaptation strategies.

This proposed research will answer the following questions:

1. What is the impact of flooding on the short- and long-term resiliency of pavements?
2. What is the sensitivity of individual pavement design features to mitigate or reduce the negative effects of flooding on resiliency?
3. What asset management strategies can be used for pavements exposed to prolonged flood events?

This relates to AASHTO Committee on Materials and Pavement's (COMP's) Strategic Plan - Goal 1.1 – Update Materials Standards and Goal 3 – Develop and Champion Research for COMP.

Literature Search Summary

Existing research documentation related to this topic discuss primarily real-time assessments of flooded pavements for purposes opening back to traffic, and reducing water intrusion through pavement design, materials selection and construction methods. No comprehensive resiliency evaluation of inundated pavements of all types, accompanied by full scale testing, has occurred.

Research Objective

The objective of this research is to determine the impact that submergence and inundation related to flooding and sea-level rise have on the long-term performance of a pavement system and provide guidance on improving pavement resiliency. It is anticipated the work will be structured as shown in the following phases and tasks:

Phase 1

Task 1. Conduct a literature review of the performance of pavements with respect to inundation and submergence. Summarize the information collected noting pertinent results as appropriate. Identify any gaps in the information. Document the results in a technical memorandum.

Task 2. Develop a detailed research plan to address the knowledge gaps identified in Task 1. It is anticipated this plan would include building laboratory and full-scale, asphalt and concrete pavement test sections that can be inundated so that the differences in the short term responses (e.g. stress, strain and deflection, etc.) and accelerated load testing performances (faulting, cracking, deflection, material properties etc.) between flooded and non-flooded test sections could be evaluated. Another portion of the research could entail doing pavement testing on pavements inundated by flooding from actual events from storms in order to compare the field results with the laboratory and full-scale test results.

Task 3. Prepare an interim report that documents the research performed in Phase I. Include an updated work plan for Phase 2.

Phase 2

Task 4. Execute the work plan approved in Task 3. Based on the results of this work, recommend a methodology for quantifying the impacts of flooding on pavements. Identify pavement properties that may influence performance and identify test methods and protocols (e.g., FWD, GPR or other tests/instrumentation) that can be used to evaluate and/or quantify the near-term load capacity and the long-term pavement damage / performance reduction caused by inundation.

Task 5. Document results and propose guidelines, standard practices, training sessions and other activities that can be given to practicing engineers for limiting flood damage to new and existing concrete pavements.

Task 6. Perform technology transfer / training concerning the project findings, guidelines and tools in a one-day pilot workshop to FHWA and DOT participants. Revise project

training materials and deliverables, as necessary, based on comments received following this workshop.

Task 7. Submit final versions of all project training materials and deliverables, along with a final report that documents the entire research effort.

Urgency and Potential Benefits

Weather and flooding events already negatively influence pavement systems. Many States; including Louisiana, Florida, North Carolina, Colorado, Vermont, Tennessee, Iowa, Texas, Missouri and Nebraska; have experienced severe precipitation events and flooding during the past several years. Fortification of pavement systems is critically needed in areas of potential flooding.

Implementation Considerations And Supporters

The results of this work will be disseminated to transportation departments through training, such as webinars, and will be adopted by them through guidelines for modifications of pavement design methods, construction specifications, material specifications, etc.

AASHTO Committee on Materials and Pavements (COMP) – Ranked #1

TRB committees and Chairs

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TRB Committee AKP30 – Asphalt Pavement Design and Rehabilitation, Dave Timm, 334-844-6282, timmdav@auburn.edu

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TRB Committee AKC60 – Asphalt Pavement Construction and Rehabilitation, Adam Hand, 775-784-1439, adamhand@unr.edu

Recommended Research Funding And Research Period

Recommended Funding: Estimated cost of research and development is \$650,000.

Research Period: 24 months.

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

James W. Mack, CEMEX, jamesw.mack@cemex.com

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Members of AASHTO COMP Technical Subcommittee 5d - Pavement Design, John Donahue (Chair), 573-526-4334, john.donahue@modot.mo.gov

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Mark E. Felag, AASHTO COMP Secretary on behalf of AASHTO COMP, 401-245-1327, mfelag@hotmail.com

Note: This was ranked #1 for COMP.

NCHRP Review of C-06

Reviewed By:

Edward T. Harrigan
eharriga@nas.edu

Comments:

The problem is potentially solvable through the proposed research. The problem statement rightly emphasizes the impact of flooding and inundation on pavements in both coastal areas due to sea level rise and in the interior United States due to the likely increase in extreme weather events. Thus, the research results will be generally applicable to all the state DOTs. The problem statement relates to the AASHTO Committee on Materials and Pavement's (COMP) Strategic Plan - Goal 1.1 – Update Materials Standards and Goal 3 – Develop and Champion Research for COMP, and it is ranked #1 by the committee.

The objective statement is clear and concise, and the scope is ambitious but achievable.

The suggested period of performance is 24 months. An increase to 36 months is recommended due to the need to build and test pavement sections in the laboratory and evaluate pavements in the field.

Considering the scale of the proposed testing, a budget of \$1,000,000 is recommended.

Review Date:

12/9/2021

FHWA Evaluation of C-06

Reviewed By:

Amir Golaripour/HRDI; Robert Kafalenos, Elizabeth Habic - HEP

Comments:

Amir Golalipour - We have finished a study on ""Assessing Flooded Pavements"" project. The project objectives are 1) develop methods to assess flooded pavements; 2) assess the capacity to carry traffic during/after flooding; 3) evaluate emergency or heavy equipment; 4) evaluate normal traffic; 5) determine the tradeoff between the user costs of road closure (and detours) versus the costs of increased road damage; and, 6) develop a decision support tool. This project report is expected to be published in 2022. Also, there is ongoing work by NOAA and FHWA focused on nature-based solutions and pavement inundation. One of the project's objectives is to predict the effects of SLR and inundation on surface transportation infrastructure under varying risk mitigation and management strategies. Then, this proposal could be updated to address the gaps identified. In the Task 1 lit review, good to include an FHWA pilot on asset mgt and resilience in Texas, and papers by Elshaer et al (2017) that grew out of the TFHRC flooded pavement project. In Task 2, suggest clarifying what portions of the work needs to be conducted in the lab versus outside. Are there ways to reduce costs by picking one over the other? In Task 5, why limit to concrete pavements? Suggest broadening to include asphalt, or clarify in the title that this is just for concrete pavements.

Robert Kafalenos, Elizabeth Habic - This looks like a really useful proposal. However, we recommend waiting a year to see the results, or preliminary progress, on some ongoing research that the Turner Fairbank Highway Research Center is conducting.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for C-06

Submitted By:

Casey Soneira
AASHTO staff
Committee on Materials & Pavements

Priority #: 1

Comments:

Knowing the impacts of flooding on our pavements will greatly help states with strategies to minimize the impacts in the short and long term through modifications in pavement design methods, specifications and guidelines. #1 Ranking from COMP and #1 from the Pavement side of our Committee (ranking was from the Chairs of the Technical Subcommittees approved by the Steering Committee).

Submitted By:

Kelly Hardy
AASHTO staff
Design-Technical Committee on Roadside Safety

Priority #: N/A

Comments:

Although this project doesn't have a direct impact on roadside safety, flooding continues to be a growing problem, especially with global warming. Understanding the undermining of inundated pavements and recognizing this distress is important to develop strategies to protect against sudden pavement failures, which in turn could lead to more crashes including hazard avoidance run-off-road crashes.

Submitter Response for 2023-C-06,From:

[email: mfelag@hotmail.com;csoneira@aashto.org, jamesw.mack@cemex.com]

Comments:

Response to NCHRP Comments:

NCHRP Comment - Suggest increasing the time to 36 months and the cost to \$1 mil.

Action: Agree. Change Funding to \$1,000,000 and Research period to 36 months

Response to FHWA Comments:

FHWA Comment:- 'In the Task 1 lit review, good to include an FHWA pilot on asset mgt and resilience in Texas, and papers by Elshaer et al (2017) that grew out of the TFHRC flooded pavement project'

Action - Edit Task 1 to say 'Conduct a literature review of the performance of pavements with respect to inundation and submergence, including recent FHWA studies.

Summarize the information collected noting pertinent results as appropriate. Identify any gaps in the information. Document the results in a technical memorandum.

FHWA Comment - 'In Task 2, suggest clarifying what portions of the work needs to be conducted in the lab versus outside. Are there ways to reduce costs by picking one over the other?'

Discussion - My original intent of the research was to look at different structural features of asphalt and concrete pavement systems, some of which may be evaluated in the lab while others may require full scale accelerated pavement test sections (e.g. accelerated loading type facility such as ALF, HVS, etc.) to see which features would improve performance. No long term field investigations were anticipated. It was left somewhat vague so that the proposers could optimize the research based on their facilities.

Action - Edit Task 2 to say 'Develop a detailed research plan to address the knowledge gaps identified in Task 1. It is anticipated this plan would rely primarily on constructing full-scale, asphalt and concrete pavement test sections with different design features in a laboratory and/or accelerated pavement test section setting that can be inundated, so

that the differences in the short term responses (e.g. stress, strain and deflection, etc.) and accelerated load testing performances (faulting, cracking, deflection, material properties etc.) between flooded and non-flooded test sections could be evaluated. However, testing may be supplemented in the field with pavements inundated by flooding from actual weather events, in order to compare the field results with the laboratory and/or accelerated pavement test results. Costs should be carefully optimized between laboratory and field testing.'

FHWA Comment - 'In Task 5, why limit to concrete pavements? Suggest broadening to include asphalt, or clarify in the title that this is just for concrete pavements.'

Action - Edit Task 5 to say 'Document results and propose guidelines, standard practices, training sessions and other activities that can be given to practicing engineers for limiting flood damage to new and existing concrete and asphalt pavements.'

FHWA Comment- We recommend waiting a year to see the results, or preliminary progress, on some ongoing research that the Turner Fairbank Highway Research Center is conducting.'

No Action Required. - thank you for the comment but recommend NO CHANGE. I am aware of this research, but also believe that by the time a researcher is selected by the NCHRP panel for this project, and it is started, it will be 6 to 12 months and those research results will be available for the literature review. Note this reason I highlighted "recent FHWA studies" above and not just the FHWA pilot, and papers by Elshaer et al.

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Review Date:

January 28, 2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2021 NCHRP Problem Statement Outline

Problem Number: 2023-C-07

Problem Title

Earthquake-Induced Bridge Displacements

Background

Highway bridges are designed to resist most “normal” loads elastically. For example, steel members are not expected to yield and no permanent deflections result due to the design dead, live or wind loads. On the other hand, seismic demands can be so large that bridges cannot resist these forces elastically. Yield stresses are exceeded and permanent deformations are likely to occur due to earthquake loading.

Seismic design of common bridges using the AASHTO *LRFD Bridge Design Specifications* and the AASHTO *Guide Specification for LRFD Seismic Bridge Design* methodologies rely on an elastic analysis from which inelastic demands are estimated. Seismic bridge response is classified in four Seismic Design Categories (SDC). SDC A is the lowest seismic hazard and presumes an elastic response during the design seismic event. Bridges located in SDC B, C and D are likely to experience inelastic demands during the design seismic event. About half of the country is subject to SDC B, C or D seismic demands. The equal displacement assumption has the same consequences on bridges designed using the force-based AASHTO *LRFD Bridge Design Specifications* and the displacement-based AASHTO *Guide Specifications for LRFD Seismic Bridge Design*. This is not just a “seismic state” concern.

It is difficult to perform nonlinear analysis of bridges. Inelastic analysis requires special computer programs that can calculate bridge response due to ground shaking (i.e., accelerograms that are themselves difficult to develop). As with most sophisticated analysis, user knowledge and experience is required to develop, interpret and verify the computer results. Due to these challenges, engineers (and the AASHTO specifications) use an approximate method of seismic analysis wherein the inelastic bridge response is estimated using an elastic bridge model. These elastic analysis methods are founded on the “*equal displacement assumption*” in which the “real” inelastic bridge is replaced by a fictitious elastic bridge that never yields.

The equal displacement approximation was introduced over 60 years ago but is not based upon significant physical validation. Advances in numerical and physical methods suggest that the equal displacement approximation underestimates the “real” seismic displacement demands. Consequently, bridges may not perform as intended when using elastic analysis methods used for most designs. The potential underestimation associated with the AASHTO provisions was verified by the recently completed NCHRP 12-106 project.

The goal of this project is to examine the equal displacement approximation and, if necessary, developed simple, reliable adjustment factors that can modify the elastic displacement predictions to better match the “real” inelastic displacement response. These design recommendations will allow engineers to better predict seismic demands resulting in safer, more reliable bridges.

Literature Search Summary

It appears that the manner in which damping is modeled may be the reason for the underestimation of seismic displacement demands. An abbreviated list of references related to the impact of damping models in structural response is shown below.
Chai, Y.H., and Kowalsky, M.J. (2014). “An Examination of Non-Viscous Damping on Seismic Inelastic Displacements” *Journal of Structural Stability and Dynamics*, Vol. 15#5.

Lanzi and Luco (2018). “Elastic velocity damping model for inelastic structures,” *ASCE Journal of Structural Engineering*, Vol. 144#6.

Priestley, M. J. N. and Grant, D. N. (2005). “Viscous Damping in Seismic Design and Analysis” *Journal of Earthquake Engineering* Vol. 9 #SP2, pp229–255.

Research Objective

The objective of the research is to develop robust yet simple procedures for calculation of inelastic displacement demands in bridges subject to earthquake demands. Specifically tasks:

Task 1: Identify and summarize the current literature on non-linear bridge response and the impacts of damping models on displacement estimation

Task 2: Review current techniques for evaluating displacement demands and compare them against the results of non-linear response history analysis for both single degree of freedom and multiple degree of freedom bridge systems.

Task 3: Prepare an interim research report documenting the results of Tasks 1 and 2.

Task 4: Develop recommendations for approaches to calculate inelastic displacement demands, as well as recommendations for appropriate damping models when non-linear response history analysis is deployed as part of design verification.

Task 5: Address review comments and prepare final research report presenting the complete results of the research.

Task 6: Develop draft AASHTO design requirements, design examples and draft ballot language

The final products of this project will be (a) methodology for accurately determining seismic displacement demands, (b) requirements for the modeling of damping in non-linear response history analysis and (c) AASHTO ballot-ready language for use in the AASHTO LRFD Bridge Design Specifications and Guide Specifications for LRFD Seismic Bridge Design.

Urgency and Potential Benefits

Current methods for evaluating displacement demands may be substantially non-conservative, leading to bridges that may sustain much higher displacements (and hence damage or collapse) than what was expected during the design phase.

Implementation Considerations and Supporters

Updated analysis recommendations for both the *AASHTO Guide Specifications for LRFD Seismic Bridge Design* and the *AASHTO LRFD Bridge Design Specifications*. AASHTO T-3 is the most relevant committee to assist in implementation.

Estimate of Problem Funding and Research Period

Recommended Funding: **\$450,000**

Research Period: thirty-six **(36)** months.

Problem Statement Author(s)

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Others Supporting the Problem Statement

Tom Ostrom, CALTRANS

Derek Soden, FHWA

Potential Panel Members

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Nico Luco, Research Structural Engineer, USGS. 303-273-8683, nluco@usgs.gov

Ian Buckle, Professor, University of Nevada Reno. 775-784-1519. igbuckle@unr.edu

Person Submitting the Problem Statement

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NCHRP Review of C-07

Reviewed By:

Ahmad Abu-Hawash

aabu-hawash@nas.edu

Comments:

This research is appropriate for NCHRP. A potential benefit of this research is more accurate seismic analysis which may result in a better understanding of seismic performance. Outcome of the research can be implemented through collaboration with AASHTO COBS T-3.

Budget of \$450,000 seems high considering that there is no experimental work involved. Research is limited to the evaluation of the current practice, specifically, the examination of equal displacement approximation and development of adjustment factors to modify the elastic displacement predictions to match the “real” inelastic displacement response.

Review Date:

12/7/2021

FHWA Evaluation of C-07

Reviewed By:

Derek Soden/HIBS-10

Comments:

This topic has been a priority for AASHTO COBS T-3 and is of interest nationally since it will validate (or update) core design assumptions and will guide future seismic (and other Extreme Event limit state) design guidance development.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for C-07

Submitted By:

Patricia Bush

AASHTO staff

Committee on Bridges & Structures

Priority #: 1

Comments: Committee on Bridges & Structures #1 of 8.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-C-08

Problem Title

Field Studies of Steel Girder Fit-up

Background Information and Need For Research

The fit condition of a steel I-girder bridge refers to the deflected geometry associated with a specific load condition in which the cross-frames or diaphragms are detailed to connect to the girders. With respect to vertical deflection, girders experience three conditions from inception to fabrication to completion of the bridge in place in the field: No-Load (NL), Steel Dead Load (SD), and Total Dead Load (TDL). As such, there are three fit conditions for steel girder bridges: : No-Load Fit (NLF), Steel Dead Load Fit (SDLF), and Total Dead Load Fit (TDLF). Consideration of the fit condition is important because the appropriate fit decision can provide significant benefit to the constructability and the overall performance of the bridge system (1). The AASHTO LRFD Bridge Design Specifications (Article 6.7.2) specify that the fit condition of the cross-frames or diaphragms should be clearly stated in the contract documents for straight I-girder bridges with skewed supports, and horizontally curved I-girder bridges with or without skewed supports. If the appropriate fit condition is not selected, the bridge could be subjected to problems during erection and construction. It could also result in systems that have errors in final steel vertical profile and cross-slope or other long-term problems.

Past studies of steel girder fit up have been only analytical. The project will include field measurements of existing steel girder systems to determine the condition of the girders relative to the design. Researchers will compare the field results to the fit condition that the girders were fabricated to. If necessary, current guidelines will be revised based on these field studies, and/or new guidelines on the best detailing practices impacting girder fit-up can also be established.

Tom Macioce of PennDOT and current Chair of AASHTO COBS Technical Committee T-14 has noted that if appropriate fit condition is not selected, the bridge could be subjected to problems during erection and construction. It could also result in systems that have errors in final steel vertical profile and cross slope, bearing performance, or other long-term problems.

- How is this problem statement related to the strategic plan or research agenda of an AASHTO Committee(s) and/or Council(s)?

Objective	How this Proposed Research Responds
1. Maintain and Enhance a Knowledgeable Workforce	The research findings would increase the overall knowledge of steel I-girder fit condition. It would also enhance the already analytical studies by conducting field measurements of existing bridges.
2. Maintain and Enhance AASHTO Specifications	The research findings could be implemented into the AASHTO LRFD Bridge Design Specifications and/or the AASHTO LRFD Bridge Construction Specifications.
3. Accelerate Bridge Delivery and Construction	With a streamlined fit condition detailing guide, designers, fabricators, and contractors will work more efficiently and consistently. Proper fit type selection will help to eliminate project delays that occur when girders do not fit together.
4. Structural Systems Optimize	The research could potentially benefit steel I-girder bridges by enhancing constructability and long-term performance.

Literature Search Summary

The authors of this RNS document are not aware of any other similar research underway.

Research Objective

The objective of this research project is to investigate the condition of steel girders in the field that were originally detailed for different fit conditions and compare analytically.

- Task 1 – Literature Review
- Task 2 – Finite Element Analysis
- Task 3 –Existing Bridge Selection – The research team would prepare a list of potential bridge candidates to perform the field testing on. The research team would obtain fabrication shop drawings for each bridge selected.
- Task 4 – Field Measurements of selected bridges
- Task 5 – FE Model Calibration and Parametric Studies – The research team would calibrate the FE Model based on the field results from Task 4. The research team would perform parametric studies, using finite element analysis, to investigate the different results of girder fit condition. The team will include different girder sizes and spans, horizontal curvature, skew angle, and other design variables in their study.
- Task 6 – Review Existing Guidelines and Develop New Guidelines – The research team will review existing guidelines (Ref 1) regarding steel bridge fit and offer revisions if necessary, or if required, develop new guidelines for choosing the best detailing method for steel girders.

- Task 7 – Develop Specification Language – The research team would review all results and propose revisions/additions to the AASHTO LRFD Bridge Design Specification if their recommendations differed from current practice.
- Task 8 – Final Report – The research team would submit all research findings, guidelines, and specification language for final review.

Urgency and Potential Benefits

This research priority is high. The potential users of this research would be the bridge engineering and construction community. This project will provide a foundation to base an engineer's decision on girder-fit up and potentially have a positive impact on steel bridge constructability. It will also provide an assessment of long-term behavior of the girders as a function of the as-built condition. This work is applicable to all DOTs, even states where concrete bridges are common. Steel bridges are often selected for complex situations such as curved bridges and bridges with high skews. Proper management of girder fit-up will help to eliminate problems and address common misconceptions on complex steel bridge construction.

Implementation Considerations

The implementation of this research can take several forms including developing a separate guideline document or adding provisions for the AASHTO LRFD Bridge Design and Construction Specifications.

The most logical location to implement this research results is within existing steel bridge guidelines that are published by the ASHTO/NSBA Steel Bridge Collaboration. One potential document that this information could be added to is Guideline G12.1 Guidelines to Design for Constructability and Fabrication. Using this AASHTO document, states can modify their design and construction specifications to address this issue.

This research would be of interest to several AASHTO COBS Technical Committees including Committee T-4 Construction and T-14 Steel Bridges.

Recommended Research Funding and Research Period

The research effort is anticipated to last 36 months. The research effort is anticipated to cost \$500,000.

PROBLEM STATEMENT AUTHOR(s): For each author, provide their name, affiliation, email address and phone.

Jamie Farris, PE; Texas Dept. of Transportation; Jamie.Farris@txdot.gov
 Brandon Chavel; National Steel Bridge Alliance; chavel@aisc.org

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

- Members of T-14 and AKB20, Authors of the statement

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

- Jamie Farris
 - 512-788-4932
 - Jamie.farris@txdot.gov
 - Affiliation (limited to): Texas DOT
-

NCHRP Review of C-08

Reviewed By:

Ahmad Abu-Hawash
aabu-hawash@nas.edu

Comments:

This research is appropriate for NCHRP. Conducting field studies to validate current detailing guidelines for assumed fit condition is beneficial to all bridge owners and practitioners. The product of this research is implementable through collaboration with AASHTO in the form of bridge design and construction specifications update.

Budget of \$500,000 seems high considering that there is no experimental work involved.

Review Date:

12/7/2021

FHWA Evaluation of C-08

Reviewed By:

Derek Soden/HIBS-10

Comments:

This statement looks complete and addresses a core need related to steel design-for-fabrication considerations.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for C-08

Submitted By:

Patricia Bush

AASHTO staff
Committee on Bridges & Structures

Priority #: 5

Comments:

Committee on Bridges & Structures #5 of 8.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT OUTLINE

AKB50 Seismic Design and Performance of Bridges

Problem Number: 2023-C-09

Problem Title

Impact of Directionality on Response Spectra for Seismic Bridge Design

Background Information and Need for Research

Seismic design maps for bridge structures were last updated over 10 years ago, and a current AASHTO project aims to update these maps to consider numerous developments, including a transition to uniform risk spectra. However, the current update does not address the impact of directionality, largely as a result of a lack of research. The primary issue at hand is the response spectra definition and its impact on displacement demand estimation. Significant underestimation of displacements (and hence damage) may occur.

Response Spectra Definition

Over the last decade, a debate has been underway in the earthquake engineering community with regards to the appropriate definition for design response spectra (Stewart et al., 2011). The essence of the argument relates to the representation of bi-directional motion via response spectra. Seismic demands for bridge structures have been established via the geometric mean (approximately RotD50) across all rotation angles for recorded earthquake ground motions. However, in the case of building structures, ASCE-7 defines the hazard on the basis of the maximum values across all rotation angles (RotD100), which is computed from conversion factors applied to the available RotD50 hazard maps (BSSC, 2009; Huang et al, 2008).

The implications of the choice of response spectra definition for single column bridges has been evaluated by Palma and Kowalsky (2020). Shown in Figure 1 is the mean ratio of actual to expected displacements for 84,000 columns designed with direct displacement-based design to ground motions from both shallow crustal and subduction zone regimes (42,000 per tectonic regime). For each tectonic regime, two definitions (RotD50 and RotD100) are considered. Column ductility from 1 to 8 are considered with effective periods ranging from 1 to 5 seconds. The mean values for structures designed to RotD50 are as high as 1.57 for shallow crustal regions, meaning that displacements may be 55% higher than expected for this regime, and on average up to 65% larger than expected for structures designed to spectra from subduction zone regime. *This is problematic as it may lead to substantially more damage in a bridge structure than a designer intended.*

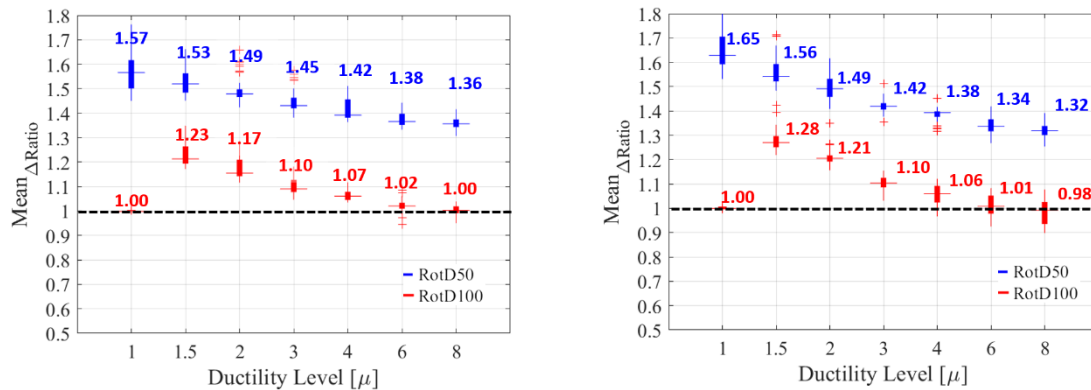


Figure 1: Comparison of Actual to Expected Displacement for RotD50 and RotD100 (Palma & Kowalsky, 2020)

While designing single column bridges to RotD100 is clearly appropriate, the answer is not so obvious for multi-span bridges, including those with multi-column bents, skew, and curved alignments. The evaluation of “real bridges” is essential before recommendations on appropriate response spectra definition can be developed.

Literature Search Summary

Boore et al. (2006) and Boore (2010) introduced orientation-independent measures of seismic intensity from two horizontal ground motions. Boore et al. (2006) proposed two measures of the geometric mean of the seismic intensity, which are independent of the in situ orientations of the sensors. One measure uses period-dependent rotation angles to quantify the spectral intensity, denoted GMRotDnn. The other measure is the GMRotlnn, where I stands for period-independent. GMRotI50, was adopted as the ground motion intensity measure used in the ground motion prediction equations (GMPEs) developed during the Pacific Earthquake Engineering Research center’s Next Generation Attenuation of Ground Motions Project (NGA-West1), which concluded in 2008.

Since more users expressed the desire to use the maximum spectral response over all the rotation angles without geometric means, Boore (2010) introduced the measures of ground shaking intensity irrespective of the sensor orientation. The measures are RotDnn and Rotlnn, whose computation is similar to GMRotDnn and GMRotlnn without computing the geometric means. While the RotI50 was an adequate measure of the median response, the Rotlnn measure showed inconsistencies when calculating the maximum response. Because RotI100 used a single orientation of the ground motion, the maximum response at each period may occur in different orientations so it will not result in the maximum spectral amplitude for all periods, which was a limitation. On the contrary, RotD100 had the characteristic of resulting in the true spectral maximum response for each oscillator period. Due to this reason, the RotDnn measure was chosen for use in the NGA-West2 models (Ancheta et al., 2014).

With regards to impact on seismic response the opinion paper by Stewart et al. (2011), and the work by Mackie et al. (2011) on impact of incidence angle on bridge response

are relevant. Specifically, Stewart et al. (2011) noted the importance of computational analysis of structures (that had not been done as of 2011) in proposing appropriate spectra definitions.

Research on the impacts of directionality on bridge response is limited. Nievas and Sullivan (2017) studied the effects of directionality on the behavior of structures, focusing on structure typology. They evaluated the response of an ‘azimuth independent’ versus that of ‘azimuth dependent’ structures to characterize the sensitivity of the geometrical configurations to the directionality of the motion. From a probabilistic perspective, Feng et al. (2021) assessed the effect of ground motion directionality on the performance of a long curved bridge in terms of monetary repair loss. They noted that the total bridge loss becomes gradually independent of the seismic excitation direction as the seismic intensity and damage increase. Furthermore, ongoing research at NC State by Palma and Kowalsky on multi-span bridge directionality effects will also be relevant to identify gaps in knowledge that must be addressed prior to the development of code-ready language.

Research Objective

The objective of this RNS is to develop recommendations on the appropriate definition of response spectra for wide classes of bridges. This research is consistent with the AASHTO Committee on Bridges and Structures Action Plan including *Maintain and Enhance the AASHTO Specifications* (Goal 4). Specific tasks of the research to accomplish the main objective include:

- Task 1: Identify current research.
- Task 2: Establish a work plan to develop the appropriate response spectra definition for bridge design that includes the selection of NN (i.e., median, maximum, or other).
- Task 3: Prepare an interim research report documenting the results of Tasks 1 and 2.
- Task 4: Execute the work plan.
- Task 5: Address review comments and prepare final research report.
- Task 6: Develop draft AASHTO ballot language and design examples.

Urgency and Potential Benefits

A current AASHTO project is updating the hazard coefficients with the latest mapped values based on ‘uniform risk’. However, the update does not address the urgent issue of response spectra definition (i.e., RotDNN). This omission was intentional since at the current time, the research does not exist to offer guidance regarding appropriate response spectra definitions. The results on this project will provide engineers with design guidance to reliably address this issue. Absent this research, it is possible that bridges may sustain displacement demands in excess of 150% of what they were designed for, leading to unexpected damage that in turn becomes difficult to explain to stakeholders.

Implementation Considerations and Supporters

Bridge design engineers will use the results of this research to more accurately predict seismic displacement demands.

Additional code and commentary language would be provided in the *AASHTO LRFD Bridge Design Specifications and Guide Specifications for LRFD Seismic Bridge Design* to address the project recommendations

Recommended Research Funding and Research Period

Recommended Funding: \$600,000

Research Period: 4 years

Problem Statement Author(s)

Mervyn Kowalsky and Ariadne Palma (Members of AKB50)
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Others Supporting the Problem Statement

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Potential Panel Members

Tom Shantz, retired Caltrans; Don Anderson, Jacobs; Carl Puzey, Illinois DOT; Nick Murray, Alaska DOT&PF; Rick Ellis, Arkansas DOT; Albert Nako, Oregon DOT; Tony Allen, Washington DOT; Derek Soden FHWA; Lee Marsh, WSP; Ian Buckle, UNR; Stephanie Brandenberger, Montana DOT

Person Submitting the Problem Statement

Richard A. Pratt, P.E. (Chair AASHTO T-3 Seismic Committee)
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References

Ancheta, T. D., Darragh, R. B., Stewart, J. P., Seyhan, E., Silva, W. J., Chiou, B. S.-J., Wooddell, K. E., Graves, R. W., Kottke, A. R., Boore, D. M., Kishida, T., and Donahue, J. L. (2013). PEER NGA-West2 Database, *PEER Report No. 2013/03*, Pacific Earthquake Engineering Research Center, University of California, Berkeley, CA.

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NCHRP Review of C-09

Reviewed By:

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aabu-hawash@nas.edu

Comments:

Budget of \$600,000 seems high considering that there is no experimental work involved. Furthermore, suggested research period of four years is beyond a typical NCHRP project. This work is better suited for a pooled fund project.

Review Date:
12/7/2021

FHWA Evaluation of C-09

Reviewed By:
Derek Soden/HIBS-10

Comments:

The statement doesn't address how the RotD50/100 directionality interplays with the 100%/30% directional load split used in current design specifications. Is the 55% underestimation mentioned in the problem statement with respect to demand calculated using the specified directional split? While still supportive of this statement, my job title needs to be updated in the statement. We would recommend prioritizing C-07 over this project.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for C-09

Submitted By:
Patricia Bush
AASHTO staff
Committee on Bridges & Structures

Priority #: 8

Comments:

Committee on Bridges & Structures #8 of 8.

Submitter Response for 2023-C-09

From:
[email: Richard.pratt@alaska.gov]

Comments:
FHWA Evaluation By: Derek Soden/HIBS-10
We offer this response:

This topic does not so much relate to the 100% / 30% RSA combination as to the manner in which the two-component orthogonal ground motions are combined into a singular spectra. Historically, the two orthogonal ground motions were combined using the geometric mean method [for example, $(x\text{-part} * y\text{-part})^{0.5}$] but more recently the "ROTDnn" method (a vector sum) has been used. In the ROTDnn method, the vector sum of the $\cos * x\text{-part} + \sin * y\text{-part}$ are combined over a suite of angles between zero and 180 degrees in small (say 5 degree) increments. The resulting spectra accelerations are organized from lowest (ROTD00) to highest (ROTD100) values. The mean value (ROTD50) is commonly used in lieu of the previous geometric mean combination. The question is, what ROTDnn should be used that best predicts the displacement demand of "real world" multiple degree of freedom structures? This project intends to address that issue and provide design specification language to clarify the appropriate ROTDnn or correction factor when using ROTD50 to best predict seismic displacement demands.

Review Date:December 17, 2021

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-C-10

Problem Title

Investigation of High-Mast Lighting Tower Large-Amplitude Vibrations

Background Information and Need For Research

Video evidence and field-measured time-history data have demonstrated high-mast lighting towers (HMLTs) are susceptible to large-amplitude vibrations. The videos depict HMLTs in first-mode harmonic resonance with tip deflections over five feet. Similar events have been observed throughout the US, in states such as Alaska, Kansas, Nebraska, South Dakota, Utah, Wisconsin, and Wyoming. Further, HMLT owners have reported collapse and severe fatigue damage during follow-up inspections. As most HMLTs are located directly adjacent to travel lanes, failure poses a high safety concern to the motoring public. For example, some of the video evidence, captured by passing motorists, depicts HMLTs vibrating in the median between travel lanes.

Large-amplitude vibrations can cause high stress ranges at fatigue sensitive details, leading to premature failure. Limited field-measured time-history data suggests a single event has the potential to expend the entire fatigue life of a pole. Additional data is required to identify the loading conditions that result in these large-amplitude vibrations. The objective of the proposed research is to conduct long-term remote monitoring to quantify the loading conditions resulting in large first-mode vibrations, thereby enabling the development of improved design procedures and effective mitigation strategies.

Literature Search Summary

In March 2011, a video was recorded in Watertown, South Dakota of a HMLT experiencing large-amplitude first-mode harmonic resonance. The initial observation occurred near the completion of an NCHRP study focused on developing the fatigue design loading for HMLTs (NCHRP Report 718). The NCHRP study monitored 11 HMLTs at eight locations over 24 months. Following the video evidence, the NCHRP 718 researchers examined the triggered time-history data from the study for any large-amplitude events. Two possible instances of large-amplitude first-mode harmonic resonance were identified during the review; however, neither case had calculated tip displacements on the order of magnitude of the displacements estimated from the Watertown, SD video.

Following the events from Watertown, SD and NCHRP 718, large-amplitude HMLT vibrations have been observed in additional states, specifically Alaska, Kansas, Nebraska, Utah, Wisconsin, and Wyoming. In addition, many HMLT owners have reported premature fatigue cracking and/or collapse, with some of the failures occurring within several years of initial installation. As a result, in 2017 the Wyoming Department

of Transportation funded a study attempting to capture the large-amplitude vibrations. The objective of the research was to use field-collected data to understand the loading condition(s) resulting in the rare loading phenomenon. The ongoing study is monitoring four HMLTs across the state of Wyoming. To date, the research has captured three events at two different monitoring locations. The largest recorded event had a peak stress-range of 78 ksi, corresponding to a calculated tip displacement range of 216 inches. Additional data is required to fully characterize the loading condition to make necessary improvements.

Research Objective

The objective of the research is to establish the loading condition(s) and determine potential mitigation strategies for HMLT large-amplitude vibrations. Study results should include developing recommended specifications for both AASHTO Standards and LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals to prevent large-amplitude vibration of new structures and/or propose mitigation strategies for existing inventory. The following are a list of major tasks required to successfully complete the research:

Task 1: Detailed literature synthesis

Task 2: Determine selection criteria for field testing and long-term monitoring and identify the monitoring sites

Task 3: Identify analytical methodology for predicting loading conditions and mitigation strategies

Task 4: Conduct field and analytical studies

Task 5: Develop proposed design recommendations and mitigation strategies

Task 6: Submit revised design recommendations and mitigation strategies (draft final report)

Task 7: Prepare and submit final report

Urgency and Potential Benefits

HMLTs are located directly adjacent to the motoring public; as such, any failure could have catastrophic results. The large-amplitude loading condition(s) have the potential to create large fatigue cracks in a short time period. Further, typical removal and replacement of a single HMLT is approximately \$80,000. Therefore, identifying the cause of the vibrations will reduce the number of premature failures, while implementing design and/or mitigation procedures will maximize the value of department of transportation (DOT) infrastructure investment today and in the future.

The previous and on-going data collection has demonstrated the large-amplitude vibrations are rare and difficult to capture. However, while rare, the large-amplitude event has a critical impact on the performance of the structure, and potentially catastrophic consequences. Additional monitoring locations are required to capture a sufficient amount of data in a reasonable timeframe. Ultimately, the proposed study will increase the likelihood for the loading condition(s) to be captured and quantified, thereby enabling potential strategies to be developed for future design and mitigation.

As a result, the study has the potential to directly impact the LRFD Specifications for Structural Supports for High Signs, Luminaries, and Traffic Signals.

Implementation Considerations

Research results would be provided to state DOT designers and leveraged to improve new HMLTs. Similarly, maintenance personnel would employ proven mitigation techniques to improve in-service performance of the existing inventory. Training seminars and webinars would be developed and used to rapidly educate appropriate personnel to be equipped to effectively implement the research results, namely the mitigation strategies to current structures. Further, a long-term implementation strategy includes updates to the LRFD Specification and a mitigation guidelines document.

The following list includes organizations interested in the research results and could help support implementation:

- AASHTO Committee T-12, Sam Fallaha, 850-414-4296, sam.fallaha@dot.state.fl.us
- TRB Sub-Committee AFF10(1), Carl Macchietto, P.E., (402) 359-6735, cmacchietto@valmont.com

Recommended Research Funding and Research Period

Research Funding: The recommended research funding for the proposed study is \$650,000, including \$50,000 for initial planning (Tasks 1-3), \$575,000 for experimental research (Task 4 and 5), and \$25,000 for final reporting and implementation activities (Tasks 6 and 7).

Research Period: The recommended research period for the proposed study is 36 months, including 6 months for planning (Tasks 1-3), 24 months for field testing and monitoring (Task 4), and 6 months for recommendation development, reporting, and implementation activities (Tasks 5-7).

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

- Ryan J. Sherman, Ph.D., P.E., Georgia Tech, (404) 894-2227, ryan.sherman@ce.gatech.edu
- Carl Macchietto, P.E., Valmont Industries, (402) 359-6735, cmacchietto@valmont.com

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Florida DOT, William Potter, AASHTO T-6 and T-10, William.potter@dot.state.fl.us;
Iowa DOT, Michael Nop, AASHTO T-7, Michael.Nop@iowadot.us; Missouri DOT, Bryan A. Hartnagel, bryan.hartnagel@modot.mo.gov
Michigan DOT, Matthew Chynoweth, AASHTO T-6 Chair, chynowethM@michigan.gov;
Nebraska DOT, Fouad Jaber, AASHTO T-10, fouad.jaber@nebraska.gov; Ohio DOT, Tim Keller, AASHTO T-7 Chair, tim.keller@dot.ohio.gov; Texas DOT, Bernie Carrasco,

AASHTO T-1 Chair, Bernie.carrasco@txdot.gov; Virginia DOT, Andrew Zickler, AASHTO T-6, T-7

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

- Sam Fallaha, Florida DOT, T-12, 850-414-4296, sam.fallaha@dot.state.fl.us
 - Wyoming DOT, Paul Cortez, (307) 777-4049, paul.cortez@wyo.gov
 - Valmont Industries, Carl Macchietto, (402) 359-6735, cmacchietto@valmont.com
 - National Steel Bridge Alliance, Jason B Lloyd, PhD, PE, (208) 421-4472, lloyd@aisc.org
-

NCHRP Review of C-10

Reviewed By:

Ahmad Abu-Hawash
aabu-hawash@nas.edu

Comments:

This research is suitable for NCHRP. Benefits of the research are applicable to all states, however, it may be limited due to the rare occurrence of large amplitude vibrations as stated by the submitter. Product of this research is implementable through collaboration with AASHTO in the form of bridge design and construction specifications update. Proposed budget of \$650,000 is reasonable for this type of work.

Review Date:

12/7/2021

FHWA Evaluation of C-10

Reviewed By:

Derek Soden/HIBS-10

Comments:

The problem statement doesn't provide much detail on the field testing regimen, so it's difficult to understand the proposed research will build on, or extrapolate, the data collected from the Wyoming project. In four years, that project has only observed three events, which is likely not enough data on which to make conclusions and establish design criteria and mitigation strategies. The proposed project period is only 36 months - how do they propose to gather data from more events than the existing project?

Review Date:

December 17, 2021

AASHTO Committee Evaluation for C-10Submitted By:

Patricia Bush
AASHTO staff
Committee on Bridges & Structures

Priority #: 4

Comments:

Committee on Bridges & Structures #4 of 8.

Submitted By:

Kelly Hardy
AASHTO staff
Design-Technical Committee on Roadside Safety

Priority #: N/A

Comments:

This project may have limited influence to the roadside safety, however this research is very important and has a high degree of urgency. High mast light is an important tool, and one that is able to keep light poles out of the clear zone, or to reduce the number of poles that must be installed in the clear zone. There are many failures occurring, and many more to happen if we don't understand the failure mechanism occurring in a number of states, as well as other countries. Structural design codes do not seem to be capturing the fatigue mechanism, so additional research is needed. There are many locations where the lighting system will have to be replaced which could have a very significant cost. States could lose some of the operation conveniences these lights have brought about.

Submitter Response for 2023-C-10From:

[email: arearick@indot.in]

Comments:

To address the concern from FHWA about a lack of detail on the field testing regimen and limited data from observed events, the Problem Statement Research Objective Tasks are proposed to be revised as follows:

Task 1: Detailed literature synthesis

Task 2:

- A- Propose hypothesis and analytical modeling to simulate and explain the phenomenon
- B- Propose wind tunnel testing to verify and calibrate the model.
- C- Once the simulations and wind tunnel testing converge, assess the conclusions and propose field testing and monitoring if needed.
- D- If field monitoring is needed, determine selection criteria for field testing and long-term monitoring and identify the monitoring sites

Task 3: ~~Identify analytical methodology for predicting loading conditions and mitigation strategies~~

Task 4: ~~Conduct field and analytical studies~~

Task 5: Develop proposed design recommendations and mitigation strategies

Task 6: Submit revised design recommendations and mitigation strategies (draft final report)

Task 7: Prepare and submit final report

Contact Info:

arearick@indot.in.gov and Sam.Fallaha@dot.state.fl.us

Review Date:

2/7/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2022 NCHRP PROBLEM STATEMENT OUTLINE

Problem Number: 2023-C-11

Problem Title

Effects of Operating Speed and Posted Speed Limit in Conjunction with Roadway Geometric Design on Safety Performance for High-Speed Rural Highways and Freeways

Background

Estimating the speed-crash relationship has long been of interest in roadway safety analysis. Because of the many contributing factors – such as roadway geometry and context, weather conditions, human factors, and vehicle type distribution – that influence both speeds and crashes, the relationship cannot be adequately established without considering the corresponding roadway geometric features, the dynamics of the vehicle and tire, and accounting for their effects on both speeds and crashes.

While a significant amount of research has been conducted to identify relationships between roadway design elements and crashes; research that has considered the contribution of operating speeds or posted speed is limited. A general subjective understanding of the contribution of operating speed of a highway or freeway, through the dynamics of the vehicle, on the severity of a crash (higher speeds are associated with more severe crashes) is known. What is desired is a quantitative understanding of how speed (both operating and posted) in conjunction with roadway geometry relates to the likelihood of a crash and crash severity.

This research would build on existing research to explore the relationships among design elements, speed, vehicle dynamics, and crashes on high-speed rural highways and freeways. These relationships will help inform future design guidance, posted speed practices, and potential safety countermeasures, which are related to desired outcomes for multiple AASHTO Committees, such as Design, and Traffic Engineering, Safety.

Literature Search Summary

The primary objective of NCHRP 17-76 was to develop a speed limit setting tool (guide and tool available at: <http://www.trb.org/main/blurbs/182038.aspx>); with part of the research funds, documented in a paper by Park et al (2021), investigating the speed-crash relationship for city streets. The speed-crash relationship jointly modeled speed, roadway characteristics, and crashes using a path analysis approach that has been recently introduced into safety analysis while incorporating a wide range of roadway- and traffic-related variables and additional speed measures. The results from the coherent path analysis identified multiple speed measures of interest that have a statistically significant association with crashes as well as having intuitive and useful interpretation. The results also supported a positive relationship between speed

variability and crash occurrence (i.e., larger spread/variability in operational speed is associated with more crashes).

The greater availability of speed data along with innovative statistical analysis techniques provides the opportunity to better consider operating speed in understanding the safety relationships among geometric design, traffic volume, posted speed limit, and crashes. Recent research efforts that should be considered in scoping the plans for collecting and analyzing data for freeways and high-speed rural highways include:

- National Cooperative Highway Research Program (NCHRP) Project No. 17-79, *Safety Effects of Raising Speed Limits to 75 mph and Higher*.
- NCHRP Project No. 17-92, *Developing Safety Performance Functions for Rural Two-Lane Highways that Incorporate Speed Measures*.
- FHWA Project *Development of Speed Crash Modification Factors (CMF) using SHRP-2 Roadway Inventory Database*.
- FHWA Project *Research Utilizing SHRP2 Data to Improve Highway Safety: Development of Speed–Safety Relationships*.
- USDOT *Rural Speed Safety Pilot Project*.
- TxDOT Project *Develop a Real-Time Decision Support Tool for Rural Roadway Safety Improvements*.
- FHWA's *Speed Concepts: Informational Guide* (FHWA-SA-10-001)

Research Objective

The objectives for this research are:

- (1) To identify the relationship(s) among roadway geometric characteristics, speed (posted and operating), and safety for high-speed rural highways and freeways.
- (2) To determine the relative contribution of speed (posted or operating) with various roadway geometric characteristics on safety for high-speed rural highways and freeways.
- (3) To determine if existing CMFs for geometric elements can be modified with a speed component (operational, posted), or if a speed related CMFs can be developed.

To explore the relationships among roadway design, operating speed, posted speed limit, and crashes, the following tasks are proposed:

- Conduct literature review on previous research.
- Identify potential data sources, especially with respect to operating speed data. Evaluate the quality of the data sources along with whether they can support the desired evaluation.
- Gather needed data.
- Perform statistical modeling and data analysis to identify the wholistic relationships among design elements, speed, and crashes on high-speed rural highways and freeways.
- Assess the effects of study factors (posted and operating speed, and roadway geometry and characteristics) to safety and perform sensitivity analysis with respect to inclusion of covariates, model forms, etc.

- Develop improved/enhanced CMFs or Crash Modification Functions for geometric elements with consideration of operating speed.
- Document the findings.

Urgency and Potential Benefits

It has been known for a long time that with increased roadway speed, crash severity is also increases. Roundabouts have demonstrated that lowering speed at conflict points greatly reduces the severity of collisions; however, vehicle speed cannot be lowered for all roadway segments and still move goods, services, and the traveling public in a timely manner. A better understanding of the interaction between speed and roadway geometrics and its effect on crashes and crash severity is needed to move vehicles efficiently and safely across the nation. With a better understanding of this relationship, transportation professionals can make more informed decisions when designing high-speed rural highways and freeways and provide safer transportation system.

Implementation Considerations and Supporters

Designers and traffic engineers who make decisions on geometric design and posted speed limits would be among those benefiting the most from implementation at the State DOT level.

Highway designers would benefit from a better understanding of the relationship that geometric features and speed have on highway safety when making project decisions. State DOT's that develop their own design guidance would be able to incorporate these research findings into their design guidance to systemically apply these relationships to project designs.

The research contract should include an item for presentation of finding to stakeholders in a webinar format, as an initial interdiction/conceptual implementation. TRB committees could jointly or separately follow up with webinars with more of a focus on implementation. FHWA and NHI could incorporate the geometric/speed/safety relationship into their existing HSM, design, roadside design, etc. trainings as appropriate. HSM3 could ultimately incorporate the findings into Part C methodologies.

AASHTO Committees that might be interested in the research results and could help support implementation: Committee on Design, Committee on Traffic Engineering, Committee on Safety.

Recommended Research Funding and Research Period

Research Funding:

- (a) Funds needed to accomplish the research objectives: \$750,000
- (b) Funds needed to accomplish initial implementation and communication activities: \$200,000

Research Period:

- (a) Time needed to accomplish the research objectives: 24 months

(b) Time needed to accomplish initial implementation and communication activities: 24 months

Problem Statement Author(s)

This problem statement was initially developed by the following individuals:

- Kay Fitzpatrick, Texas A&M Transportation Institute (TTI), k-fitzparick@tamu.edu; Marcus Brewer, TTI, m-brewer@tti.tamu.edu; Subasish Das, TTI, s-das@tti.tamu.edu; Eun Sug Park, TTI, e-park@tamu.edu; Brian K. Frazer, Caltrans, brian.frazer@dot.ca.gov; Alberto M Figueroa Medina alberto.figueroa3@upr.edu; Alan Glen Alan.Glen@aecom.com; John Ferris jbferris@vt.edu; Tracy Borchardt <Tracy.Borchardt@aecom.com>

Others Supporting the Problem Statement

- The Committee on Design ranked this project #1 (tied with another project)
- Comments and support were provided by:
 - TRB AKD10: Performance Effects of Geometric Design

Potential Panel Members

Brian K. Frazer, Caltrans, brian.frazer@dot.ca.gov, 916-521-4795.

Person Submitting the Problem Statement

AASHTO Technical Committee on Geometric Design, supported by the TRB Standing Committee on Performance Effects of Geometric Design (AKD10)

Contact: Marshall Elizer, Chair, AASHTO Technical Committee on Geometric Design
Assistant Secretary for Multimodal Development & Delivery, Washington State
Department of Transportation
310 Maple Park Avenue SE, PO Box 47351, Olympia WA 98504-7351
e-mail: ElizerM@wsdot.wa.gov

NCHRP Review of C-11

Reviewed By:

Zuxuan Deng
zdeng@nas.edu

Comments:

Operating speed data, especially operating speeds when crashes occurred, are difficult to retrieve. It is worth exploring new data sources using emerging technologies to quantify the relationship between operating speed, roadway characteristics and safety effects.

Review Date:

12/15/2021

FHWA Evaluation of C-11Reviewed By:

Chris Bruntz/HICP-10

Comments:

We are supportive of this research in light of October 7, 2015, FHWA memo in regards. Please also consider NCHRP report 504 in literature reviews, as well as FHWA online tool USLIMITS2.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for C-11Submitted By:

Patricia Bush
AASHTO staff
Committee on Design

Priority #: 1Comments:

Committee on Design ranked #1 (tied) of 4.

Submitted By:

Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/AComments:

Combine with G-02 to ensure that AT needs and opportunities are adequately addressed in both high-speed rural highways and arterial roadways. Consider including identification of these types of roads that are designated or proposed as US Bicycle Routes and implications for vulnerable road user safety.

Submitted By:

Kelly Hardy
AASHTO staff
Design-Technical Committee on Roadside Safety

Priority #: N/A

Comments:

This research would have a medium-to-high priority.

Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: N/A

Comments:

Since the research is looking at BOTH operating and posted speeds, it would be helpful to understand the variations in travel speeds as that impacts safety and if the observed speed variance is impacted by geometry, speed limit and enforcement activities. This research has a medium priority but the cost seems high.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT OUTLINE

Problem Number: 2023-C-12

Problem Title

Developing of Fragility Curve for Multi-Span Precast Girder Concrete Bridges in Seismic Regions

Background Information and Need for Research

There are significant number of multi-span precast girder concrete bridges in high seismic regions and long duration earthquakes that have been designed and constructed at a time when seismic resiliency requirements were nonexistent or inadequate by today's standards. To avoid bridge collapses, reduce the risk of extensive damage in future earthquakes, and most effectively allocate the financial resources, the vulnerability of bridges to earthquakes must be identified by developing appropriate fragility curves with consideration to bridge superstructure, substructure and foundation complexity. The fragility curves are required to relate the hazard to the likelihood of bridge closure as the expansion joints open and to collapse when the opening becomes too large. These curves should relate spectral acceleration and spectral displacement to the likelihood of collapse for different structural periods and for different structure types.

Fragility curve is one of the widespread methods used in seismic evaluations of existing bridges. The fragility curves provide conditional statements of probability of a bridge reaching or exceeding a particular damage level for a given intensity level. The fragility analysis generally includes simulation of bridge, simulation of ground motions, and generation of fragility curves from the seismic response data of the bridge models. The seismic response data can be obtained from elastic spectral analysis, or nonlinear static analysis, or nonlinear time history analysis. There is a need to determine fragility curves to capture the seismic vulnerability of multi-span precast girder concrete bridges per SGS and for long duration earthquakes specific to the Pacific Northwest.

Literature Search Summary

The proposed research differs from the existing body of research found in a review of relevant literature. None of the available literature match the title or address the objectives of the proposed research statement in the suggested websites:

TRID (<http://trid.trb.org>)

1. PROJECT: Performance of Existing ABC Projects – Inspection Case Studies (University of Washington), Accelerated Bridge Construction University Transportation Center (ABC-UTC), \$70000, 2019, Active2019-01-01

2. Comparison of Curved Prestressed Concrete Bridge Population Response Between Area and Spine Modeling Approaches Toward Efficient Seismic Vulnerability Analysis Engineering Structures, Volume 150, Issue 0, 2017, pp 176-1892017-11-01
3. Vulnerability Sensitivity of Curved Precast-Concrete I-Girder Bridges with Various Configurations Subjected to Multiple Ground Motions, Journal of Bridge Engineering, Volume 22, Issue 2, 2017, Content ID 040161182017-02
4. A THEORETICAL ANALYSIS OF THE MOMENT-CURVATURE RELATIONSHIP IN REINFORCED PRESTRESSED CONCRETE BEAMS, Giornale del Genio Civile, Volume 116, 1978, p. 3-14
<http://rip.trb.org/>
1. PROJECT: Performance of Existing ABC Projects – Inspection Case Studies (University of Washington), Accelerated Bridge Construction University Transportation Center (ABC-UTC), 2019

Research Objective

The objective of this research is to develop fragility curves to capture the vulnerability of multi-span precast girder concrete bridges in long duration earthquake regions and associated seismic hazards. The first step in this effort would be to address the collapse vulnerability of multi-span precast girder concrete bridges. The support length is required, but the relative stiffness of adjacent frames, pier skews, and abutment types effects cannot be readily captured for each bridge. The following steps will be considered in this proposed research project:

1. Domestic and international literature study to determine current state of knowledge on fragility curves of multi-span precast girder concrete bridges in long duration earthquake regions.
2. Identify parameters that need to be considered to accurately predict the seismic hazards due to end and in-span support unseating, pier skews, and abutment types.
3. Develop a range of fragility curves that relate ground motion to increased probability of collapse for different periods and different bridge types as more states transition to displacement-based design. Test fragility curves using database of bridge inventories and bridge damage from previous earthquakes.
4. Submit a final report including design guidelines and design examples demonstrating that fragility curves can be used for multi-span precast girder concrete bridges in mega and long duration earthquake regions.

Urgency and Potential Benefits

Concisely explain:

Currently there is little work on calculating the probability and risk of multi-span precast girder concrete bridges in long duration and mega earthquakes despite it being the most common cause of bridge collapse. Therefore, this research can be seen as addressing three topics in the AASHTO Highway Subcommittee on Bridges and Structures “Grand Challenges: A Strategic Plan for Bridge Engineering”:

- Grand Challenge 1: Extending Service Life

- Grand Challenge 2: Optimizing Structural Systems
- Grand Challenge 4: Advancing the AASHTO Specifications

This project should be implemented through NCHRP.

Implementation Considerations

State DOTs and transportation agencies Bridge engineers, and asset managers and planners will be using the research results.

State DOTs can implement the research within their own organization through asset management identifying bridges in immediate need for retrofit.

Categorizing bridges per their type, size and location seismicity could be used to support implementation.

Additional products such as presentations, training workshops, peer exchanges, and webinars will help create awareness and facilitate implementation of the research results.

AASHTO Committee(s) T-3 seismic and T-9, and T-18 – and precast concrete organization might be interested in the research results and could help support implementation.

Bijan Khaleghi, (360) 705-7181, Bijan.Khaleghi@wsdot.wa.gov; Amy Leland, Amy.Leland@wsdot.wa.gov; Jerry Shen, jia-dzwan.shen@dot.gov; and Anthony Mizumori, Anthony.Mizumori@wsdot.wa.gov

Recommended Research Funding and Research Period

Recommended Funding: The cost to complete the research proposed is estimated to be approximately \$250,000.

Research Period: Time needed to accomplish the proposed research will be on the order of 24 months.

Problem Statement Author(s)

Bijan Khaleghi, PhD, PE, SE
State Bridge Design Engineer
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Anthony Mizumori, PE, SE
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 Olympia, WA 98504-7340
 Anthony.Mizumori@wsdot.wa.gov

Potential Panel Members

State DOTs seismic specialists, bridge designers, universities and consultants specialized in seismic performance of bridges

Person Submitting the Problem Statement

Bijan Khaleghi, PhD, PE, SE
 State Bridge Design Engineer
 WSDOT, Bridge & Structures Office
 Olympia, WA 98504-7340
 Bijan.Khaleghi@wsdot.wa.gov

NCHRP Review of C-12

Reviewed By:

Ahmad Abu-Hawash
aabu-hawash@nas.edu

Comments:

This research is better suited for a state funded or a pooled fund project as it has limited applicability. As stated in the problem statement, the objective is to determine fragility curves to capture the seismic vulnerability of multi-span precast girder concrete bridges in the Pacific Northwest.

Review Date:

12/7/2021

FHWA Evaluation of C-12

Reviewed By:

Derek Soden/HIBS-10

Comments:

The current HAZUS fragility model set does include a classification for multispan concrete and steel bridges. The problem statement doesn't acknowledge that model, nor address how it could be improved through the proposed project to better suit the needs of bridge owners. As written, the statement seems to be focused on addressing

ground motion characteristic for the Pacific Northwest, which would limit its applicability nationwide.

Review Date:
December 17, 2021

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT OUTLINE

Problem Number: 2023-C-13

Improved Superelevation Design Based on Advancing Technologies

Background

The side friction factors may need to be adjusted due to multiple factors. Both tires and road wearing surfaces have changed, which affect the friction between them. Additionally, vehicle technologies such as electronic stability control have changed vehicle dynamics and may influence speeds that drivers are comfortable at while traversing horizontal curves. Since NCHRP Report 439 (*Superelevation Distribution Methods and Transition Design*) was published, there have been findings that superelevation following the NCHRP 439 transitions may cause greater side forces than expected. More sophisticated vehicle dynamics simulation models are also now available that provide advantages over using the point-mass model for design, such as accounting for grade, deceleration/acceleration, and analysis of the dynamics of individual axles.

Changing the design superelevation from increments of two tenths, which may be too precise, needs to be considered. What precision can contractors actually construct? Many believe this is not practical to contractors. Considering performance-based design principles, are there acceptable differences in superelevation from the current design superelevation rate that would be acceptable? Could the design speeds for the various design superelevation rates be modified? The side friction factor also represents the lateral acceleration, so the way lateral acceleration is modeled in horizontal curve design may need to be changed. Since the previous research was completed, there are different vehicle types in the vehicle fleet and a departure from the point-mass model. Are there better models that should be used that work better with the current fleet of vehicles? If there are better models, which should be used and how does that change the equations used for design?

The AASHTO *Highway Safety Manual* and TRB Special Report 214 have shown that the minimum radii in AASHTO's "Green Book" are not threshold values that correlate to safety or operational problems.

Literature Search Summary

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Research Objective

This research will update appropriate values (such as side friction, superelevation, e and f distribution) for use in horizontal curve design. Multiple advancements have affected previous data and models that have been used to establish horizontal curve design guidance. Side friction factors were established in the 1930s and 1940s, and then they were reviewed in 2000 under NCHRP Report 439 and found the values to be generally consistent with the prior values. With advancements in tire design and manufacturing and pavement wearing surfaces and mixes continuing to develop, a reexamination of appropriate side friction factors for use in design need to be examined. More sophisticated vehicle dynamics simulation models have also been developed to model the behavior of vehicles in curves. Current Green Book horizontal curve design is based on the point-mass model. As the vehicle fleet has advanced, the newer vehicle models may also be able to refine acceptable driver comfort as it relates to horizontal curvature within superelevation transition areas and when the curve is fully superelevated. The vehicle fleet now includes connected and automated vehicles. As the automation technology increases, the vehicles will become self-driving. This research should examine how this change in the vehicle fleet may impact horizontal curves, cross slopes, and vehicle models for such design elements. The research should show how the AASHTO current design vehicle(s) would compare to the proposed design vehicle(s).

Potential Tasks

1. Completion of a comprehensive literature review.
 - a. Identify research on vehicle fleet composition, performance of the vehicle, advanced technologies and their presence in the vehicle, percentage of vehicles with the advanced technologies (i.e., stability mechanics and other performance/safety innovations), tire / pavement friction based on current tires in production and typical pavement surface parameters.
 - b. Identify available vehicle models and which may be candidates to replace the point-mass model.
2. Evaluate the current research and identify which components need additional research. This could include:
 - a. Tire performance / friction factors (Wet & Dry)
 - b. Pavement wearing surface (Types & Friction in combination with tire performance)
 - c. Vehicle fleet
 - i. Which vehicles to use in design (i.e., keep two primary categories of heavy vehicles/trucks and everything else, or some other classification)
 1. Traditional Human Driven Vehicles
 2. CAV with automation level up to 3
 3. Mixed fleet: Human Driven and CAV
 4. Autonomous vehicles (Automation level 4 / 5)
 - ii. Stability capabilities
 3. Cross-slope constructability (Is 0.2 the appropriate interval for design superelevation? NYSDOT has adopted 0.5 increments.)
 4. Vehicle operator
 - a. Should the design parameters be modified if we have a high presence of “older” drivers? What would quantify “high presence”?
 - b. Connected and Automated Vehicles
 5. Perform the research based on needs identified above and make recommendations.
 - a. Revised side friction factors for use in design.
 - b. Revised design superelevation rates.
 - c. Superelevation transitions.
 - d. Appropriate vehicle model.
 - e. Propose new text based on the results of the research project for the next edition of the AASHTO “Green Book”. Revisions would be expected in Chapter 3. “Elements of Design”.

Urgency and Potential Benefits

This research is important, because as our vehicular technology advances, so must our design criteria. We should use design criteria that is applicable to our current vehicle fleet. Designing to a prior vehicle fleet and old vehicular models may cause over design (additional costs) or under design (potential safety impacts). The benefits of updating the design criteria could be substantial. We would like to have the results of this research before the next edition of the “Green Book” is published (expected in 2025).

This research topic was identified as a high priority by the AASHTO Technical Committee on Geometric Design, the TRB Committee on Geometric Design, and the

TRB Committee on Operational Effects of Geometrics at their combined meeting in June 2018 from among a broad set of problems considered.

Implementation Considerations and Supporters

We expect the research team will need to reach out to original equipment manufacturers to better understand the automation levels of vehicles and their capabilities.

Organizations potentially interested in research findings and who could support implementation:

- AASHTO Council on Highways and Streets (CHS)
- AASHTO Committee on Design (COD)

Recommended Research Funding and Research Period

\$500,000 over 12-24 months

Problem Statement Author(s)

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Others Supporting the Problem Statement

AASHTO Committee on Design

TRB AKD10 Performance Effects on Geometric Design Committee

Potential Panel Members

David McDonald, Hanson Professional Services (TRB AKD10 Member)

Person Submitting the Problem Statement

AASHTO Technical Committee on Geometric Design, supported by the TRB Standing Committee on Performance Effects of Geometric Design (AKD10)

Contact: Marshall Elizer, Chair, AASHTO Technical Committee on Geometric Design
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NCHRP Review of C-13

Reviewed By:

Zuxuan Deng
zdeng@nas.edu

Comments:

Admittedly, there are the newer vehicle models coming out every now and then. But what would be appropriate design vehicles to use for the roadway with a life span of 50 years or more. Will consistency across infrastructures designed using different standards cause issues? What is the significance of a 0.2 interval for design superelevation and is it constructible by an average contractor? It does not seem that the current fleet composition on the roadways warrant a reevaluation of these design elements, or at least it does not seem to be so time sensitive at this moment.

Review Date:

12/15/2021

AASHTO Committee Evaluation for C-13Submitted By:

Patricia Bush
AASHTO staff
Committee on Design

Priority #: N/A

Comments:

Endorsed by Committee on Design.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2022 NCHRP PROBLEM STATEMENT OUTLINE

Problem Number: 2023-C-14

Problem Title

Improve highway safety by developing guidance and standards for the design of left turn pocket approach tapers on single and multilane highways.

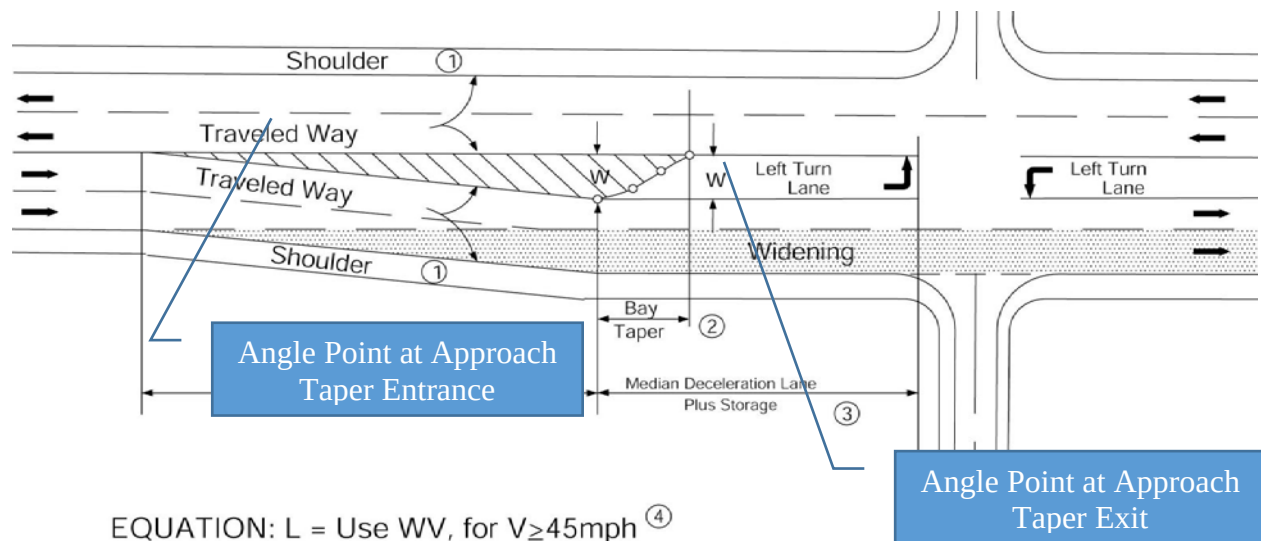
Background

Current design guidance and standards do not adequately address the design of turn pocket approach tapers. Existing standards provide turn pocket lengths without addressing the issue of horizontal alignment for the lane shifts necessary to accommodate the added width of left turn pockets. Vehicles passing on through-movements to the right of left turns traverse a horizontal alignment change that is different than the roadway centerline alignment and should therefore be designed as such for traveler safety.

This problem statement seeks three primary goals to address these separate alignments:

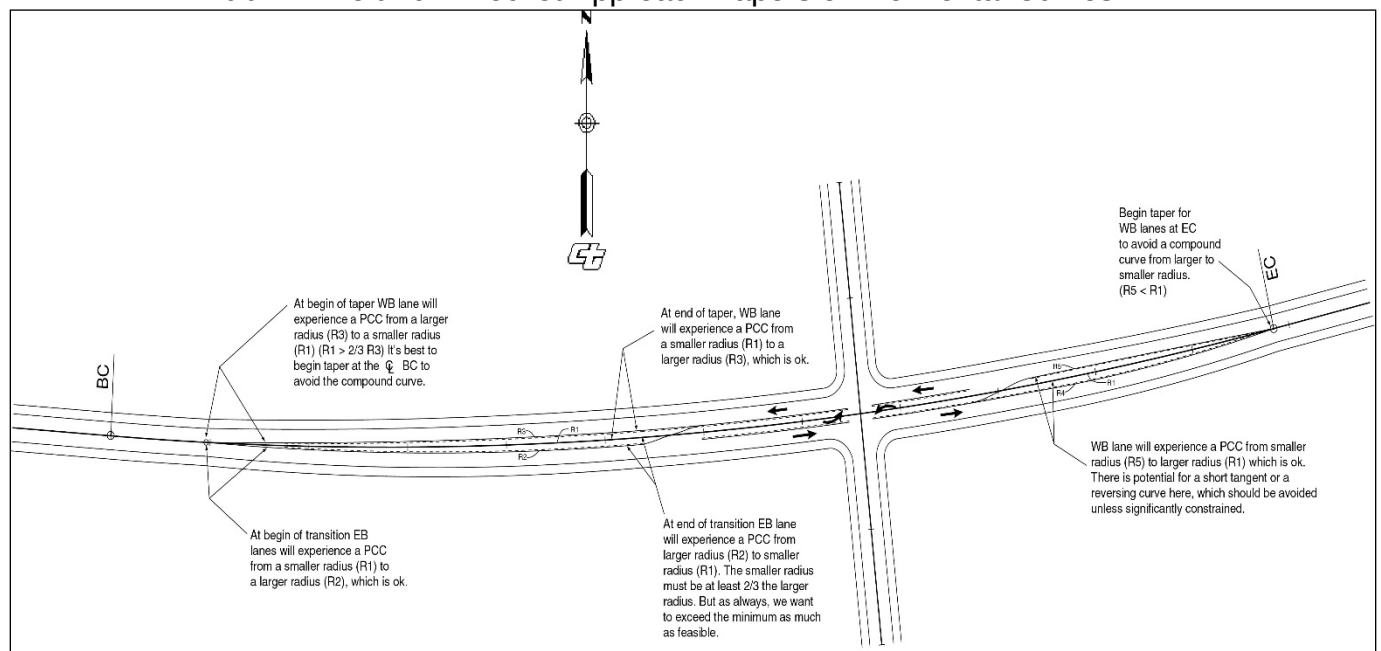
1. Create guidance for treating approach tapers as independent alignments for each of the two directions of travel.
2. Create guidance and standards for highways with tangent centerline alignments – Existing design guidance typically consists of equations providing approach taper lengths dependent upon width of shift and vehicle speed, however, angle of deflection is not discussed. Most importantly, acceptable maximum angle of deflection is not addressed. Large angles of deflection can result in erratic movements other than what is expected where vehicles cross over the right edge line when entering an approach taper and the left edge double yellow striping when exiting the approach taper in order to negotiate their desired direction of travel. (See Exhibit A for an illustration)

Exhibit A: Caltrans Highway Design Manual Fig 405.2A – Standard Left Turn
Channelization



3. Create guidance and standards for highways with horizontal curve centerline alignments – There is currently no existing guidance related to approach taper shifts on horizontal curves. Since angles of deflection are inappropriate for horizontal curves, use of compound curves may be a more appropriate solution and should therefore be studied. Furthermore, guidance for superelevation is needed to address changes in curve radii between adjoining curves, which may require different superelevation rates to address different alignments on adjacent directions of travel. (See Exhibit B for an illustration)

Exhibit B → Left Turn Pocket Approach Tapers on Horizontal Curves



The lack of design guidance for the conditions described above affect the ability of our nation's design and traffic engineers to design safe highways.

A thorough and complete literature search is necessary to exhaust all possibility of prior efforts and sources of applicable guidance. Developing guidance and standards requires field research to measure the physical characteristics and constraints of vehicle instabilities while traversing a range of angle points on tangent alignments and curved alignment of varying design speed. Field observations and evaluations of driver behaviors of external vehicle movements using cameras and possibly in-automobile as well, could provide the appropriate design guidance that matches driver expectations and real life behaviors for the range of situations.

Improving the design of the left turn pocket approach taper will improve efficiency and mobility while reducing collisions. Improving transportation safety is part of AASHTO's Mission Statement where Safety Focused is its top Value. Safety is the top priority in the USDOT and FHWA Strategic Plan and Mission Statement. Turn pockets are typically the result of safety improvements for vehicles who await gaps in traffic to make left turn movements the approach tapers to turn pockets pose an even greater risk to overall highway safety because all drivers passing through the approach taper are affected by the horizontal alignment change from the centerline of the roadway. Consequently, properly designed approach tapers increase the safety of all motorists traversing left turn pocket approach tapers.

Literature Search Summary

A thorough literature search has already been performed and the lack of national and State guidance regarding left turn pocket approach taper lengths and alignment, particularly in restricted situations and on curved alignments, prompted the need for this problem statement. The following literature searches have been performed:

- The Caltrans Division of Research, Innovation, and System Information (DRISI) contracted with its primary research consultants, CTC and Associates, who performed a thorough national literature search. The report is available at: <https://dot.ca.gov/programs/research-innovation-system-information/preliminary-investigations>
- The Caltrans senior librarian performed a database literature search of all available Caltrans, TRB, NCHRP, and AASHTO literature.
- Caltrans design experts performed in-depth reviews of AASHTO 7th Edition, Caltrans Highway Design Manual, and various TRB/NCHRP publications.
- During winter 2021, the DRISI and FHWA will query all State DOTs for subject guidance and standards for supportive information to assist with this proposed research objective.

Research Objective

The objective of this research is to improve the safety of the traveling public by developing guidance and standards for the nation's engineers who design left turn pocket approach tapers on single and multilane highways. The workplan should include:

- Task 1. Review of Literature and Current Practice.
- Task 2. Field Data Collection:
 - o Establish a data set of existing site conditions by locating existing turn pocket approach tapers consisting of a range of approach speeds, angle points and horizontal curvature.
 - o Investigate collision data associated with the data set locations for applicability to design.
 - o Observational Study: Assemble and analyze video footage of vehicle paths and movements traversing the approach tapers in the data set locations.
 - o Behavioral Study: Assemble and analyze in-automobile video footage of driver behaviors while traversing the tapers within the data set locations (This is an Optional Task).
 - o Analyze vehicle performance using ball bank indicator testing or similar techniques for the data set locations. Investigate the possibility of replacing field testing with analytical models.
- Task 3. Identify Critical Parameters: The objective of the task is to identify the critical parameters that affect vehicle movement in left turn pockets and in the adjacent through lanes, such as design vehicle, angle of deflection, horizontal curvature, grade, lane width, shoulder width, cross-slope, superelevation, etc.
- Task 4. Develop Framework for Model: The objective of this task is to develop a framework for incorporating the critical parameters identified in Task 3.
- Task 5. Develop Workplan: The objective of the task is to develop a workplan for calibrating the model based on the results from Tasks 2 and 3.
 - o Problem assessment using crash analysis
 - o Field Data Analysis
 - o Testing of analytical and simulation models
 - o Analysis of results
- Task 6. Prepare Interim Report: Using the results of Tasks 1 – 5 to,
- Task 7. Develop Design Guidance: Consideration for standards recommendations for use in AASHTO, State, and local agency manuals and guidance.
- Task 8. Prepare Final Report:

Urgency and Potential Benefits

The research is needed immediately to fill a gap in current left turn pocket approach taper design guidance, standards, and policy. The consequences of not conducting this research will be the continued misinterpretation of left turn pocket approach taper design, mainly the use of angle points and curvilinear alignments that are mismatched to vehicle speeds due to a lack of subject information and guidance. Consequently, all private and government transportation engineers, general civil engineers, and practitioners will benefit from filling this knowledge gap.

Implementation Considerations and Supporters

The results of this research will be implemented by the AASHTO Technical Committee on Geometric Design in a future edition of the AASHTO Green Book. The California Department of Transportation has committed to incorporating the research into our Highway design manual and will make these changes available to other State DOTs.

Recommended Research Funding and Research Period

Total Funds Requested: \$500,000

Research Period: 18 months

Problem Statement Author(s)

John Roccanova, Project Delivery Coordinator, Caltrans, HQ Division of Design, (916) 275-2890, John.Roccanova@dot.ca.gov

Others Supporting the Problem Statement

The AASHTO Committee on Design has endorsed this statement for submittal.

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Josue Pluguez, Design Program Manager, FHWA California Division, (916) 498-5035, Josue.Pluguez@dot.ca.gov

Potential Panel Members

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Person Submitting the Problem Statement

AASHTO Technical Committee on Geometric Design, supported by the TRB Standing Committee on Performance Effects of Geometric Design (AKD10)

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NCHRP Review of C-14

Reviewed By:

Zuxuan Deng

zdeng@nas.edu

Comments:

The proposed research can fill the knowledge gap in current left turn pocket approach taper design guidance, standards, and policy.

Review Date:
12/15/2021

FHWA Evaluation of C-14

Reviewed By:
Intersections Team/HSA/HRDS

Comments:

While better developed and consistent guidance would be helpful since this overlaps the MUTCD and AASHTO GB (and potentially AASHTO HSM and TRB HCM), it is questionable whether this project could have a significant impact. Making an explicit and statistically confident connection between turn lane geometrics and crashes would be quite difficult, as detailed geometric information at this level is not typically collected/inventoried or readily available. Additionally, while determining whether a turn lane should be added has a safety dimension (and CMFs), the length and particulars of the design are dependent on context, field conditions, traffic demand, etc. and rarely an explicit basis of safety.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for C-14

Submitted By:
Patricia Bush
AASHTO staff
Committee on Design

Priority #: N/A

Comments:

Endorsed by Committee on Design.

Submitted By:
Kelly Hardy
AASHTO staff
Safety

Priority #: N/A

Comments:

Will this research include a development of a crash modification factor or some other form of safety performance on the taper? How will "improve highway safety" will be measured?

Submitter Response for 2023-C-14

Comments:

Response to FHWA Evaluation

Comment: "While better developed and consistent guidance would be helpful since this overlaps the MUTCD and AASHTO GB (and potentially AASHTO HSM and TRB HCM), it is questionable whether this project could have a significant impact." Response: Thank you for your comments. In California, we construct numerous standalone safety projects specifically scoped for adding left turn pockets to address fatal and injury collisions, many of which cannot meet AASHTO or California Highway Design Manual standards due to a variety of constraints. Consequently, we believe the project will have a significant impact.

Comment: "Making an explicit and statistically confident connection between turn lane geometrics and crashes would be quite difficult, as detailed geometric information at this level is not typically collected/inventoried or readily available." Response: It is agreed that tying collision data directly to vehicle instability and driver behaviors related to left turn pocket taper shift alignments will be difficult, however, determining vehicle instability and driver behaviors for a range of deflection angles will not be difficult and is one of the primary purposes of this problem statement. There are a number of proven techniques such as ball-bank indicators, computer modeling, video camera observations ...etc, that have been used successfully for these purposes.

Comment: "Additionally, while determining whether a turn lane should be added has a safety dimension (and CMFs), the length and particulars of the design are dependent on context, field conditions, traffic demand, etc. and rarely an explicit basis of safety." Response: We have found in California that safety is a factor in left turn pocket approach taper design because the taper introduces a change in horizontal alignment for both directions of travel on conventional highways. When left turn pockets are added into existing two-lane highways, current guidance and standards use a deflection angle without providing guidance for determining the maximum safe deflection angle for constrained situations. There is a safety need to provide consistent guidance for determining horizontal alignment maximum deflection angles for a given design speed. Consequently, when designers introduce deflection angles that are too large for the design speed, it introduces vehicle instability and erratic driving behaviors, which is by definition a safety concern. The "particulars of the design are dependent on context, field conditions, traffic demand, etc" are the normal project factors that limit the ability to obtain standard left turn pocket approach taper deflection angles.

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Review Date:
1/24/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-C-15

Problem Title

Effect of Pavement Surface Quality on Highway Capacity and Operations

Background Information and Need For Research

Pavement surface quality has an impact on traffic safety, operating speed, driver comfort and maneuverability, and service volume. Poor pavement surface quality on uninterrupted flow segments, i.e., basic freeway, merge, diverge and weaving segments, and two-lane highways has a significant detrimental effect on the segments' capacities and speeds as well as vehicle emissions and fuel consumption. Currently, the US Highway Capacity Manual (HCM) uses FHWA's 5-point pavement rating scale in some of its bicycle mode methodologies. The uninterrupted flow methodologies consider the effect of roadway geometry (e.g., lane width, lateral clearance) but do not take into account the effect of pavement quality on traffic operations and level of service (LOS) determination. There is a need to incorporate the effect of pavement quality on the HCM methodologies and provide the tools to transportation agencies to perform benefit/cost analyses and better support their performance management for infrastructure conditions decisions to meet congestion reduction targets.

Literature Search Summary

There is relatively little research that has investigated the relationship between traffic operations and roadway pavement conditions and quality. In one of the earliest studies, Karan et al. (1978) developed a model to predict vehicle speeds as a function of the pavement roughness, using data from Ontario, Canada. Chandra (2004) further found that the effect of roughness is more apparent on the speed of passenger cars than on heavy vehicles. The author also found that the capacity of two-lane roads in India decreases by 300 pc/h when road roughness increases by 1,000 mm/km. Haj-Ismael (1989) found that when the pavement distress decreases, the mean speed of traffic increases, independent of the time of day. Yu and Lu (2014) developed a regression model to capture the decrease in vehicle speed as a function of pavement roughness, although the authors did not differentiate between vehicle types. Ghazlan et al. (2015) estimated free-flow speed (FFS) as a function of pavement condition, speed limit, lateral clearance, and access point density. The authors recommend the inclusion of pavement condition in the FFS prediction equations. Using field data from two-lane highways in Egypt, Hashim et al. (2018) also concluded the significant impact of pavement distress on the mean speed.

In addition, state agencies frequently refer to the NCHRP 720 Report (2012) to quantify the effects of pavement conditions. This report presents a vehicle operating cost model, a fuel consumption model, a tire wear model, and a repair and maintenance costs

model. It is important to investigate how these models can inform the operational and quality of service impacts of pavement condition and improve the HCM methodologies.

References:

- Chandra, S. "Effect of road roughness on capacity of two-lane roads". *Journal of Transportation Engineering*, 130(3), pp. 360-364, 2004.
- Ghazlan, K.A., Al-Omari, B.H., Mahmoud, M.A. "Effect of pavement condition on multilane highway free-flow speed". *Institute of Transportation Engineers. ITE Journal* 85(8), pp. 31-36, 2015.
- Haj-Ismael, I.A. "The effect of roadway surface condition on traffic speed during day and night operations". PhD Thesis, Texas A&M University, 1989.
- Hashim, I.I., Younes, M.A., El-hamrawy, S.A. "Impact of pavement condition on speed change for different vehicle classes". *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)*, 43(1), pp. 271-290, 2018.
- Karan, M.A., Hass, R., Kher, R. "Effect of pavement roughness on speeds". *Transportation Research Record* 602, National Research Council, Washington, D.C., pp. 122-127, 1978.
- National Academies of Sciences, Engineering, and Medicine 2012. *Estimating the Effects of Pavement Condition on Vehicle Operating Costs*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/22808>.
- Yu, B., Lu, Q. "Empirical model of roughness effect on vehicle speed". *Internal Journal of Pavement Engineering*, 14(4), pp. 345-351, 2014.

Research Objective

The major objective of this research is to enhance the HCM 6th Edition uninterrupted flow methodologies and incorporate the effect of pavement surface quality and conditions on the operational quality of the uninterrupted flow segments.

The following tasks are proposed:

Task 1: Literature Review: Conduct extended literature review on the effect of pavement quality on traffic stream operations.

Task 2: Draft Methodology and Data Collection Plan: Identify candidate methodological frameworks to incorporate pavement quality into the existing LOS methodologies. In addition, describe data sources that could be used to support these methodological frameworks.

Task 3: Data Collection: Upon panel approval, collect the appropriate field data to quantify the effect of pavement quality and develop the necessary adjustments to the HCM methodologies.

Task 4: Model Development and Update HCM: Derive the final models and adjustments to be included in the HCM. Validate the methodologies with additional field data. Update all relevant chapters of the HCM and update the computational engines to implement the proposed changes.

Urgency and Potential Benefits

High. This research will address several limitations of the current methodologies of the uninterrupted flow chapters. A clear connection between traffic stream operations and pavement conditions will help traffic and pavement engineers for asset management and transportation performance management decision-making and benefit/cost analysis. A benefit of this research is to provide agencies approaches to identifying pavement condition improvements as part of Transportation Performance Management for Infrastructure Condition which can also support agency efforts to meet Congestion Reduction targets.

Implementation Considerations

As this research will result in new and/or improved Highway Capacity Manual methodologies, the target audience includes transportation engineers and planner, asset management, transportation performance management, and maintenance personnel, and educators.

Recommended Research Funding and Research Period

\$350,000

36 months

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Joe Fazio, Ph.D., University of Illinois at Chicago, fazioj@gmail.com

Alexandra Kondyli, Ph.D., University of Kansas, (785) 864-6521, akondyli@ku.edu

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Person Submitting The Problem Statement: Name, Affiliation, Email Address And Phone.

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NCHRP Review of C-15

Reviewed By:

Camille Crichton-Summers

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Comments:

This research expands the use of pavement quality data to better understand its influence on level of service (LOS) to inform pavement asset management and capitol programming decisions. The objectives and scope include field data collection which will

require additional resources. Thirty-six months is sufficient barring difficulty with data collection, but an increased budget of 500K is suggested.

Review Date:
12/17/2021

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-C-16

Problem Title

The Feasibility and Performance of Composite Pervious Pavements for High Traffic Volume Roads

Background Information and Need For Research

Pervious (also called Permeable) pavements have a significant role in reducing the Best Management Practices (BMPs) cost. They also help the environment and provide an added layer of safety for road users. The following is an excerpt from the Environmental Protection Agency (EPA) website:

“Alternatives to traditional pavement on our paved surfaces can help reduce runoff by infiltrating rain water and melting snow. These alternative materials which include pervious asphalt, pervious concrete, interlocking pavers, and plastic grid pavers, allow rain and snowmelt to seep through the surface down to underlying layers of soil and gravel. In addition to reducing the runoff from the rain that falls on them, permeable pavements can help filter out pollutants that contribute to water pollution. Permeable pavements can also reduce the need for road salt and reduce construction costs for residential and commercial development by reducing the need for some conventional drainage features.”

While Pervious Concrete Pavements are durable and capable of performing under heavy traffic loads, the surface characteristics make them inappropriate for use for high-speed high-traffic routes. The smoothness and raveling are the main concerns for using this pavement as a surface layer.

On the other hand, an Hot Mix Asphalt (HMA) Open Graded Friction Course (OGFC) is a sustainable surface layer, however, due to the limitation of the thickness and relatively short service life could not be used as a structural pavement layer.

A combination of OGFC on top of a pervious concrete pavement acting as a composite pavement could provide the structural and functional performances of a totally permeable pavement.

Literature Search Summary

- Kayhanian, M., H. Li, J. Harvey, X. Liang Application of permeable pavements in highways for stormwater runoff management and pollution prevention: California research experiences, International Journal of Transportation Science and Technology, Vol 8, Iss. 4, Dec. 2019, pp. 358-372

- James, W. 2002. Green Roads: Research into Permeable Pavers. Stormwater. March/April.
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- Schueler, T. 1987. Controlling urban runoff: a practical manual for planning and designing urban BMPs. Metropolitan Washington Council of Governments. Washington, DC.
- Marvin, J., Scott, J., Van Seters, T., Bowers, B., Drake, J. Winter Maintenance of Permeable Interlocking Concrete Pavement: Evaluating Opportunities to Reduce Road Salt Pollution and Improve Winter Safety, submitted to Transportation Research Record May 2020, under review
- Ferguson, B.K. 2005. Porous Pavements. Integrative Studies in Water Management and Land Development. Taylor and Francis: New York.

Research Objective

The research is proposed to evaluate the feasibility and provide a measure of performance for a composite pervious pavement consisting of an HMA-OGFC over a Pervious Concrete Pavement. The research would also provide a method for designing this type of pavement and provide guidelines for section and construction of composite pervious pavements. The proposed design methodology could be incorporated into the AASHTOWare Pavement ME Design in the future.

Urgency and Potential Benefits

- Reduced cost associated with roadway drainage systems and Best Management Practices (BMPs) to collect and direct stormwater runoff.
- Direct filtration of contaminated surface water into the ground water, thereby reducing the need to process the stormwater pollution.
- Rapid drainage of snow melt and reduced puddling on road surface.
- Porous materials have less thermal conductivity and thermal capacity than traditional impervious pavement, thereby reducing the urban heat island effect.
- Permeable pavements installed around tree planting zones help provide air and water to root systems, thereby contributing to healthier, longer lasting trees that require less manual irrigation.

- Permeable asphalt surfaces (OGFC) are quieter since they absorb sound energy and dissipate air pressure around tires before any noise is generated.
- Permeable/pervious pavements have the potential for earning LEED sustainable sites credits for reducing stormwater pollution and runoff, urban heat island mitigation, and conservation of materials and resources.

Implementation Considerations

The considerations to implement a composite pervious pavement are:

- Performance (structural and functional) and service life
- Constructability
- Maintenance and preservation
- Cost (Life Cycle Cost Analysis)

Recommended Research Funding and Research Period

We recommend that this project be for 24 months with a budget of \$400,000.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

- Mehdi Parvini, California Department of Transportation (Caltrans)
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Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

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Person Submitting The Problem Statement: Name, affiliation, email address and phone.

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NCHRP Review of C-16

Reviewed By:

Amir Hanna
ahanna@nas.edu

Comments:

A. The performance of pervious concrete pavements with an open-graded friction course (OGFC) layer can be addressed through research. However, such pavement cannot be regarded as a composite pavement because of the small thickness and low structural value of the OGFC layer and thus the research will simply address pervious concrete pavements.

B. Investigating the performance of pervious concrete pavements with an OGFC should be of interest to the majority, if not all, state DOTs.

C. The objective, as stated in the problem statement, is confusing as pervious concrete pavements with an OGFC cannot be considered a composite pavement. The objective should be explicitly modified to call for the investigation of the performance of pervious concrete pavements with an OGFC layer.

D. The scope is not clearly defined. However, it is expected to address the performance of pervious concrete pavements with an OGFC.

E. The estimated duration of 24 months seems adequate.

F. The estimated budget of \$500,000 seems adequate.

G. Several publications are cited but further literature review, surveys, and other information gathering should be performed as part of this research.

FHWA Evaluation of C-16

Reviewed By:
JSKrolak/HIBS-20

Comments:

We do not support this RNS as it does not address the fundamental physics of permeability, conductivity, and neglects clogging. It also seems better suited as a synthesis. Seems duplicative as well and potentially conflicts with BIL elements.

Review Date:
December 17, 2021

Submitter Response for 2023-C-16

Thanks for your reviews.

Regards,
Mehdi Parvini

Comments:

Response to FHWA Comments:

We do not support this RNS as it does not address the fundamental physics of permeability, conductivity, and neglects clogging.

R: The goal of the research is to address the performance of the proposed pavement, including the permeability, conductivity, and clogging potential.

It also seems better suited as a synthesis.

R: No response.

Seems duplicative as well and potentially conflicts with BIL elements. Review Date: December 17, 2021

R: No duplicative research was found in the literature.

Response to NCHRP comments:

A. The performance of pervious concrete pavements with an open-graded friction course (OGFC) layer can be addressed through research. However, such pavement cannot be regarded as a composite pavement because of the small thickness and low structural value of the OGFC layer and thus the research will simply address pervious concrete pavements.

R: The term "composite" refers to the functional aspect of the pavement, and the research is aimed to evaluate the functional (not structural) performance of the pavement. As was mentioned rightfully, the OGFC layer does not provide a structural contribution to the pavement.

B. Investigating the performance of pervious concrete pavements with an OGFC should be of interest to the majority, if not all, state DOTs.

C. The objective, as stated in the problem statement, is confusing as pervious concrete pavements with an OGFC cannot be considered a composite pavement. The objective should be explicitly modified to call for the investigation of the performance of pervious concrete pavements with an OGFC layer.

R: As was mentioned before, the term "composite" refers to the functional aspect of the pavement. However, it is a valid point to refer to this pavement type as "pervious concrete pavement with an OGFC layer" to avoid confusion.

D. The scope is not clearly defined. However, it is expected to address the performance of pervious concrete pavements with an OGFC.

R: The general scope is to evaluate the performance of the proposed pavement type from a functional perspective. However, there is definitely room to better clarify the scope of the research proposal.

E. The estimated duration of 24 months seems adequate.

F. The estimated budget of \$500,000 seems adequate.

G. Several publications are cited but further literature review, surveys, and other information gathering should be performed as part of this research.

R: That is definitely a valid statement and should be part of the research.

Contact Info:

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Review Date:

02/07/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-C-17

Problem Title

Field data collection to monitor volume change of problematic pavement subgrade materials to calibrate general and local predictive models.

Background Information and Need For Research

Swelling and shrinkage of the subgrade soils under pavements cause damage to the pavements resulting in unsafe driving conditions as well as frequent repair works. This eventually results in high costs in repairs and rehabilitation to the DOTs and taxpayers and may result in road safety issues to the users. Expansive clays are widely distributed over many states from the Gulf of Mexico to the Canada border. Their shrinkage and swelling leads to deformation of pavement from the center to the paved edge due to differential moisture distributions and environmental loads.

Current engineering practice avoids high volume change conditions by soil replacement and soil treatment. However, the volume change will persist if the depth of influence of climate is greater than the normal 3-4 ft treated zone. Furthermore, lime stabilization is useless if the soil contains soluble sulfates. Therefore, it is important to determine the depth and breadth of the volume change and incorporate the analysis in design procedures upfront. Current methodologies for determining the volume change behavior of such soils, are mostly based on simplified tests, correlations with index properties, or other empirical methods. Such practices, although useful, can lead to poor and often expensive designs. As a result, distresses to foundations, pavements, and other structures on high volume change soils are common and repairing them can be quite expensive.

Several models have been developed to estimate or incorporate the damage caused by expansive soils to pavement. Although these models have been in use for design purposes, there is not enough field test data to calibrate and validate these models for different environmental conditions and a range of soil types. Use of limited field test data makes the models' validation effort unreliable in predicting the swelling/shrinkage behavior of soils undergoing high volume change. In order to increase the reliability of models to predict the high-volume change caused by distresses due to environmental loads, there is a need for data collection that will allow not only the calibration of general models at a national level but also for local models to be used by state DOTs and other practitioners.

Literature Search Summary

Although the fundamental behavior of high-volume change soils under various soil compositional and environmental factors is not completely understood, there have been

studies on engineering behavior and characterization practices of these soils that allows for better implementation techniques into current pavement design practice (Pedarla et al., 2012). Some models have been developed based on field data, and empirical correlations like the PVR method widely used in the state of Texas (TXDOT 1978), or the Site Factor component of the International Roughness Index used in the AASHTOWare Pavement Mechanistical-Empirical design procedure. A study done by Lytton in 2008 stated that the PVR equation, although being very popular for design purposes, overestimates the volume change and this makes the designers to calculate inaccurate distresses for the pavements.

The most rigorous models available are those presented by Lytton, Aubeny and Bulut show a lot of potential to provide accurate estimates of volume change but they need to be validated with more data collected for a range of soil types. Several studies have been conducted to address high volume change distresses in subgrade materials, and researchers have been successful calibrating models that predict the behavior of the subgrade soils. One such model, based on suction, was developed by Lytton et al. (2005) and further improved by Aubeny & Long (2007) by fitting a Fourier equation to the climate data. Vann & Houston (2021) developed correlations between the 30-year Thornthwaite Moisture Index and soil suction envelopes using measured data from over 40 geotechnical studies to measure the volume change (Thornthwaite, 1948; Witczak et al., 2006; Vann, 2019). However, the data collected were not under covered areas and therefore, it is not appropriate for pavement conditions.

Recently studies presented an improved framework for estimating volume change of shrink/swell soils under pavements due to time-varying climatic effects using Lytton et al. (2005) approach with the suction envelope models developed by Vann & Houston (Olaiz et. al., 2021). Data from the Seasonal Monitoring Program (SMP) from the LTPP can be partially used to validate these models but the effect of traffic and environmental loads are difficult to discriminate. In addition to validation of current models, there is a need to have more accurate database collected from the field and calibrated according to the local environmental loads and climatic conditions. Having a wide array of data covering the nation will also be helpful in calibrating a general model which could be used for design checks and calculating potential distresses in the pavements during initial geotechnical investigations.

Research Objective

The objective of this research is to develop and execute a field instrumentation and monitoring program, that combined with laboratory testing, will allow for the collection of data needed to calibrate the most important methodologies available to predict high volume change in subgrade materials. The program includes the following tasks: a) Review of rigorous methodologies available to predict volume change and determine the input parameters needed to calibrate to field conditions; b) Choose roads in strategic locations to instrument for temperature, moisture and volume change; c) Collect samples for laboratory testing that includes index properties, soil-moisture retention data and volume change; d) Acquire sensors and install them in the field; e) Field data collection and monitoring for a period of two years; f) Calibration of models at

national and local levels; g) Dissemination of information collected to DOT agencies to be used on volume change models and preliminary investigations.

Urgency and Potential Benefits

USDOT and State DOTs bear millions of dollars in annual repair costs of pavements associated with rehabilitation, and soil chemical and mechanical improvement due to volume change of subgrade soils. Even though there are various models developed to predict swelling/shrinkage behavior of subgrade soils, there is a lack of data needed to calibrate these models under pavement structures so that an accurate prediction can be made on the volume change of the subgrade soils due to environmental distresses. The results of this research program will allow agencies to incorporate the analysis in design procedures and access models calibrated at local conditions.

Having field test data gathered on a wide variety of soils from several regions in the United States that could potentially pose a high-volume change problem will help in calibrating general and local level models that can be used to predict the swelling/shrinkage pattern of any type of soil undergoing distresses caused by environmental loads.

The incorporation of models in the analysis and design of pavements is a sustainable solution that will help reduce the maintenance and costs associated with the repair works. In addition, the roads designed using the accurate models will experience less damages providing a safe driving experience to the users. The data collected can be used for preliminary investigations to locate problematic areas and work on the plan of action to optimize funding, saving the DOTs substantial amount of resources.

Implementation Considerations

Successfully calibrated models both on national and local levels will help DOTs monitor pavement health and predict volume change of the subgrade layers that may cause damage to the pavement in the future.

The collected data and the models provided to DOTs would also work as a design tool for new highway projects where prediction of the volume change of the soils will further provide the boundary conditions for foundation designs of highway structures like roadway bridges improving the overall efficiency of projects.

Recommended Research Funding and Research Period

\$600,000 over 5 years

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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NCHRP Review of C-17

Reviewed By:

Amir Hanna

ahanna@nas.edu

Comments:

A. The problem is solvable through the proposed research. However, a long time period is required to adequately monitor changes in soil behavior and volume change in subgrade materials, and develop related models.

B. The topic of research should be of interest to those state DOTs in areas having subgrade soils susceptible to shrink/swell and/or frost heave.

C. The objective, as stated in the problem statement, focuses on data collection to predict high volume change in subgrade materials. Research is currently underway under NCHRP Project 01-59 to develop enhancements to the Pavement ME Design procedures to better reflect the influence of subgrade soils susceptible to shrink/swell and/or frost heave on pavement performance. The proposed research would be more beneficial if it focuses on calibrating these enhancements through limited field and laboratory investigations and not on developing models for predicting volume change.

D. The stated scope appears to be specific. However, the anticipated models will likely require a substantial effort to support their implementation in pavement design procedures.

E. The proposed 5 years project duration may not be long enough to acquire sufficient data to develop reliable models for predicting volume change. However, if the project focuses on calibrating the anticipated enhancements to the MEPDG models a shorter time period (e.g., 3 to 4 years) should be adequate.

F. Field instrumentation and investigations generally require an extensive level of effort and cost; the proposed \$600,000 may not be sufficient. However, if the project focuses on calibrating the anticipated enhancements to the MEPDG models, a lower budget (e.g., \$500,000 or less) should be adequate.

G. Several relevant reference are cited. However, the problem statement omits the reference to NCHRP Project 01-59 and the work currently in progress on subgrade soils susceptible to shrink/swell and frost heave and their effect on pavement performance.

Submitter Response for 2023-C-17

From:

[email: john.siekmeier@state.mn.us]

Comments:

Thank you for your very valuable comments. I agree with the comments and will be happy to provide an updated problem statement in the future if requested.

The revised problem statement would contain the follow addition, which addresses the reviewer's comments. "The research completed during NCHRP Project 01-59 "Enhancements to Pavement ME Design: Improved Consideration of the Influence of Subgrade Soils" has developed enhancements to the Pavement ME Design procedures to better reflect the influence of subgrade soils. These proposed enhancements require calibration using more accurate field and laboratory measurement of soils susceptible to shrink/swell and/or frost heave. The objective of the proposed research is to execute a field instrumentation and monitoring program, combined with laboratory testing, which will allow calibration of the NCHRP Project 01-59 enhancements for Pavement ME Design and other important methodologies available to predict high volume change in subgrade materials. Calibrated models will help DOTs monitor pavement health and better predict volume change of the subgrade layers in order to improve pavement performance and reliability."

Contact Info:

John Siekmeier

Minnesota Department of Transportation

Chair AKG40 TRB Standing Committee

john.siekmeier@state.mn.us

Review Date:
February 7, 2022

Research Field D

MATERIALS AND CONSTRUCTION

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-D-01

Problem Title

Determining the Monthly Average Available Workdays (AAWD) for Highway Construction Projects

Background Information And Need For Research

Highway construction operations can be affected by various environmental factors such as rainfall, tropical storms, snowfall events, and cold weather conditions. Unforeseen extreme weather affects construction productivity, causing significant project delays, which constitute a frequent source of contractor delay claims [1]. For example, excessive rainfall affects grading operations, and paving operations cannot be performed when air temperatures fall below ~40 F. The determination of accurate construction windows is a critical task for the successful completion of any highway construction projects, and to avoid unnecessary legal issues. FHWA policy [2] requires each state to establish necessary written procedures for determining contractor performance windows for projects. Therefore, various contract time determination systems (CTDSs) or procedures have been developed by state DOTs [3]. Approximately 15 DOTs have developed and use CTDSs, 17 DOTs currently use engineering experience in determining contract time, and other DOTs use various alternative methods [3]. There is an increase in the number of DOTs that are aware of the criticality of weather as a major factor that affects the productivity rates of construction projects [3]. The impact of weather on production rates has been considered in CTDSs developed by Indiana, Oklahoma, and Wisconsin DOTs [3].

To appropriately determine construction contract times and productivity rates, engineers should consider several factors, e.g., weather, location, soils, traffic, and equipment technology [3]. However, guidance in considering adverse weather conditions on construction operations is currently lacking. The development of a project-specific contract time or production rate often relies on “rules of thumb” or engineering judgment. Without adequate weather data analysis, the contract time could be over- or under-estimated, leading to serious cost implications when projects are delayed due to weather.

Literature Search Summary

The impact of adverse weather conditions such as rainfall is a common cause of delays, legal claims, and economic losses in construction projects. Engineers managing highway construction projects should consider impacts of the expected amount, frequency, intensity, and duration of precipitation on various construction operation tasks. However, almost no or very little guidance is given on how to quantify the impact of rainfall and other adverse weather conditions on construction tasks. Various studies

have been conducted to integrate weather data or forecasting into progress schedules and critical paths to determine the contract time [2]. Moselhi et al. [4] estimated weather impact on the duration of construction activities and developed an automated decision support system (named WEATHER) to estimate the combined effect of reduced labor productivity and work stoppage caused by adverse weather conditions on construction sites. The developed system is portable and can be used in cities across Canada where weather data is available, however, the model cannot be used for construction projects in the U.S. The contract time is commonly defined by working days. An often-debated question is “How should a project schedule incorporate workdays that might be lost to adverse weather?”. A simple way to consider the weather impacts is to determine the average available workdays (AAWDs) that construction operations can proceed in each month. For example, Alabama DOT’s Construction Bureau developed AAWDs for each Page 2 of 3 DOT district to guide in determining the contract time. ALDOT engineers used 3–5 years of rainfall data from major cities in Alabama to manually count the number of available workdays in each month to determine AAWDs by excluding weekends, legal holidays, rainy days, and days with cold air temperatures.

Research Objective

The primary objective of this research is to develop a comprehensive guide and a Geographic Information System (GIS) platform to determine the monthly AAWDs nationwide for highway construction projects using local historical rainfall and air temperature data.

General Scope of Work:

Task 1: Literature Review and State-of-the-Practice Survey. Complete a comprehensive literature review and survey to identify current practices being used by state DOTs and identify commonly used construction scheduling practices that consider the effects of adverse weather conditions.

Task 2: Identify and Assess Weather-Related Factors Affecting the Construction Operations and Contract Time Determination. Develop a list of weather parameters that affect various construction activities and develop a matrix on how weather parameters affect construction operations and contract time determination. This task will also identify how and where to obtain historical weather databases over many stations in the U.S. to provide the necessary data for determining the monthly AAWDs.

Task 3: Develop Guidance for Determining the Monthly AAWDs for Highway Construction Projects. The research team will apply the findings from Tasks 1 and 2 to develop detailed approaches for the most common practices in determining AAWDs consider adverse weather conditions.

Task 4: Develop a GIS Platform to Implement the Guidance and Determine AAWDs for Construction Projects in the U.S. The developed GIS platform should be user-friendly, allowing for the identification of available historical data from weather stations located near selected project locations. The user would be able to select rainfall and air temperature thresholds and when construction operation would stop. The GIS platform should be able to process historic data to determine monthly AAWDs for analyzed construction projects. Users, (i.e., State DOT engineers) should be able to conduct an

analysis either state-wide or by selecting several counties (representative of a DOT district/region) and select one or several weather stations to determine monthly AAWDs. Task 5: Prepare a Case Study. Apply the guidance and the GIS platform to determine the monthly AAWDs in one selected state DOT for several districts/regions or a specific construction site.

Task 6: Project Report. Prepare a project report summarizing the findings from Tasks 1 – 5. The report should include recommendations and experience for implementing the guidance and the GIS platform.

Task 7: Outreach and Training. The research team will provide outreach and education on the implementation of the developed GIS platform including a prerecorded webinar

Urgency and Potential Benefits

The need for investing in infrastructure rehabilitation projects has been at the forefront of recent bipartisan political agendas. Thus, the duration of highway construction projects will become more critical today than it was in the past due to increased resurfacing, restoration, and rehabilitation projects [2]. For most projects, one of the essential elements in determining contract time is to understand potential factors such as impact on business closures, delays and safety risks caused to motorists, and environmental/weather constraints. Seasonal or weather limitations for certain construction operations should be considered when determining both the number of days the contractor will be able to work as well as production rates. This project will seek to provide guidance and a GIS platform to help state DOTs and contractors efficiently plan for highway construction projects. This research project would seek to develop nationwide weather based guidance to determine the monthly average available workdays for highway construction projects using historic weather databases, which lead to considerable cost savings for state DOTs and taxpayers

Implementation Considerations

Research results will be used by a variety of individuals within state DOTs including construction engineers, managers, and external contractors working to complete construction projects. Results of this work are expected to be immediately implementable and will allow DOTs to advance construction planning, scheduling, and contracting methods. Proposed Tasks 5 and 7 will include case studies and outreach materials to facilitate the implementation of research results. The AASHTO Technical Committee on Hydrology and Hydraulics (TCHH) along with the AASHTO Committee on Construction would be interested in research results and could help support implementation.

Recommended Research Funding And Research Period

\$250,000 for 24 Months

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Jason Humphrey, P.E.; South Dakota Department of Transportation; AASHTO COC Research Chair; Jason.humphrey@state.sd.us; 605-773-5287

NCHRP Review of D-01

Reviewed By:

Christopher T. McKenney
CMcKenney@nas.edu

Comments:

In construction, weather will always be a major factor in planning and scheduling. Weather is also regional, even within a state's boarder, so providing state DOTs with the means to determine Average Available Workdays, to individualize schedules, and maximize productivity would be of great assistance to construction projects.

Overall, the Research Objectives are clear with a few recommendations. For Task 2, the National Oceanic and Atmospheric Administration website and databases should be able to provide the necessary historical data needed for this research. For Task 4, consideration should be taken into account for future maintenance and updates of the GIS platform beyond implementation. For Task 5, additional case studies should be considered, which could provide more evidence for the need of the GIS platform.

The undertaking of more case studies, as well as considering current climate changes, may potentially require additional time and funding. It is recommended to increase the funding to \$400,000 for a duration of 36 months.

Review Date:

12/1/2021

AASHTO Committee Evaluation for D-01

Submitted By:

Casey Soneira
AASHTO staff
Committee on Construction

Priority #: 2

Comments:

The Committee On Construction (COC) has chosen this RNS to assist states with calculating project durations and potential delay periods. This will determine contract times and productivity rates. Guidance in considering adverse weather conditions on construction operations is currently lacking and greatly needed when meeting public expectations. The results of this research will help the construction industry be consistent nationwide. Providing a prediction of the potential delay as a result of weather conditions will assist in making decisions regarding the optimum construction approach to meet the project schedule given expected weather conditions. The COC members will calculate by using a GIS platform along with local rainfall and air temperature data to determine the AAWD for projects.

Submitter Response for 2023-D-01
From:

[email: csoneira@ashto.org;]

Comments:

Thank Mr. McKenney to provide the comments to the problem statement.

- (1). Thank you for your general and positive comments on the problem statement and the study to determine Average Available Workdays for all DOTs using a GIS platform.
- (2). Yes, for Task 2, NOAA website and databases will be resources to find the necessary historical data needed for this research. NOAA databases can be updated through GIS platform for the future years after the project is completed.
- (3). The comment for Task 4 is great: considering future maintenance and updates of the GIS platform beyond implementation.
- (4). Yes, we agree that more case studies will be useful for the project.
- (5). Yes, to increase the funding to \$400,000 for a duration of 36 months is a great suggestion to do more case studies and additional work for Task 4.

Contact Info:

Casey Soneira csoneira@ashto.org
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Review Date:

2/7/22

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-D-02

Problem Title

Guidebook on Progressive Design-Build for Transportation Projects: Project Planning through Project Implementation

Background Information and Need For Research

Transportation agencies started using design-build (DB) over 25 years ago, and it is now considered a standard “tool in the toolbox.” The most commonly used methodology for DB contractor selection involves a best value process, with significant weight accorded to price, resulting in a fixed price contract for design development and construction. Progressive Design-Build (PDB) is an advancement of fixed price DB that allows early contractor involvement, including elements similar to construction manager/general contractor (CM/GC). It transfers design and construction responsibilities to a design-build team starting with a preliminary planning and design phase through construction completion, with negotiation of the price for final design and construction at the end of preliminary design phase, similar to the process used for CM/GC pricing. The qualifications and experience of the DB team are significant factors in contractor selection, and while legislation often dictates consideration of price in the selection, in some cases public owners use a pure qualifications-based selection process.

PDB contracts include procedures for development of the design, schedule/phasing plan and a price for final design and construction which typically is in the form of a Guaranteed Maximum Price for Construction (GMP). The development of the GMP is a key component of PDB as it allows owners to hire a designer-builder without a price commitment for final design and construction until after reasonable design details are defined. In addition, to ensure agencies are able to make the price reasonableness determination required for federally funded projects, the public owner often hires an Independent Cost Estimator (ICE) to develop a full price of construction based upon an agreed upon scope of work and schedule. The negotiated price typically includes allowances and contingencies to account for potential unknowns and risks that are agreed upon by the owner and the contractor. Several state departments of transportation (DOTs) have started to use PDB, based on models that have been successfully used in water/wastewater, airport, municipal street/roadway projects, flood control, and transit sectors.

The documented benefits of using PDB include:

- greater agency control of design decisions, scope, cost, and schedule;
- flexibility of delivery;

- risk mitigation and contingencies;
- innovative project-specific solutions and better scoping of owner needs and expected outcomes;
- accelerated schedule and phasing opportunities;
- increased diversity in contracting opportunities and workforce development;
- increased life-cycle value for money;
- and greater designer and contractor collaboration.

Moreover, in contrast to traditional design-bid-build (DBB) and CM/GC, and like fixed price DB, PDB transfers design liability to the contractor.

Only a few states have implemented PDB to date. For example, Maryland successfully used PDB for their I-270 project and Utah used PDB for their US 89 project. Washington began their first PDB on a grouping of fish passage projects. California, Missouri, Michigan and Florida also are interested in PDB to maximize the dual benefits of DB and CM/GC delivery methods. However, little PDB guidance is available, if any, for state DOTs to implement PDB on their highway projects.

Literature Search Summary

PDB is a project delivery method that is of great interest to many sectors and more specifically to the transportation sector, that has not been the subject of specific research. There has been a few CRP publications (TCRP G-08, A Guidebook for the Evaluation of Transit Project Delivery Methods and ACRP A01-05, A Guidebook for Airport Capital Project Delivery Systems, ACRP Legal Digest 38: Legal Issues Related to Large-Scale Airport Construction Projects) addressing various aspects of PDB whether in terms of selection or legislation requirements. However, to date no detailed guidance has been developed for DOTs to implement it most effectively and accrue many of the pronounced advantages. Specifically, no prior research has been conducted for NCHRP on PDB. At the state DOT level, Alleman and Tran (2021) studied Maryland's I-270 PDB project and the challenges of implementing PDB in highway construction. However, in most these studies, the thrust of the research was to assist transit and airport agencies in making their project delivery selection decision and included very little detail on the mechanics and implementation best practices of PDB.

NCHRP 10-85: A Guidebook for Construction Manager-at-Risk Contracting for Highway Projects (published as the AASHTO CMGC Guide) is related to this research project in that CM/GC uses a negotiated pricing structure similar to that used in PDB. This research would provide guidance that is also relevant to the DB contractual environment. ACRP Legal Digest 38: Legal Issues Related to Large-Scale Airport Construction Projects address the legal framework upon which PDB could be implemented effectively within the regulatory constraints.

Research Objective

Because of the benefits offered by PDB, combined with the growing reluctance of the contracting community to bid on fixed price DB contracts due to the risk of cost overruns, there is a need to investigate how PDB can be most effectively implemented

on highway projects. This will require research into key issues such as statutory authority and permits needed for PDB, availability of and effects on the owner's in-house staff, level of design detail and control, and level of risks, among others. The main objective of the proposed research is to develop guidelines that will assist state DOTs in the effective and efficient use of PDB for highway projects. The research will answer the following questions:

1. What is the current state-of-practice for successful implementation of PDB? How could the current state-of-practice and lessons learned of PDB from other sectors' projects apply to highway projects? What are the benefits and challenges of PDB beyond fixed price DB, specific to highway projects?
 2. What are the critical skill sets, knowledge, resources, legislation, etc., that agencies need prior to executing PDB projects? How do traditional agency functions and responsibilities change under PDB? How do these changes impact staff requirements and roles? How does an agency representative become a champion for PDB? What type of training is needed to implement PDB?
 3. To maximize the likelihood of selecting the best PDB contractor for a specific project, what evaluation elements should be emphasized when developing and implementing a PDB procurement? These elements include team qualifications and availability, selection criteria, and procurement processes, among others.
 4. What are the skill sets, knowledge, team structure and experience (i.e. qualifications) expected of a contractor team (builder and designer) to successfully deliver a PDB project?
 5. What are the challenges in administering a PDB contract and how can they be overcome?
 6. What are the inherent conflicts between PDB delivery and NEPA (National Environmental Policy Act) requirements? How can they be addressed?
 7. What are the funding restrictions from a timing and scoping perspective?
 8. What other barriers exist to utilizing a PDB delivery method?
- How are risks allocated and effectively managed on PDB projects? How should contractual "off-ramps" be structured to ensure that the owner has appropriate alternatives if issues arise during the preliminary design phase or pricing is too high? What are the risks and benefits of exercising an "off-ramp," including the timing of "off-ramp" and professional liability? How can the risks be mitigated?

Urgency and Potential Benefits

This research would result in an NCHRP research report providing updated information about successful practices, case law and statutes relating to PDB project delivery to assist agencies in evaluating when PDB should be considered for a project, and how to develop the framework for successful use of PDB. If added to the DOT project delivery standard "toolbox," PDB also represents a possible solution to reducing the costs of unrealized risks found in fixed price DB projects, and increases the pool of contractors interested in proposing on DB projects, by permitting a negotiated construction cost based on more design detail with public owner control of the design decisions.

Implementation Considerations

This research will be utilized by Planners, Engineers, and Contractors involved in highway construction planning, scoping, development, construction, and maintenance activities. This guidebook share lessons learned from agencies that have already utilized PDB, and will identify all of the necessary tools to guide an agency from the planning phase to implementation phase.

Recommended Research Funding And Research Period

\$300,000 for 24 months.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

- Eric Kahlig, PE, Ohio Department of Transportation – eric.kahlig@dot.ohio.gov; 614-387-2406
- Douglas Gransberg, Ph.D. Chair AFH 15 – dgransberg@gransberg.com; 405-503-3393

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

- Eric Kahlig, PE, Ohio Department of Transportation – eric.kahlig@dot.ohio.gov; 614-387-2406
- Ryan Mitchell, Michigan Department of Transportation – mitchellr13@michigan.gov 517-614-7025

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Jason Humphrey, P.E. South Dakota Department of Transportation; AASHTO COC Research Chair; Jason.humphrey@state.sd.us; 605-773-4391

NCHRP Review of D-02

Reviewed By:

Christopher T. McKenney
CMcKenney@nas.edu

Comments:

Understandably, a detailed guidebook could be of great use to state DOTs and relevant stakeholders. However, a primary obstacle could be how to translate Progressive Design-Build (PDB), which is widely used in the private sector, and transform this delivery method into a deliverable that would be attractive to the public sector. The Design-Build Institute of America could be valuable resource, being a leader in the PDB method for the construction industry.

Fortunately, the PDB process could be investigated with state DOTs programs such as Virginia DOT, under different designations such as Lean Construction Program and Value Engineering Program, or as Alternative Delivery Program Design-Build projects like ARDOT's 30 Crossing Design-Build project. Another potential source is the US Army Corps of Engineers who utilize these tools for government contract projects.

A recommendation would be to consider combining problem statement D-02 with D-12 due to the potential overlap in research. The period of time and funding is adequate if it is decided to keep D-02 as a separate problem statement.

Review Date:

11/30/2021

FHWA Evaluation of D-02

Reviewed By:

Patrick DeCorla-Souza/HCFB

Comments:

It would be cost-effective to expand the scope of this research to include Progressive P3 contracting. Progressive P3s are very similar to Progressive DB, simply adding financing and O&M to the private partner's responsibilities. In fact, the problem statement confuses the Maryland I-270 project, which is a Progressive P3, with PDB. They are very similar.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for D-02

Submitted By:

Casey Soneira

AASHTO staff

Committee on Construction

Priority #: 1

Comments:

Progressive Design-Build (PDB) will allow states to improve their current fixed price Design Build program and include elements similar to construction manager/general contractor (CM/GC). There are many advantages to PDB but little centralized guidance on how to implement it. This guidebook will provide guidance on establishing PDB for states including identifying potential obstacles to PDB (restrictive procurement regulations, subcontractor procurement challenges, etc.). This guidebook will provide

consistency nationwide on the implementation of PDB. The COC members will benefit by having a quick reference to PDB from planning to project completion utilizing this project delivery method.

Submitter Response for 2023-D-02

From:

[email: csoneira@ashto.org; mkulkarni@mdot.maryland.gov]

Comments:

Comment #1:

In response to the following review comments from Patrick DeCorla-Souza/HCFB: “It would be cost-effective to expand the scope of this research to include Progressive P3 contracting. Progressive P3s are very similar to Progressive DB, simply adding financing and O&M to the private partner's responsibilities. In fact, the problem statement confuses the Maryland I-270 project, which is a Progressive P3, with PDB. They are very similar.”

Respective response to comment #1:

Although a study to include Progressive P3's would be beneficial, it would likely take much longer to complete. The inclusion of financing and O&M makes a progressive P3 project much more complex than a “traditionally funded” Progressive Design-Build. P3s typically involves a different contracting structure since the “developer” will likely be a limited liability entity that subcontracts out the design-build work. This study could act as a step for a future study on Progressive P3s since PDB is just one component of Progressive P3s with funding/financing component being other big component. The funding/financing component substantially alters the risk profile. It was intended that this study be restricted to only PDB with consideration given to a future separate study on Progressive P3's being preferable. The belief is keeping the ideas separate with resultant product(s) diving deeper and therefore providing more substantive guidance.

Comment #2:

In response to the following review comments made by Christopher T. McKenney (CMcKenney@nas.edu): “Understandably, a detailed guidebook could be of great use to state DOTs and relevant stakeholders. However, a primary obstacle could be how to translate Progressive Design-Build (PDB), which is widely used in the private sector, and transform this delivery method into a deliverable that would be attractive to the public sector. The Design-Build Institute of America could be valuable resource, being a leader in the PDB method for the construction industry.

Fortunately, the PDB process could be investigated with state DOTs programs such as Virginia DOT, under different designations such as Lean Construction Program and Value Engineering Program, or as Alternative Delivery Program Design-Build projects like ARDOT's 30 Crossing Design-Build project. Another potential source is the US Army Corps of Engineers who utilize these tools for government contract projects.

A recommendation would be to consider combining problem statement D-02 with D-12 due to the potential overlap in research. The period of time and funding is adequate if it is decided to keep D-02 as a separate problem statement.

Respective response to comment #2:

As the two statements are currently written, there would be synergies with D-02 and D-12 and therefore should work in concert with each other, share information, and divide up overlapping tasks. With that said, there is still likely different research topics as AASHTO is focusing on an updated Guidebook for DB to then also include PDB. It may be prudent to keep the two separate as the overlap of a “traditional” DB and a PDB would be limited to primarily the first phase (RFQ) of the procurement process. While both delivery mechanisms are design-build, management of the contract has substantial differences. D-02 will cover topics directly related to PDB, will be able to do a more in-depth evaluation of the process, and will ultimately be of good use to D-12. Not sure if a coordination provision can be added to both, but if possible, it should be considered. There could also be concerns with combining these two at the current timeframe and values proposed for D-12 may not adequately evaluate PDB. If D-02 and D-12 studies are combined, either singular effort should be expanded ensure the PDB is adequately considered.

Contact Info:

Casey Soneira, csoneira@aaashto.org

Review Date:

1/10/22

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-D-03

Problem Title

Recommended Minimum Qualifications for Transportation Project Quality Management Roles

Background Information and Need For Research

Effective management of quality during the design and construction of public transportation projects is a critical, yet often overlooked part of the successful delivery of these projects. Owner agencies, designers, contractors and material suppliers all require specific quality roles and functions to assure that the project meets design requirements and long-term performance expectations. Typical quality roles include owner quality assurance engineers/managers; design quality managers; construction quality managers; quality control plan administrators and quality control managers. These roles and functions will vary depending on project delivery method specified by the owner or their organizational structure. While the minimum qualifications for roles such as lead designer, project manager or construction engineer are usually well-defined to include specific levels of education, experience and professional licensure, minimum requirements for quality-related roles often do not include specific training or certification in quality management principles. This may be due to an assumption that education and experience in a particular design or construction discipline provides the skills necessary to provide effective quality management; this ignores the fact that quality management is itself a specialized discipline that requires training and experience. It is also critical that individuals in these roles understand the overall project quality efforts and how their functions support those efforts. The pervasive lack of training in quality management principles leads to compromised overall short and long-term quality of projects.

Some owner agencies specify or recommend minimum qualifications for personnel filling key management roles focused on quality engaged on public construction projects. For example, the Army Corps of Engineers (USACE) and U.S. Naval Facilities Engineering Command (NAVFAC) require QC managers/administrators working on their projects to hold a certificate in Construction Quality Management for Contractors, that is offered as a partnership between those agencies and two national contractor associations. The Federal Transit Authority (FTA) "Quality Management System Guidelines" recommends that certain project personnel hold certifications through the American Society for Quality including Manager of Quality/Organizational Excellence; Quality Engineer; and Quality Auditor. Several state DOTs in the northeast require QC plan administrators to hold the Quality Assurance Technologist certification administered by the NorthEast Transportation Training and Certification Program (NETTCP). However, most agencies do not require certification for quality management

roles. Instead they rely on minimum educational and experience levels that may or may not include training on or experience with quality management principles.

Increased knowledge of quality management principles will lead to improved outcomes on transportation projects, including well defined and understood roles, less rework, shorter project completion times, extended facility life, reduced operating costs, and fewer traffic delays.

This relates to AASHTO Committee on Materials and Pavement's (COMP's) Strategic Plan - Goal 1.1 – Update Materials Standards and Goal 3 – Develop and Champion Research for COMP.

Literature Search Summary

Several published reports and articles discuss quality management approaches on public transportation projects (many specific to design-build contracting). However, none discuss in detail the qualifications needed to effectively conduct various quality roles.

Kraft, E. and Molenaar, K.: “Fundamental Project Quality Assurance Organizations in Highway Design and Construction” – ASCE Journal of Management in Engineering, July 2014.

Gransberg, D., Molenaar, K.: “Analysis of Owner's Design and Construction Quality Management Approaches In Design/Build Projects” – American Society of Civil Engineers, 2004.

Baabak Ashuri, Ph. D., Yashovardhan Jallan, Jung Hyun Lee: “Materials Quality Management for Alternative Project Delivery” - Georgia Department of Transportation, May 2018.

Ghada M. Gad, Simon A. Adamtey, Douglas D. Gransberg: “Trends in Quality Management Approaches to Design–Build Transportation Projects” - Transportation Research Record: Journal of the Transportation Research Board, No. 2504, Transportation Research Board, Washington, D.C., 2015, pp. 87–92.

Gransberg, D., and K. Molenaar: “Analysis of Owner's Design and Construction Quality Management Approaches in Design/Build Projects” - Journal of Management in Engineering, Vol. 20, No. 4, 2004, pp. 162–168.

Gransberg, D., Datin, J., and Molenaar, K. (2008). NCHRP Synthesis 376: Quality Assurance in Design-Build Projects, Transportation Research Board, Washington, DC.

Research Objective

Develop recommended minimum qualifications for design and construction quality management roles on public transportation projects.

Possible tasks include:

Task 1 – Literature review. Include public transportation agency specifications related to quality management for design and construction.

Task 2 – Survey of public transportation agencies to determine current requirements for quality management roles (including agency, designer and contractor roles), for both traditional delivery and alternative delivery projects.

Task 3 - Identify existing training/certification programs for quality management roles that are related to transportation project delivery, or other related industry sectors.

Review the prerequisites, course content, intended audience guidelines, examination process, and recertification requirements.

Task 4 – Develop suggested minimum qualifications for various quality management roles, including education, certification, and experience requirements. Consider both traditional and alternative project delivery methods.

Task 5 – Publish a guide for agencies to use to develop minimum qualification/certification requirements for various quality management roles for public transportation projects.

Urgency and Potential Benefits

Ineffective quality management in the transportation project delivery process can lead to project delays and cost escalation due to constructability problems, rework, and disputes, as well as reduced service life and increased maintenance costs of completed facilities. Published reports have estimated that rework on construction projects can account for as much as 25 percent of total project cost. Given the total cost of delivering public transportation projects in the United States, improved quality management in design and construction could result in millions of dollars in annual savings to taxpayers.

Implementation Considerations and Supporters

Implementation of the guidelines will be accomplished through presentations at the AASHTO Committee on Materials and Pavements, AASHTO Committee on Construction, and through presentation at various regional and national meetings and conferences (including the TRB annual meeting), as well as a TRB webinar. Potential challenges will be similar to those encountered when organizations worked to improve safety. It will require a shift in cultural beliefs for agencies and industry to invest in additional training and/or certification of quality management staff. Inconsistent terminology related to QA will present challenges by inhibiting effective communication at the national level.

AASHTO Committee on Materials and Pavements (COMP) – Ranked #4

AASHTO Committee on Construction

TRB Committee AKC30 – Quality Assurance Management

Recommended Research Funding and Research Period

Recommended Funding: \$300,000

Research Period: 24 months

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Rick Bradbury, Maine Department of Transportation, Tel: 207-624-3482,
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Robert Lauzon, Connecticut Department of Transportation, Tel: 860-258-0312,
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Adam Hand, University of Nevada Reno, Tel: 775-784-1439, adamhand@unr.edu

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Members of AASHTO COMP Technical Subcommittee 5c – Quality Assurance and Environmental, Curt Turgeon (Chair), 651-366-5535, curt.turgeon@state.mn.us.

Rick Bradbury, Maine Department of Transportation, 207-624-3482,
Richard.bradbury@maine.gov

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Mark E. Felag, AASHTO COMP Secretary on behalf of AASHTO COMP, 401-245-1327,
mfelag@hotmail.com

NCHRP Review of D-03

Reviewed By:

Amir Hanna
ahanna@nas.edu

Comments:

- A. The problem is solvable through the proposed research.
- B. The topic of research should be of interest to the majority, if not all, state DOTs.
- C. The objective, as stated in the problem statement, provides a clear intent of the research. It will develop recommended minimum qualifications for design and construction quality management roles on public transportation projects.
- D. The scope is clearly defined, it will lead to developing a guide to help agencies identifying minimum qualification/certification requirements for various quality management roles for public transportation projects.
- E. The estimated duration of 24 months seems adequate.

F. The estimated budget of \$300,000 seems adequate.

G. Several publications are cited but further literature review, surveys, and other information gathering should be performed as part of this research.

Note: This problem statement is one of 4 problem statements submitted by the AASHTO Committee on Materials and Pavements; it was ranked fourth by the committee.

FHWA Evaluation of D-03**Reviewed By:**

Tim Aschenbrener/HICP-40

Comments:

Very important for successful project completion as many contractors are not following the minimum qualifications. This was rated in AASHTO COMP's top 4.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for D-03**Submitted By:**

Casey Soneira
AASHTO staff
Committee on Construction

Priority #: N/A

Comments:

The COC supports this problem statement from COMP.

Submitted By:

Casey Soneira
AASHTO staff
Committee on Materials & Pavements

Priority #: 4

Comments:

To fully achieve quality within a construction project it is important that all personnel on the project be aware of what roles they need to play. This includes not only owner representatives within design, construction and materials but contractors and materials suppliers. Each play a critical role that needs to be defined. This project will do that. The Committee on Construction also supports this as an important project.

Submitter Response for 2023-D-03**From:**

[email: mfelag@hotmail.com;csoneira@aashto.org]

Comments:

The submitters appreciate the positive feedback. (Rick Bradbury - Author)

Contact Info:

Mark Felag - mfelag@hotmail.com; Casey Soneira - csoneira@aashto.org

Review Date:

December 28, 2021

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-D-04

Problem Title

Variability in Pavement Materials and Construction

Background Information and Need For Research

Variability is inherent in all pavement materials and construction processes. Understanding the magnitude of variability is important to pavement construction industry stakeholders. State Highway Agencies (SHAs) need to quantify the typical variability of pavement materials and construction processes in order to establish rational specification limits. Material producers and contractors need to identify and measure sources of variability in order to manage quality.

While quality has traditionally been defined as “fitness for use” or “degree of excellence,” a modern definition of quality states “quality is inversely proportional to variability.” Relating pavement material properties to variability has traditionally relied on quality characteristics such as binder content, aggregate gradation, mix volumetrics, in-place density and smoothness for asphalt pavement, and compressive strength, air content, thickness, permeability, and smoothness for concrete pavement. NCHRP Synthesis of Highway Practice 232, Variability in Highway Pavement Construction (1996) published typical variabilities for many of these quality characteristics. However, in the past twenty-five years, improvements in mix design practices, test equipment and methods, material processing and construction practices, increased use of recycled materials and changes in SHA specifications including improved quality measures such as percent-within-limits and alternative project delivery methods (which typically include advanced quality management program components) are likely to have impacted variability. In addition, new performance tests such as performance-graded binder tests, and asphalt mixture cracking and rutting tests and concrete tests such as the Super Air Meter and surface resistivity are being introduced, most of which have not been evaluated for typical variability values.

As SHAs move from pavement acceptance based on traditional quality characteristics to performance tests (some of which rely on test methods that cannot be performed as frequently as traditional tests due to testing complexity) it is critical that the variability of pavement materials and construction processes be better understood so that pavements consistently meet the long-term expectations of SHAs. Also, introduction of nondestructive test methods and technologies, with greater coverage than traditional methods, have the potential to provide a great deal of useful data regarding pavement construction that can be leveraged to improve quality if their variability is documented. It is also important to know if quality assurance (QA) specifications instituted by many

SHAs since 1996 have resulted in decreased variability, and therefore have resulted in improved pavement quality.

This relates to AASHTO Committee on Materials and Pavement's (COMP's) Strategic Plan - Goal 1.1 – Update Materials Standards and Goal 3 – Develop and Champion Research for COMP.

Literature Search Summary

1. Hughes, C.S., Variability in Highway Pavement Construction, NCHRP Synthesis of Highway Practice No. 232, Washington, DC: National Cooperative Highway Research Program, 1996.
2. Hughes, Charles S., "State Construction Quality Assurance Programs", NCHRP 346 Transportation Research Board, Washington, D.C., 2005.

How this will build upon the above is explained within Section 2.

Research Objective

The objective of this research is to prepare a report quantifying the typical variability of pavement construction materials and processes and provide guidance for SHAs to evaluate the variability of newly-implemented performance tests.

Possible tasks include:

Task 1 – Literature review to identify the major fundamental sources of variability for mixture production, transportation, and placement for both concrete and asphalt pavements. Compile a prioritized list of data and metadata that could be useful for the analysis, with consideration of what is possible to obtain from agencies, producers, and contractors.

Task 2 – Conduct a survey to identify SHAs that have pavement quality characteristic test data stored in digital format that spans a decade or more to evaluate in the range of variability over time.

Task 3 – Collect test data and metadata from agencies, producers, and contractors on various pavement quality characteristics using the list compiled in Task 1.

Task 4 – Identify the main components of variability that comprise overall material variability. Conduct statistical analysis to determine typical variability for various quality characteristics and the relative impacts of key materials and/or construction processes that impact the variability of these quality characteristics.

Task 5 – Quantify the changes in the variability of quality characteristics that has occurred since publication of Synthesis of Highway Practice 232.

Task 6 - Develop guidelines for SHAs to quantify variability of new test methods for pavement materials and processes, including mixture performance tests and nondestructive tests of various construction quality characteristics.

Task 7 – Publish a report of the research work and findings.

Urgency and Potential Benefits

Understanding variability is critically important to setting rational specification limits for pavement materials. Specification limits that are either too wide or too restrictive can result in incorrect acceptance or rejection decisions or incorrect pay adjustment for pavements. Quality improvement is dependent on reducing variability; therefore, it is necessary to determine if variability has been reduced in order to evaluate whether or nor QA specifications have achieved their intended goal of improving quality. Incorrect pavement acceptance decisions could result in millions of dollars of over/under payment for pavement construction, as well as impact performance predictions for newly-constructed pavements.

Implementation Considerations and Supporters

Results of the report will be directly applicable to agencies for evaluation of existing pavement QA specifications and for future implementation of performance specifications. As SHAs implement performance specifications, they will need accurate measures of material and construction variability in order to reliably predict long-term pavement performance from performance test data. The AASHTO committee on Materials and Pavements and Committee on Construction will be important stakeholders for implementation of the research findings. Industry groups including the National Asphalt Pavement Association, the American Concrete Pavement Association and the National Concrete Consortium will benefit from the information provided by this project.

Potential challenges to implementation include resistance to change by agencies and industry, and perceived cost impacts if the data indicates that specification ranges can be reduced due to decreased variability.

AASHTO Committee on Materials and Pavements (COMP) – Ranked #2
TRB Committee AKC30 – Quality Assurance Management

Recommended Research Funding and Research Period

Recommended Funding: \$500,000.00
Research Period: 30 months

8. Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Rick Bradbury, Maine Department of Transportation, Tel: (207) 624-3482,
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srao@ara.com

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Members of AASHTO COMP Technical Subcommittee 5c – Quality Assurance and Environmental, Curt Turgeon (Chair), (651) 366-5535, curt.turgeon@state.mn.us.

Rick Bradbury, Maine Department of Transportation, (207) 624-3482,
Richard.bradbury@maine.gov

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Mark E. Felag, AASHTO COMP Secretary on behalf of AASHTO COMP, 401-245-1327,
mfelag@hotmail.com

NCHRP Review of D-04

Reviewed By:

Amir Hanna
ahanna@nas.edu

Comments:

- A. The problem is solvable through the proposed research.
- B. The topic of research should be of interest to the majority, if not all, state DOTs.
- C. The objective, as stated in the problem statement, provides a clear intent of the research.
- D. The scope is clearly defined, it will build on the work presented in NCHRP Synthesis 232, Variability in Highway Pavement Construction, and should yield the intended product.
- E. The estimated duration of 30 months seems adequate.
- F. The estimated budget of \$500,000 seems adequate.
- G. Only two NCHRP publications are cited but further literature review, surveys, and other information gathering should be performed as part of this research. Note: This problem statement is one of 4 problem statements submitted by the AASHTO Committee on Materials and Pavements; it was ranked second by the committee.

FHWA Evaluation of D-04

Reviewed By:

Tim Aschenbrener/HICP-40

Comments:

Understanding variability is the key to improving quality. Very important. This was rated in AASHTO COMP's top 4.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for D-04Submitted By:

Casey Soneira
AASHTO staff
Committee on Materials & Pavements

Priority #: 2Comments:

As more and more states move to performance-based specifications with pay factors it is more important that the variability be better known. This is also critical due to newer tests coming on-line for both concrete and asphalt.

Submitter Response for 2023-D-04From:

[email: mfelag@hotmail.com;csoneira@ashto.org]

Comments:

The submitters appreciate the positive feedback. (Rick Bradbury - Author)

Contact Info:

Mark Felag - mfelag@hotmail.com; Casey Soneira - csoneira@ashto.org

Review Date:

December 28, 2021

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-D-05

Problem Title

Developing a Friction Performance Index for Asphalt Concrete Mixtures

Background Information And Need For Research

For the majority of asphalt mixtures produced in the U.S., their design is based solely on volumetric considerations. For a small but growing number of these mixtures, the design may also be based on structural performance, e.g., balanced mixture design (BMD). With the BMD concept and/or changes to the current design methodology, it is likely that mixtures will become finer, have an increased asphalt content, and potentially higher amounts of recycled materials. All of these changes will affect the functional characteristics; however, there does not currently exist a methodology to assess asphalt mixture designs to ensure that their functional performance characteristics. Worse, engineers lack a reliable, vetted procedure to consider functional performance at the mixture design stage. As such, state DOTs cannot actively engineer asphalt mixtures to exhibit sufficient functional and structural performance thresholds. Thus, they rely on ad hoc corrections when issues are identified.

This project will address this need by developing a procedure for state DOTs to evaluate their mixtures to either screen for those with poor functional performance or (ultimately) to design mixtures to avoid functional failures associated with material characteristics that do not balance functionality with structural durability. The experiences in developing BMD practices for rutting and fatigue demonstrate that failure to consider the consequences of potential test implementation (for example implementing a rutting test without including a cracking test) drives mixture behaviors in unexpected and unforeseen ways.

This research will address this problem by identifying the most effective, discriminating, and implementable test method or methods that state DOT's can adopt and that other researchers can use to develop practical mixture design methodologies and also for quality assurance approaches. This project would be clearly aligned with the AASHTO Committee on Materials and Pavements, which is concerned with, among other things, asphalt materials testing, specification, and performance, as well as management. Given the connection between the surface condition of roadways and safety, this research also addresses the strategic goals for the Safety committee whose primary goal is to eliminate serious traffic crashes and save lives.

This relates to AASHTO Committee on Materials and Pavement's (COMP's) Strategic Plan - Goal 1.1 – Update Materials Standards and Goal 3 – Develop and Champion Research for COMP.

Literature Search Summary

Many functional failures associated with asphalt mixture characteristics (skid resistance, splash/spray, noise, etc.) can be ultimately traced to insufficiencies in surface macro and microtexture. In fact, the AASHTO Guide for Pavement friction explicitly recognizes the role of texture on friction and ultimately the safety performance of roadways when it defines friction demand as “the level of friction needed to safely perform braking, steering, and acceleration maneuvers.” Owing to the tremendous safety implications from poor skid resistance, much of the research in this domain has focused on finding correlations between laboratory assessment of skid and polishing resistance and the actual skid resistance situation in the field. These studies have incorporated information on aggregate mineralogy, surface texture, traffic, and climate situation into the studies (Hofko et al. 2019; Kogbara et al. 2016; Masad et al. 2009; Merritt et al. 2015). The main objectives of these studies have been to understand the impact of employed materials and field conditions on the evolution of in-service skid resistance and how to simulate this evolution in the laboratory. The main elements considered in such studies can be summarized as follows:

- Characterization of the polish resistance of the individual aggregate fractions, e.g., BS EN 1097-8:2020 or aggregate abrasion measured via AASHTO T 327 (ASTM D7428-15),
- Characterization of the aggregate shapes, mixture gradation, and surface mean texture depth (MTD) or mean profile depth (MPD), e.g., testing via the Circular Track Meter (ASTM E2157 -15 2015), laser scanners, the ASTM E965 sand patch method, and others.
- Characterization of the change in surface skid resistance under traffic. Currently, there are two laboratory devices that have been used in different studies; 1) the Three Wheel Polishing Device (TWPD) and 2) the Wehner Schulze Device (WZD), manufactured in Germany. Each device measures friction at different polishing cycles.

Some advances have been made to describe and standardize the methods for measuring the surface friction and texture characteristics. However, more research is needed because there is still not a formal procedure to address final surface skid resistance during material design nor is there a process to accommodate the varying levels of friction that are required across and along typical roadways. A similar lack of knowledge and tools exists for other functional characteristics as well. To develop a mix design procedure that incorporates asphalt mixture texture, some challenges must be addressed; for example, both the TWPD and the WZD use field or lab-compacted slabs while the current Superpave mix design protocol produces a specimen with geometry that is dictated by the Superpave Gyratory Compactor. In addition, multiple devices can be employed to measure friction and texture in the field; this has caused problems in developing a single and reliable transfer function linking laboratory measurements with field observations.

Research Objective

The objectives of this research are to develop a methodology to assess the functional performance of asphalt concrete mixtures with respect to friction and macrotexture. The methodology should be applicable to both the mixture design/selection procedures and quality assurance/quality control process. A draft set of tasks that will likely need to be performed to achieve this goal are:

- Review of existing methodologies for laboratory and field determination of asphalt mixture texture and friction and ongoing research in this domain. This evaluation should consider not only the role of friction and texture in safety (as defined by AASHTO and in NCHRP Report 37) and readily accessible datasets such as the Kentucky continuous friction measurement data, asphalt mix design (including materials source), and crash data.
- Select the most promising experimental method(s) to evaluate asphalt mixture performance with respect to friction and texture that can be applied both during design and after construction.
- Develop the methodology for performance assessment. This methodology should be capable of evaluating asphalt mixtures macrotexture and microtexture (combinations of specific aggregate, asphalt binder, and proportions of each) but could consist of a combination of component material and composite tests and models.
- Establish initial performance thresholds for evaluation at the mixture design stage and for process control and quality assurance, and refinement in later research.
- Develop a draft AASHTO specification (or specifications) for review and submission as a provisional specification.

5. Urgency and Potential Benefits

There is an urgent need for this work to address the unknown impacts on safety (i.e. friction qualities) of asphalt mixtures as the balanced mix design method is implemented by agencies. Developing a means of evaluating functional performance properties that can be applied both during design and post-production will allow functional performance and safety to be designed into asphalt mixtures, and will provide a means of ensuring that this performance is maintained through the QC/QA process.

6. Implementation Considerations and Supporters

The results of this research will be used by state DOTs (specifically state DOT materials engineers), asphalt mixture designers, and asphalt paving contractors to ensure that asphalt mixtures are designed and produced with balanced structural and functional performance. Implementation activities may include:

- conference presentations (e.g. TRB Annual Meeting, RPUG, AASHTO), regional user-producer group presentations, BMD workshops, and webinars (e.g. TRB, AASHTO).
- supporting supplementary materials could include: a technical brief, short instructional videos, and whiteboard videos.

- a national workshop or webinar with invited participants for discussion on implementing the inclusion of functional assessment as part of mixture design and quality assurance/quality control processes.
- development of a follow-up effort to formulate guidelines to help state DOTs implement the functional assessment methodology into their mixture design and quality assurance processes.
- partnership with state DOTs currently participating in TPF-5(345/463) or similar studies.

AASHTO Committee on Materials and Pavements (COMP) – Ranked #3
 TRB Committees AKM30, AKM40, and AKP50
 TPF-5(345/463) – All members

Recommended Research Funding and Research Period

Research Funding: \$500,000
 Research Period: 30 months

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

- Shane Underwood and Boris Goenaga, North Carolina State University, 919-515-8632, shane.underwood@ncsu.edu
- Ilker Boz, Virginia Transportation Research Council,
- Stacey Diefenderfer, Virginia Transportation Research Council
- Magdy Mikhail, Transportation Industry Solutions, AgileAssets
- Brian Schleppi, Ohio Department of Transportation

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Members of AASHTO COMP Technical Subcommittee 2c – Asphalt Aggregate Mixtures, Allen Myers (Chair), 502-564-3160, allen.myers@ky.gov.

Person Submitting The Problem Statement: Name, Affiliation, Email Address And Phone.

Mark E. Felag, AASHTO COMP Secretary on behalf of AASHTO COMP, 401-245-1327, mfelag@hotmail.com

NCHRP Review of D-05

Reviewed By:

Edward T. Harrigan
 eharriga@nas.edu

Comments:

This problem statement is solvable through research. It complements the present development of balanced mix design procedures to introduce performance testing into asphalt mix design. As such, it is likely of interest to the majority of the DOTs.

The objective statement is clear and concise, and the scope is achievable.

Both the suggested period of performance and funding are reasonable.

The following are related references identified in Google Scholar:

Saghafi, Mahdi, Imad N. Abdallah, and Soheil Nazarian. "Practical Specimen Preparation and Testing Protocol for Evaluation of Friction Performance of Asphalt Pavement Aggregates with Three-Wheel Polishing Device." *Journal of Materials in Civil Engineering* 34, no. 1 (2022): 04021397.

Yang, Guangwei, Kelvin Wang, Joshua Qiang Li, Matt Romero, and Wenyao Liu. "Laboratory and Field Performance Evaluation of Warm Mix Asphalt Incorporating RAP and RAS." *KSCE Journal of Civil Engineering* (2021): 1-13.

Adeli, Sasan, Reza Salehfard, and Behnam Amini. "The Influence of Asphalt Mixture Components on Pavement Skid Resistance and Accident Rate in Urban Un-signalized Intersections." *International Journal of Pavement Research and Technology* (2021): 1-11.

Pranav, Cibi, Minh-Tan Do, and Yi-Chang Tsai. "Analysis of High-Friction Surface Texture with Respect to Friction and Wear." *Coatings* 11, no. 7 (2021): 758.

Zhan, You, Joshua Qiang Li, Cheng Liu, Kelvin CP Wang, Dominique M. Pittenger, and Zaman Musharraf. "Effect of aggregate properties on asphalt pavement friction based on random forest analysis." *Construction and Building Materials* 292 (2021): 123467

Lin, Cong, and Wang Tongjing. "Effect of fine aggregate angularity on skid-resistance of asphalt pavement using accelerated pavement testing." *Construction and Building Materials* 168 (2018): 41-46.

Aldagari, Sand, Mohammad Al-Assi, Emad Kassem, Arif Chowdhury, and Eyad Masad. "Development of predictive models for skid resistance of asphalt pavements and seal coat." *International Journal of Pavement Engineering* (2020): 1-13.

Khasawneh, Mohammad Ali, and Mohammad Ahmad Alsheyab. "Effect of nominal maximum aggregate size and aggregate gradation on the surface frictional properties of hot mix asphalt mixtures." *Construction and Building Materials* 244 (2020): 118355.

Wang, Dawei, Pengfei Liu, Huining Xu, Jonas Kollmann, and Markus Oeser. "Evaluation of the polishing resistance characteristics of fine and coarse aggregate for asphalt

pavement using Wehner/Schulze test." *Construction and Building Materials* 163 (2018): 742-750.

FHWA Evaluation of D-05

Reviewed By:

Amir Gopalipour/HRDI; Tim Aschenbrener/HICP-40

Comments:

Amir Gopalipour - This is an ambitious problem statement. We suggest ... Section 2, Line 6: their "Safety" functional performance characteristics. Section 4, first bullet point: remove "not only". Section 4, third bullet point: Do we need to be more specific in indicating how to validate the methodology? Lab test or field testing or both? Section 4, forth bullet point: Is this the methodology for selecting what level of friction is needed for a particular roadway segment? We may be off base, but it seems this effort requires multiple pieces ... one is to identify the process for determining the level of friction demand needed for a particular roadway. Another piece is to identify the test method(s) to be used during mix design to ensure that the mix will provide the level of friction needed for that roadway. And we agree that it is also important to identify a process for QA during construction. Will the AASHTO spec include all of these, or is this project just focused on the test method(s) during mix design and QA?

Tim Aschenbrener - Not all States have a friction problem due to aggregate availability, so research has some limitations to wide-spread implementation. This was rated in the AASHTO COMP's top 4.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for D-05

Submitted By:

Casey Soneira
AASHTO staff
Committee on Materials & Pavements

Priority #: 3

Comments:

This research will help compliment other recently completed work to make sure that the designs produced do not have poor functional performance and avoid costly failures.

Submitter Response for 2023-D-05

From:
[email: mfelag@hotmail.com]

Comment

(NCHRP) Response 1: We have reviewed the cited references and think they are useful and supplement the references cited in the original proposal. We also believe that they collectively confirm that the knowledge gap addressed by the RNS (the lack of a formal procedure to include functional performance during the mix design) does exist. They do point out the emergence of the DFT and TWPD which will be important for the research team and panel to consider if this idea is chosen for project development. We would recommend including these references with the background and status of the literature section.

Comment 2 (FHWA): Section 2, Line 6: their "Safety" functional performance characteristics.

Response 2: We agree that this change is needed, but suggest changing to 'safety related functional performance characteristics'.

Comment 3 (FHWA): Section 4, first bullet point: remove "not only".

Response 3: We agree that this statement should be removed.

Comment 4 (FHWA): Section 4, third bullet point: Do we need to be more specific in indicating how to validate the methodology? Lab test or field testing or both?

Response 4: We would agree that more specificity is warranted, but the choice on how specific to be should be decided by the project panel (if the project is selected). To make it clearer that the goal of the validation is field performance, we recommend changing the third bullet point to read;

Develop and validate the methodology for performance assessment. This methodology should be capable of evaluating asphalt mixtures macrotexture and microtexture (combinations of specific aggregate, asphalt binder, and proportions of each), but could consist of a combination of component material and composite tests and models. Since the procedure should relate to in-service performance, the validation methodology will likely consist of lab tests coupled with field testing.

Comment 5 (FHWA): Section 4, fourth bullet point: Is this the methodology for selecting what level of friction is needed for a particular roadway segment? We may be off base, but it seems this effort requires multiple pieces ... one is to identify the process for determining the level of friction demand needed for a particular roadway. Another piece is to identify the test method(s) to be used during mix design to ensure that the mix will provide the level of friction needed for that roadway. And we agree that it is also important to identify a process for QA during construction. Will the AASHTO spec include all of these, or is this project just focused on the test method(s) during mix design and QA?

Response 5: This is a very good point. The intention of this research idea is to focus primarily on the test method(s) to be used during mixture design and QA. However, when originally written the belief was that in order to improve implementation it will likely

be important to provide an initial set of thresholds on the basis of data currently available or accessible to the research team selected (with support from members of the project panel). We believe this is something that the panel needs to consider when finalizing the research problem statement (if selected). Friction demand is not a one size fits all issue and despite several attempts in the past to move research projects forward through NCHRP to address this issue, none have been successful. Until that demand is appropriately addressed then the implementation of this research would need to be done with engineering judgment and local experience. The project should articulate the issues at hand (speed, grades, horizontal alignments, traffic volume, potential for vehicle movement conflicts, etc.) and provide some guidance on what needs to be considered in establishing appropriate limits. This articulation could be done in the form of an annex (non-required information) in the standard and the report would describe the studies that have attempted to develop limits so that state highway agencies could follow their own local calibration.

We suggest clarifying this objective thusly;

Develop guidance on how friction demand should be considered to establish threshold values for the developed test method and identify potential ranges in limits based on a review of available data sources for refinement in later research.

Comment 6 (FHWA): Not all States have a friction problem due to aggregate availability, so research has some limitations to wide-spread implementation.

Response 6: We agree that having good quality aggregates available will reduce the potential issues with friction/microtexture. However, research recently conducted by the NCDOT (report pending) suggests that macrotexture and friction reductions immediately after construction (even before potential polishing effects begin) can result in increased wet crash rates. There are other factors at play as well; construction practices/issues that can lead to different surface characteristics for the same mix design or job mix formula, variations during production from the approved mixture design, bleeding/flushing, thermal segregation during construction, and aggregate segregation during construction to name a few. Current solutions are operational (temporary slippery when wet signage) or the use of functionalized overlay (open graded friction course, ultra thin bonded wearing course, grooving/grinding, etc.). Current state efforts to address durability concerns with asphalt concrete materials seem to be resulting in finer aggregate structures with tighter surface texture (lower macrotexture) and/or higher asphalt contents. These decisions may have propagating effects on mixture safety and hence the need to identify ways for mixture design practices beyond selecting good quality, low polishing aggregates.

Contact Info

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and

Shane Underwood, shane.underwood@ncsu.edu, 919-515-8632

Input provided by: Boris Goenaga (NCSU), Jenna Bowers (AKM40 chair), Stacey Diefenderfer (AKM40 past chair), Magdy Mikhail (AKP50 chair), Brian Schleppe (AKP50

research coordinator), and Ilker Boz (VTRC)

Review Date:
1/22/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-D-06

Problem Title

GFRP Barrier Testing Evaluation and Repair Strategies

Background Information And Need For Research

Deterioration of bridge decks and safety barriers in salt exposure conditions using traditional steel reinforced concrete, or even using epoxy coated steel, has demonstrated the inability of steel reinforcement to satisfy today's desired 100-year service life due to the susceptibility of traditional steel reinforcement to galvanic corrosion. While the AASHTO LFRD Specifications do not specify a specific service life for bridges more recent guides provide a path for selecting a target service life including life cycle cost analysis approaches. Other international standards such as the British Standards set a specific required 120-year service design life.

One solution to address the long-term service life target of 100 years that many DOT's desire in their bridge deck systems is to use noncorrosive reinforcing materials such as glass fiber reinforced polymer (GFRP) in lieu of traditional steel or steel coated systems. Since the late 1990's and early 2000's, GFRP materials have been demonstrated in bridge elements including bridge decks in both hybrid reinforced deck applications or more recently fully steel free GFRP reinforced decks. However, a few challenges in the 2000's and 2010's have slowed the widespread implementation of steel free GFRP usage into bridge deck systems. These are generally perceived as 1.) AASHTO design standards developed for using these materials, 2.) remaining concerns on the materials long-term durability, and 3.) development of barrier systems along with physical crash testing and repair strategies for damaged barrier systems. Fortunately, in recent years, efforts have been made to address challenges one and two. Late in 2018, AASHTO produced the second edition of the GFRP Design Guide Specification (AASHTO, 2018). In addition, several states including Florida, Ohio, and Missouri have initiated efforts to develop and standardize GFRP reinforced barriers. The first major effort to thoroughly investigate a significant number of GFRP RC bridge decks after 15-20 years of service exposure has been completed showing no signs of degradation in the reinforcing materials. In this investigation, eleven bridges situated mostly in aggressive northern climates were inspected, sampled, and studied in depth including microstructure analysis.

It appears that the remaining issue to have a fully validated steel free deck system including the bridge barrier is to 1) develop repair strategies on the barrier configurations developed/under development by the aforementioned DOT's, 2) conduct full scale crash testing on both undamaged GFRP RC barriers as well as repaired GFRP impact damaged barriers, and 3) benchmark the test results in objective 2 to

currently available crash test data for traditional reinforced barriers. This NCHRP project statement aligns well with AASHTO strategic efforts to extend the service life of the transportation infrastructure, reduce bridge maintenance costs, and extend efforts to be more sustainable and environmentally sensitive.

Literature Search Summary

GFRP reinforcement has recently drawn tremendous amount of interest in engineering practice. Years of research together with successful pilot implementation projects have provided confidence to engineers for field implementation of GFRP in bridge structures. GFRP is a composite that combines the high strength and stiffness of the glass fiber and the ductility of the soft resin. This combination has given GFRP superior mechanical performance and durability in comparison with steel reinforcement. The GFRP rebars have been extensively investigated and validated as sound alternative reinforcing materials.

There have been both field implementations of GFRP bars and design code (AASHTO, 2009; CSA, 2000) in terms of development length and bar strength limit. Field implementation of GFRP bars in reinforced concrete superstructures are still in the early stage. In North America, there are several examples of field implementation that have demonstrated the validity of using GFRP reinforcement in a traffic barrier. Current efforts to develop standardized GFRP barriers in Florida, Ohio, and Missouri (see Fig. 1) have undergone design development with some laboratory testing such as pendulum testing. However, a gap exists in terms of full-scale crash testing that this effort proposes to investigate and validate the full crash testing validation of the barriers. Secondly, questions have arisen by barrier designers and experts, what approaches would be taken to repair impact damaged GFRP RC barriers and if proposed repair designs would be resilient to a secondary crash testing. This project statement proposes to address both of these issues.

Research Objective

The objective of this project will be to build on existing research on GFRP RC barriers in terms of both crash testing and tested design repair strategies for impact damaged GFRP RC barriers to restore full crash test capacity to damaged GFRP RC barriers. The desire in terms of the repair strategies is to examine anchorage and internal continuity detailing such as innovative couplers and splicing details.

Major tasks will include:

- A State DOT survey and literature review to collect all information on current DOT GFRP RC Barrier systems such as Florida, Missouri, Ohio, etc. along with any laboratory and field-testing undertaken to date.
- A literature review to identify promising coupler and continuity devices that have demonstrated experimental results to develop full tensile capacity in discontinuous GFRP bars. These are to be considered in the repair strategies.

- To design and evaluate GFRP RC barriers developed with repair strategies under finite element method (FEM) modelling and laboratory static and cyclic evaluation.
- To compare existing data on baseline RC control barriers (w/steel and GFRP) to the same barriers that have been incorporated the repair strategy in the prior task.
- Undertake full scale crash testing and FEM modelling on undamaged GFRP RC barriers as well as damaged GFRP RC barriers that have undergone the repair strategy. MASH TL-4 impact conditions for initial testing and repair, which will consider static/dynamic component testing for investigations/verifications as required. Results from these field tests are to be benchmarked to existing crash tested steel RC barriers of the same size and cross section.

Deliverables will include:

- Interim report on the first three major tasks to the project panel prior to proceeding to the laboratory and field-based crash testing.
- A final publication synthesizing the findings of the project for practitioners – including DOT survey results, literature review, repair strategies, design approach, FEM modeling, experimental findings and crash testing results.

Urgency and Potential Benefits

Addressing the research gap in crash testing and repair strategies for GFRP RC barriers is required to move GFRP technology to full implementation of steel free deck systems. Transitioning away from bridge decks and barriers that use reinforcing steel will address concerns with reinforcing corrosion and greatly extend the service design life of bridge deck systems. The benefits to DOT's that move to the implementation of GFRP RC barrier systems include cost savings due to longer service design life and reduced maintenance costs over the life of the bridge deck and barrier system.

Implementation Considerations

This research builds on GFRP barrier systems that State DOT's have very recently designed and developed, but not demonstrated full-scale crash testing worthiness. This effort will allow bridge designers and their DOT's to directly implement GFRP RC barrier systems with known impact resistance. Furthermore, it will provide a path forward to address GFRP RC barrier systems that are exposed to vehicular impact damage. AASHTO Committees T-6, T-7, T-10 and T-1 will be able to directly communicate the results broadly to State DOT's in the US. Furthermore, it is anticipated that TRB Committees AKB10 and AKB30 can develop co-sponsored Webinars and Workshops at future TRB events to communicate the findings and results to the broader bridge design community and technical societies including ACI, PCI and ASCE.

Recommended Research Funding and Research Period

Research Funding:
 \$850,000 (achieving full research objectives)
 \$95,000 (initial 2 tasks of survey & review)

Research Period:
 36 Months
 12 Months

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

John Myers, Ph.D., P.E. , Missouri Univ. of Science & Technology, jmyers@mst.edu (573) 341-6618

Tim Bradberry, P.E., Texas DOT, (512) 416-2179, Tim.Bradberry@txdot.gov

Chenglin (Bob) Wu, Ph.D., Missouri Univ. of Science & Technology, (573) 341-4465, wuch@mst.edu

Ron Faller, Ph.D., P.E., University of Nebraska-Lincoln, (402) 472-6864, rfaller1@unl.edu

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Florida DOT, William Potter, AASHTO T-6 and T-10, William.potter@dot.state.fl.us;

Iowa DOT, Michael Nop, AASHTO T-7, Michael.Nop@iowadot.us; Missouri DOT, Bryan A. Hartnagel, bryan.hartnagel@modot.mo.gov

Michigan DOT, Matthew Chynoweth, AASHTO T-6 Chair, chynowethM@michigan.gov;

Nebraska DOT, Fouad Jaber, AASHTO T-10, fouad.jaber@nebraska.gov; Ohio DOT, Tim Keller, AASHTO T-7 Chair, tim.keller@dot.ohio.gov; Texas DOT, Bernie Carrasco, AASHTO T-1 Chair, Bernie.carrasco@txdot.gov; Virginia DOT, Andrew Zickler, AASHTO T-6, T-7

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Bryan A. Hartnagel, (573) 751-0267, bryan.hartnagel@modot.mo.gov, Missouri DOT
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NCHRP Review of D-06

Reviewed By:

Ahmad Abu-Hawash
aabu-hawash@nas.edu

Comments:

This research is suitable for NCHRP. Validating the crashworthiness of steel-free rail/deck system is of interest to many states. Product of this research is implementable through collaboration with AASHTO in the form of bridge design and construction specifications update.

Proposed budget of \$850,000 is reasonable for this type of work which includes analytical modeling and crash testing.

Review Date:

12/7/2021

AASHTO Committee Evaluation for D-06Submitted By:

Patricia Bush
AASHTO staff
Committee on Bridges & Structures

Priority #: 3

Comments:

Committee on Bridges & Structures #3 of 8.

Submitted By:

Kelly Hardy
AASHTO staff
Design-Technical Committee on Roadside Safety

Priority #: N/A

Comments:

This research would have medium priority.

Submitter Response for 2023-D-06From:

[email: bryan.hartnagel@modot.mo.gov]

Comments:

I was only able to view one review from Ahmad Abu-Hawash and I concur with that review.

Contact Info:

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**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-D-07

Problem Title

Guidance for Efficient Timelines and Incentives/Disincentives for Accelerated Bridge Construction Projects

Background Information and Need For Research

- What is the problem, and whom does it affect?

State DOTs operate to minimize the impact of construction activities on the traveling public and commerce. Given the operational needs of DOTs, project timelines have become more compressed and prescriptive. Contractual provisions and methods such as incentives/disincentives (I/D), payment for acceleration, liquidated damages (LQD), and cost-plus time (A+B) procurement have been used for conventional construction projects to promote meeting project schedule targets. In addition, accelerated bridge construction (ABC) methods can greatly compress the closure time required during bridge construction. Generally, ABC minimizes the overall construction window (from months to weeks), or minimizes the out-of-service time of the facility (from weeks to hours). Compressed project schedules may reduce impacts and improve safety for the traveling public; however, the project staff and contractor may be subject to safety risks because of the accelerated work schedule and nature of ABC technology. Generally, ABC techniques alleviate significant user costs; however, these technologies may have significant project costs that are difficult to accommodate within limited owner construction budgets. For example, the use of self-propelled modular transports (SPMT) could significantly increase the construction cost of a project.

- How will the research solve the problem?

This research will answer the following underlying questions that owners must address when using both ABC techniques and contractual provisions to achieve project goals:

- 1) What type of contractual timeframes are appropriate when using ABC?
- 2) What are the risks that contractors face in implementing specific ABC approaches?
- 3) What are appropriate ranges of incentives and disincentives?
- 4) What types of risks are introduced to project staff, contractors, and the public as a result of accelerated timelines, and how are those risks addressed?

- How is this problem statement related to the strategic plan or research agenda of an AASHTO Committee(s) and/or Council(s)?

This statement addresses research needs related to Goal 5, “Accelerated Bridge Delivery and Construction,” of the Strategic Plan for the Committee on Bridges and Structures, September 2018.

Literature Search Summary

This research will compile, analyze, and build upon the synthesis research project on this topic conducted by the ABC-UTC in 2018 and also the various other research projects that focused on specific aspects of construction contract time and risk.

Research Objective

The objective of this study is to develop guidelines that DOTs and other bridge owners may use in making project-specific ABC implementation decisions related to contract provisions.

This will be done by accomplishing the following tasks:

Task 1. Review and summarize contemporary literature and guidance documents related to construction scheduling, schedule risks, and I/D contract clauses.

Task 2. Study the existing inventory of State DOT ABC projects that utilize Geosynthetic Reinforced Soil (GRS) abutments, precast bridge elements, SPMTs, bridge slides, etc., to document the project time goals and actual construction times. In addition, document which projects met the goals, by how much, and the amount of incentive paid to the contractor, if any. The ABC-UTC ABC Project Database and other available sources should be utilized in developing and assessing the current inventory of ABC projects.

Task 3. Interview project staff and contractors related to specific ABC projects to collect information.

Task 4. Develop methods to estimate specific time savings related to implementation of various ABC methods over conventional construction details, addressing site-specific constraints.

Task 5. Develop a guide document that will help DOTs better understand ABC project implementation risks, better estimate practical goals for project schedules using ABC methods, and what associated contractual incentives should be coupled with the ABC technologies.

Task 6. Provide insightful commentary on implications of tight project timeframes and risks that may be introduced to contractors, project staff, traveling public, and DOT project owners.

Task 7. Provide guidance on construction oversight staffing needs as well as recommendations related to safe contractor staffing levels.

Task 8. Provide guidance to project staff that will help identify and mitigate project implementation risks related to ABC technologies.

Task 9. Provide recommendations on which combinations of strategies and contract incentives are most effective.

Task 10. Produce tools that project staff can use to estimate appropriate levels of incentives/ disincentives (I/D), payment for acceleration, and liquidated damages (LQD) for projects that employ ABC techniques.

Urgency and Potential Benefits

This work will help DOTs and owners manage project schedules and set appropriate contractual provisions related to time and incentives for projects utilizing ABC techniques. Significant costs can be saved upon implementation, e.g., reduced cost as measured by comparison of actual incentives paid. These results will also incentivize the construction industry to introduce ABC details into projects to mitigate schedule requirements and maximize competitiveness.

Implementation Considerations

DOTs, local public agencies (LPAs), FHWA, AASHTO CBS T-4, and private design consultants would use these guidelines in the development and implementation of projects. This research will give bridge designers, project staff, and owners tools to assure that construction projects have realistic and practical project goals for timelines and contractual costs. This will also help identify implementation risks and methods to mitigate them.

Recommended Research Funding and Research Period

Research Funding: The estimated funding for this project is \$275,000.

Research Period: The research will take approximately 18 months to complete.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

William L. Oliva, P.E.

Chief of Structures Development Section

Wisconsin Department of Transportation

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Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

William L. Oliva, P.E., Wisconsin DOT (Problem Statement Author)

Members of AASHTO COBS T-4

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

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Vice-Chair, AASHTO Technical Committee for Construction, T-4

Chair, TRB ABC Joint Subcommittee

Reviewed By:

Ahmad Abu-Hawash
aabu-hawash@nas.edu

Comments:

Many state DOTs are still looking for guidance regarding the appropriate timelines and the use of incentives/disincentives for accelerated bridge construction projects. This research is suitable for NCHRP. Product of this research is implementable through collaboration with AASHTO in the form of bridge design and construction specifications update.

Proposed budget of \$275,000 is appropriate for this type of work.

Review Date:

12/7/2021

AASHTO Committee Evaluation for D-07Submitted By:

Patricia Bush
AASHTO staff
Committee on Bridges & Structures

Priority #: 2

Comments:

Committee on Bridges & Structures #2 of 8.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation****FY2023 NCHRP – IMPLEMENTING UTILITY INVESTIGATIONS****Problem Number: 2023-D-08****Problem Title**

Guidance for Implementing Utility Investigations in Alignment with Project Delivery

Background Information and Need For Research

While it is recognized to be in the public interest to permit the installation of utility infrastructure in roadway right-of-way (ROW), the practice has contributed to utility-related issues being one of the leading causes of delays for transportation projects (FHWA, 2018). These delays are often attributed to unknown or inaccurate utility locations. Utility investigations, inclusive of subsurface utility engineering (SUE), are procedures state departments of transportation (DOTs) can implement to locate utilities and assist their project development teams with avoiding these issues. However, there is little guidance specific to an alignment of the timelines for implementing utility investigation procedures with those of the project delivery process. Further, there are many factors that influence the optimal approach of utility investigations for a specific project, such as project type, project environment, utility types, etc. Further, there are variations in utility investigation needs based on the timing of design elements within the project delivery process, e.g. what utilities investigations are needed for alignment and grade design, and when will that design occur.

SUE is a standardized process defined by the American Society of Civil Engineers (ASCE) 38-02 “Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data.” SUE has been presented as a useful tool for utility investigations but varies in application and understanding. Some state DOTs have been successful in SUE practices while others are still in the development of their program. Improved understanding could lead to more widespread utilization or a change in protocol for many state DOTs. There is a gap in guidance for the implementation of SUE, quality assurance for SUE deliverables, and depiction guidelines at state DOTs. While the American Society of Civil Engineering (ASCE) 38-02 standard is effective in defining the process, there is still a need for a guide for SUE implementation to help state DOTs in development of a SUE program. Recent updates to ASCE 38-02 will include guidance for depiction and present that standard as a more holistic utility investigation approach.

It should be clearly noted that best practice does not necessarily involve a linear application of SUE quality levels to the phases of project development. That is, it is not necessary to perform SUE quality level D, followed by C, and so on. A more appropriate practice would be the identification of quality level needs according to project characteristics, where multiple SUE quality levels would be collected concurrently but may vary by location and project need.

The needed guidance for implementing utility investigation approaches therefore includes:

- Application criteria;
- Depiction approaches;
- Prequalification of service providers;
- Deliverable expectations;
- Quality assurance practices;
- Alignment of utility investigation to design phases;
- Alignment of design element timelines to utility investigation; and
- Approaches to staffing and roles, and other programmatic decisions.

Literature Search Summary

ASCE 38-02

23 CFR 645 Subpart A and B

Research Objective

The primary objective of this research is to develop guidance for DOTs to strategically align utility investigations to project development phases. The guidance to be developed will address:

The strategic implementation of SUE/ utility investigations by

- Project Type
- Project phase and delivery step/scope and need
- Design element timelines and needs
- Project environment (rural/urban)
- Documented geophysical site conditions and equipment selection, including the use of advanced equipment, such as multichannel ground penetrating radar
- Facility Types and densities
- Public interest and project risk
- Project delays

Communicating and modeling the utility investigation information should also be addressed in this guidance for:

- Depiction approaches, showing quality levels on plans
- 3D modeling and clash detection, to include buffers and all ranges of conflicts (direct, indirect, etc.)
- Risk assessment of 3D subsurface utility models
- Use of information for design/project development (e.g. schedule changes) decision making
- Maintenance of utility investigation data through the design process
- Communicating as-built/relocated utility information
- Quality assurance of information collected.

The research objective will be achieved through the completion of research tasks to be described by the research team that best addresses the research questions and goals. Possible tasks include:

- State department of transportation surveys
- Survey of consultant design firms
- Examination of case studies and best practices, e.g. SHRP2 products R01A, R15B and ASCE 38 Guidelines
- Development of guidance documents
- Conduct an exploratory workshop for refinement
- Implement a proof-of-concept trial on a state DOT project
- Production of final guidance.

Urgency and Potential Benefits

Inappropriate utility investigations contribute to the \$50 billion drain on the United States economy caused by utility and highway coordination. This is also a major factor in utility impacts being one of the top three causes of delays for projects. The proper investigation of utility locations will help project teams eliminate substantial risk from DOT projects. DOTs are highlighting the importance of utility investigation and coordination just as more utilities are being installed within ROW.

Implementation Considerations

Standards are needed before these trends exacerbate the previous defined problems.

Recommended Research Funding and Research Period

The estimated cost is \$400,000 and duration is 36 months.

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Written – 09/2021–Roy Sturgill, Gary Young, Deanne Popp, Corey Biddle, Lance Parve

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

AASHTO Utility Project Scoping & Coordination Technical Council Chair

AASHTO Committee of Right of Way, Utilities and Outdoor Advertising

Utilities Subcommittee

Patrick Overton

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NCHRP Review of D-08

Reviewed By:
David M. Jared
djared@nas.edu

Comments:

Although both this research and that proposed in D-10, "Risk-Based Subsurface Utility Engineering Needs Assessment" focus on Subsurface Utility Engineering (SUE), the proposed investigations complement rather than duplicate one another. The goal of D-08 is to better align utility investigations (leveraging SUE) with project delivery, while D-10 aims to generate statistics for designers and project managers to make risk-based decisions re: the need for SUE on state DOT projects. Besides mutual emphasis on SUE, the projects complement each other in their consideration of utility-related risks on construction projects.

Review Date:
12/9/2021

FHWA Evaluation of D-08

Reviewed By:
Morgan Kessler/HRDI

Comments:

This seems like a good, well-founded RNS. The topic has direct nexus with FHWA's RUMI effort.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for D-08

Submitted By:
Casey Soneira

AASHTO staff
Right of Way, Utilities, Outdoor Advertising

Priority #: 3

Comments:

Inappropriate utility investigations contribute to the \$50 billion drain on the United States economy caused by utility and highway coordination. This is also a major factor in utility impacts being one of the top three causes of delays for projects. The proper investigation of utility locations will help project teams eliminate substantial risk from DOT projects. DOTs are highlighting the importance of utility investigation and coordination just as more utilities are being installed within ROW.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-D-09

Problem Title

Guidance for Including Right-Of-Way and Utilities in Value Engineering Studies
AASHTO Committee on Right-of-Way, Utilities & Outdoor Advertising Control:
Subcommittee on Utilities

AKD60, TRB Standing Committee on Utilities

Background Information And Need For Research

According to 23 CFR 627, a Value Engineering (VE) analysis is the systematic process of reviewing and assessing a project to identify the needed project functions, optimize the value and quality of the project; and reduce the time to develop and deliver the project. It also indicates that state transportation agencies (STAs) must conduct VE studies for projects on the National Highway System (NHS) receiving Federal assistance with an estimated total cost of \$50 million or more; and bridge projects on the NHS receiving Federal assistance with an estimated total cost of \$40 million or more. It is not necessary to conduct VE studies for design/build projects, but the federal regulations provide guidance for construction manager/general contractor (CM/GC) projects. STA policies and requirements typically mirror those at the federal level. VE studies have been effectively incorporated into the STA project development process. A valuable consideration would be to enhance the VE concept by providing focused guidance for the specialties of right of way and utilities will be valuable.

The VE studies body of knowledge is largely silent on the topic of right-of-way and utilities. At the national level (both federal regulations and FHWA guidance documents), there are only casual references to right-of-way or utilities in VE studies. Something similar happens at the state level. STA manuals typically include guidance on how to conduct VE studies, but any reference to right-of-way or utilities is brief and without any practical guidance. This lack of documented knowledge increases the risk that VE study teams will lack the kind or level of right-of-way and utility information they need to do their job properly. It also means that VE studies might be missing unique opportunities to add value to a project.

Considering that right-of-way and utilities are frequently considered two of the top three reasons that projects experience delays (the third reason is the environmental process), it is important to identify and implement ways to include right-of-way and utility topics more effectively in the scope of and procedures for conducting VE studies.

Literature Search Summary

The body of knowledge is silent on the topic of right-of-way and utilities in VE studies. At the national level (both federal regulations and FHWA guidance documents), there are only casual references to right-of-way or utilities in VE studies. Something similar happens at the state level. STA manuals typically include guidance on how to conduct VE studies, but any reference to right-of-way or utilities is brief and without any practical guidance.

Research Objective

The proposed research objective is to complete the following tasks:

- Conduct online survey of STAs to examine practices to conduct VE studies, with a specific focus on right-of-way and utilities.
- Conduct follow-up interviews with select STAs.
- Review sample VE study reports and conduct interviews with the corresponding STA officials and VE study teams that.
- Develop guidelines for the inclusion of right-of-way and utilities in VE studies.
- Test the guidelines on pilot VE studies.

Urgency and Potential Benefits

Utility and right of way issues are repeatedly documented as causes for project delay and increased costs. It is imperative to the tenants defined in value engineering to consider these aspects of project development and delivery. They are critical factors in project costs, potentially offsetting the VE benefits garnered through the VE process. The research would have a number of benefits including, but not limited to, the following:

- Earlier and more effective identification of right-of-way issues that might have been overlooked by a project team reduces project risk in terms of cost and schedule.
- Earlier and more effective identification of utility issues that might have been overlooked by a project team reduces project risk in terms of cost and schedule.
- Construction delay claims will be reduced with fewer right-of-way and utility issues
- Lower right-of-way acquisition and utility relocation costs are expected.

Implementation Considerations

The use of inaccurate utility data contributes to billions of wasteful spending in the U. S. caused by utility and highway coordination. With few exceptions, the public bears the cost of utility delays in form of traveler costs, added transportation costs in retail products, loss of business efficiency (resulting in higher costs and lower profits), and fewer public dollars available to spend on a variety of project needs. With the advantages of 3D design and BIM being explored at STAs, this research is imperative to analyzing conflicts with improved confidence in the associated risks.

Recommended Research Funding And Research Period

It is estimated that this research will take 24 months to complete and will require \$400,000.

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

The AASHTO Committee on Right of Way, Utilities, and Outdoor Advertising Controls Utility Project Scoping & Coordination Technical Council drafted, edited and supports this Research Needs Statement.

Contact: Casey Soneira, csoneira@ashto.org, 202-624-5824

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

AASHTO Utility Project Scoping & Coordination Technical Council Chair

AASHTO Committee of Right of Way, Utilities and Outdoor Advertising

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AASHTO Committee on Right of Way, Utilities, and Outdoor Advertising Control

Utilities Subcommittee

Utility Project Scoping & Coordination Technical Council

Contact: Casey Soneira, csoneira@ashto.org, 202-624-5824

NCHRP Review of D-09

Reviewed By:

David M. Jared

djared@nas.edu

Comments:

This research could help strengthen VE studies conducted by transportation agencies by emphasizing an aspect that has not been emphasized in VE guidelines to-date.

Review Date:

12/9/2021

FHWA Evaluation of D-09

Reviewed By:

Maggie Duncan-Augustt/HEPR

Comments:

This research effort may prove to benefit highlighting ROW efforts in VE, especially on those projects required by law and regulation to receive VE analyses. Although the problem statement in general seems viable, more specific information should be detailed in the problem statement to address how the research objectives will be met. For example, the third bulleted item under #4, RESEARCH OBJECTIVE, is not very clear, and should provide additional information. Also, the proposed cost of the project seems high (\$400,000) given that only surveys will be done online (there is a reference to follow-up interviews, but there is no explanation of how the follow-ups will be conducted) and only guidelines are planned to be developed (no discussion of implementation).

Review Date:

December 17, 2021

AASHTO Committee Evaluation for D-09
Submitted By:

Casey Soneira

AASHTO staff

Right of Way, Utilities, Outdoor Advertising

Priority #: 2Comments:

Utility and right of way issues are repeatedly documented as causes for project delay and increased costs. It is imperative to the tenants defined in value engineering to consider these aspects of project development and delivery. They are critical factors in project costs, potentially offsetting the VE benefits garnered through the VE process. We expect this research will help in many ways; including improved identification of right-of-way and utility issues which may lead to reduced project costs due to construction claims, right-of-way acquisition and utility relocation costs.

Submitter Response for 2023-D-09
From:

[email: csoneira@ashto.org;]

Comments:

FHWA COMMENT: This research effort may prove to benefit highlighting ROW efforts in VE, especially on those projects required by law and regulation to receive VE analyses. Although the problem statement in general seems viable, more specific information should be detailed in the problem statement to address how the research objectives will be met. For example, the third bulleted item under #4, RESEARCH OBJECTIVE, is not very clear, and should provide additional information. Also, the proposed cost of the project seems high (\$400,000) given that only surveys will be done online (there is a reference to follow-up interviews, but there is no explanation of how the follow-ups will be conducted) and only guidelines are planned to be developed (no discussion of implementation).

Response: The research objectives have been amended (see attached) to clarify expectations and how the objectives will be met. We have reviewed the cost proposed and believe it is a valid figure. There are substantial and long lived activities involved in this proposal including in person interviews, case studies, two pilot studies and implementation webinars. We expect that the cost for these items will warrant the proposed budget.

NCHRP COMMENT: This research could help strengthen VE studies conducted by transportation agencies by emphasizing an aspect that has not been emphasized in VE guidelines to-date.

Response: The drafters agree that this research will strengthen VE studies.

Contact Info:

Casey Soneira, csoneira@ashto.org, 202-624-5824

Review Date:

1/12/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-D-10

Problem Title

Risk-Based Subsurface Utility Engineering Needs Assessment
AASHTO Committee on Right-of-Way, Utilities & Outdoor Advertising Control:
Subcommittee on Utilities

AKD60, TRB Standing Committee on Utilities

Background Information and Need For Research

Subsurface utility engineering is the convergence of new site characterization and data processing technologies that allows for the cost-effective collection, depiction, and management of existing utility information. These technologies encompass surface geophysics, surveying techniques, mapping techniques, CADD/GIS systems, etc. Rather than disclaiming responsibility for existing utility information, subsurface utility engineers certify utility information in accordance with a standard classification scheme (utility quality levels) that allows for a clearer allocation of risk between the project owner, project engineer, utility owner, and constructor. State Transportation Agencies (STA) often must design in proximity of existing underground utility facilities that are not a party to the design contract. Designers may receive utility data of various sources and unknown accuracy to make decisions about utility conflicts. Due to the variability, the data may be highly accurate or less accurate and missing the actual utility location by inches, feet, or tens of feet. As a result, project success requires a sound understanding of the risk introduced by the locational accuracy and confidence of the existing utility data. The risk lies with designers use of utility information of varying degrees and quality to make critical design decisions. This effort involves assumptions regarding the location, quality of the record-based plans and unknown or estimated distances between existing and proposed facilities. The high risk nature of using inaccurate utility data or inaccurate assumptions about the data has resulted in unnecessary design work, unnecessary requests for Subsurface Utility Engineering (SUE) data, unnecessary relocation of third-party facilities, and re-design or safety risks during construction.

ASCE standard 38/02 describes quality levels (QLs) of SUE data that are a value judgement as to the locational uncertainty of existing facilities. In general, QL D is more uncertain than QL C, which is more uncertain than QL B and finally QL A. Utility quality level D (QLD) information is determined primarily from existing records. Although each level provides increasingly better certainty about the location of a utility facility, only QL A provides location information in x, y, and z direction with typical surveying accuracy. However, this information is only available at certain points within a project, which are called test holes.

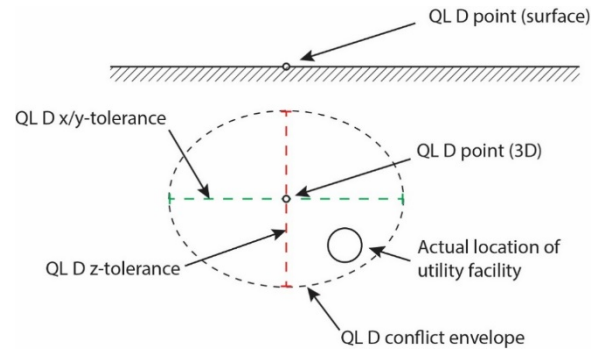


Figure 1. Cross Section of Utility Facility Within Conflict Envelope

Literature Search Summary

STAs are increasingly using 3D project design and modeling techniques during highway design, for example Building Information Modeling (BIM) tools or 3D CAD tools. Designing in three dimensions allows automated clash detection using a conflict envelope around existing and planned facilities. This conflict envelope (or “zone of influence”) is defined by the expected variability of the depicted underground facility, which is information that is not readily available to designers (Figure 1). This research is intended to help define the conflict envelope for a variety of utility facility types.

- ASCE 38/02
- Kevin Vine. Subsurface Utility Engineering (SUE): Avoiding 4 Potential Pitfalls to Ensure a Successful Program. Paper Prepared for the Presentation at the Utilities Management - Past Present Future Session Of the 2014 Conference Transportation Association of Canada (TAC) Montréal, Québec.
- Michigan Utility Coordination Committee’s Geospatial Utility Infrastructure Data Exchange 2014 Pilot.
- Michigan Department of Transportation Road Design Manual.

Research Objective

This research will aid designers in answering the question “How close can I design to an existing facility?” As such, the research will assess utility records versus test hole data or SUE QLA data to determine statistical accuracy for risk-based SUE need determination, which will greatly aid project practitioners. The research will generate statistics for use by designers and project managers to make risk-based decisions regarding the need for SUE on STA projects, and to be input into a BIM model for use in clash detection.

This research will also identify and prioritize other risk factors to be used to automate risk-levels. Some of these key attributes may include items such as facility-owner, facility-type, age, facility dimensions, facility material, installation method, existing record quality, etc. The research will also develop a SUE risk matrix guidance document to recommend when and how to implement SUE on a project. The research will address the following objectives:

- Develop guidance for STAs to determine when to involve a SUE consultant after the STA has collected utility information originating from various sources.
- Perform a statistical analysis of record project utility location data versus actual locations to define conditional risk-based envelope matrices that are dependent upon known project conditions (to be identified during the research.)
- Determine whether it is feasible to develop an algorithm that can predict the need for SUE that varies as a function of the deviation from the “3D Point (QLD)” based on results of the statistical analysis of actual location (QLA) vs records (QLD).
- Develop a risk matrix for obtaining the proper SUE Quality Levels within areas of a project.
- Develop a Scope of Work SUE checklist.

Urgency and Potential Benefits

Contractors working on STA project around the country employ multiple mechanisms to protect themselves from poor utility data provided within construction plans. All states now have a one-call statute in place whereby the contractor must call all known utility owners before construction begins. Utility owners then have the burden of marking their utilities on the ground surface for damage prevention purposes. Many times, the paint marks indicating the location of the utilities do not agree with the utilities depicted on the design plans. Contractors know this will happen and typically increase their bid price to account for this contingency. They will also ask for change orders and claims when necessary. Usually the project owner is obligated to pay these change orders and claims due to utilities being treated as a differing or unknown site condition in the standard contract documents. STA implementing a process of determining if SUE is required earlier in a project will only reduce contractor risk.

There are numerous benefits for a risk based SUE guidance process on highway projects. By using SUE, significant benefits are derived for the DOT, utility companies, SUE consultants, contractors, and the general public. Some of the benefits that have been obtained are as follows:

- DOT Quality: electronic mapping accuracy, concept of a comprehensive SUE process, improved risk management, improved project productivity and quality, minimize environmental damage;
- DOT time savings: less unforeseen utility conflicts, relocations, delays due to utility cuts, elimination of duplicate surveys;
- DOT Cost savings: lower project bids, lower project contingency fees, project design less conflict redesign, claims, change orders, Right-of-Way acquisition costs, and lowered insurance;
- Public Benefits: reduced motoring public travel delays during construction, less damage to existing pavements, less utility customers' loss of service, less traffic disruption, increasing DOT confidence;
- Stakeholder benefits: reduced utility companies' cost to repair damages, improved working relationships with utilities;

Implementation Considerations

The use of inaccurate utility data contributes to billions of wasteful spending in the U. S. caused by utility and highway coordination. With few exceptions, the public bears the cost of utility delays in form of traveler costs, added transportation costs in retail products, loss of business efficiency (resulting in higher costs and lower profits), and fewer public dollars available to spend on a variety of project needs. With the advantages of 3D design and BIM being explored at STAs, this research is imperative to analyzing conflicts with improved confidence in the associated risks.

Recommended Research Funding and Research Period

The estimated cost is \$350,000 and duration is 18 months. The research will complete the following tasks:

1. Review related literature, including best practices in SHRP2 products RO1A, R15B & ASCE 38.
2. Survey stakeholders, including STAs and consultant design firms.
3. Identify STAs with utility record data and or SUE QLA data available for analysis and request data.
4. Examine STA data and develop appropriate statistical models.
 - a. 100 data points per facility type sourced from case studies, for gas lines, water lines, underground electric lines, and communication lines.
5. Analyze STA data using statistical models.
6. Develop draft guidance documents.
7. Conduct an exploratory workshop to collect feedback on draft guidance documents.
8. Refine and finalize guidance documents.

Note: The research should have a focus on sharing information with potential bidders with the goal that utility risks during construction are better understood, potentially lowering construction bids.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Alexis Kinter, PE, PMP, Michigan DOT Metro Quality/Contracts , KinterA@michigan.gov

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Bill Jackson, Maryland DOT Assistant Statewide Utility Engineer, Office of Construction
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Person Submitting The Problem Statement: Name, affiliation, email address and phone.

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NCHRP Review of D-10

Reviewed By:

David M. Jared
djared@nas.edu

Comments:

Although both this research and that proposed in D-08, "Guidance for Implementing Utility Investigations in Alignment with Project Delivery" focus on Subsurface Utility Engineering (SUE), the proposed investigations complement rather than duplicate one another. The goal of D-08 is to better align utility investigations (leveraging SUE) with project delivery, while D-10 aims to generate statistics for designers and project managers to make risk-based decisions re: the need for SUE on state DOT projects. Besides mutual emphasis on SUE, the projects complement each other in their consideration of utility-related risks on construction projects.

Review Date:

12/9/2021

FHWA Evaluation of D-10

Reviewed By:

Morgan Kessler/HRDI

Comments:

We believe this research is needed. From the RNS, our assessment is that this project would feed into the larger discussion of digital asset management.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for D-10

Submitted By:

Casey Soneira
AASHTO staff
Right of Way, Utilities, Outdoor Advertising

Priority #: 1

Comments:

Contractors working on STA projects employ multiple mechanisms to protect themselves from poor utility data provided within construction plans. Contractors

typically increase their bid price to account for poor utility data in addition to requesting change orders and claims when necessary. STA implementations to clarify SUE needs will reduce project risk. We expect to find many time and cost savings on STA projects if fully implemented.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation****FY2023 NCHRP PROBLEM STATEMENT TEMPLATE****PROBLEM NUMBER: 2023-D-11****Problem Title**

To develop best practices to leverage digital technologies to improve the Project Development and Delivery Processes for Transportation Projects.

Background Information and Need For Research

Overnight, the Covid-19 pandemic thrust the workforce to utilize digital technologies to support transportation project development and delivery. Standard project development and delivery processes and procedures are now substantially different. In particular, these differences span both internal and external agency communications. Examples of these communications include project correspondence, plans development coordination, plan reviews, electronic access to files, project team interfaces, plans routing, development approvals, stakeholder coordination, public involvement, project advertising, and project award. Fundamentally, most agencies and industry partners have pivoted from in person to remote operations to support project development and delivery to achieve organizational goals. Many of these differences resulted in procedural shifts that benefit the project management process by reducing project development timelines and project costs. The intent of this research is to document how agencies introduced new technologies to produce efficiencies into their project development and delivery processes, quantify the resulting efficiency benefits, and summarize the results into a best practices guidance document to allow transportation project management professionals to benefit from these recent innovations.

The intent of this research is to prepare a best practice guidance document on how agencies may utilize digital technologies to improve the efficiency of the project development and delivery process.

The Technical Committee on Project Management and Committee on Design's goals include providing guidance, technical expertise, tools, research, knowledge, and a basis for training in all areas of transportation project management. By consolidating recent agency innovations into a best practices guidance document, agencies and industry partners throughout the country will be better positioned to capitalize on proven innovations.

Literature Search Summary

A thorough literature review was completed and there was no recent research found on this topic. The attached document shows the depth and breadth of the literature review. Entities researched include: Transportation Research Board (TRB), Transport Research International Documentation (TRID), Google Scholar, National Cooperative Highway Research Program (NCHRP), and

GDOT.

Research Objective

Prepare a best practices guidance document for project managers and project teams that will help them take advantage of agency and industry innovations that were implemented during the pandemic. These innovations are expected to generally revolve around procedural changes that resulted from the implementation of digital technologies. Effective procedures will be catalogued and described. The benefits will be quantified so that administrators are well positioned to cross collaborate and capitalize on project development and delivery efficiencies that have been implemented by others in the industry.

The process to prepare the best practices guidance document is outlined below:

- Survey and interview state DOT project managers and other relevant staff to find out what changes proved effective and will be adopted as standard practice in their respective agencies going forward.
- Quantify the benefits of these procedural changes in terms of savings in time and money.
- Consolidate the results into a best practices guidance document.

This information will be presented in a best practices guidance document that spotlights effective project development and delivery procedural changes. In effect, the best practices guidance document will be a source for transportation agencies and industry partners to learn from other's successes. It is the intention of the TCPM to actively engage in sharing the results of this effort and the resulting best practices guidance document with industry partners and peers through AASHTO and other appropriate outreach mechanisms.

Urgency and Potential Benefits

State agencies and the industry partners have been incredibly innovative during the pandemic to support project development and delivery. Standard practice has changed in most areas and it is beneficial to share effective innovations within the broader industry.

If states do not take advantage of this recent learning experience, they may lose the opportunities to learn from their peers and save time and money in the project development and delivery processes.

Ultimately, the public benefits most from this research by improving processes that provide project development and delivery in a timely and cost-efficient manner. Inexperienced project managers will benefit from having a consolidated best practices guidance document. Agencies will benefit by learning about, and then implementing proven project development and delivery procedural changes. Additionally, agencies can benefit from the use of more digital technologies in the workplace to retain and recruit staff.

Implementation Considerations

State DOT leadership and staff responsible for project development and delivery are the target audience for the best practices guidance document.

The research would be used as a best practices reference guide and each entity would implement the catalogued project development and delivery innovations as they see fit.

Implementation would be in the form of an electronic best practices guidance document made available through an AASHTO publication. A flow chart to show a state's existing project development process and enhancements could be highlighted within the guidance document to show the improved efficiencies.

Virtual presentations, workshops, and peer exchanges could emphasize the opportunities available to states.

The Committee on Design, the technical committees, and the support groups related to the Committee on Design Committees would have interest in research results related to improving the timeliness and efficiency of the project development and delivery processes.

The Committee on Design has reviewed and endorses this research proposal.

Recommended Research Funding And Research Period

The cost estimate for this research is attached and is \$400,576.92 over the period of 18 months.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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Paul F. Schneider, NJDOT, 609-963-1821, paul.schneider@dot.nj.gov

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Leah Quattlebaum, PE, SCDOT, 803-737-1751, QuattlebLB@scdot.org

Technical committee for Project Management supports the research for this problem statement.

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

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TCPM, Paul F. Schneider, Director, Capital Program Support, NJDOT, 609-963-1821, paul.schneider@dot.nj.gov

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Technical Committee for Project Management Member:

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NCHRP Review of D-11

Reviewed By:

Christopher T. McKenney
 CMcKenney@nas.edu

Comments:

This problem statement presents the opportunity to investigate how DOTs transitioned to remote working and digital technologies, and how the pandemic may have changed the pre-COVID office environment.

A suggested research objective or task may want the research team to quantify productivity rates from DOTs. How did the transition to remote working and digital technologies effect productivity rates?

Considering the time it would take to collect a representative sampling from multiple areas from a DOT, it is recommended to increase the duration to 24 months and the funding at \$400,000.

Review Date:

12/7/2021

AASHTO Committee Evaluation for D-11

Submitted By:

Patricia Bush
 AASHTO staff
 Committee on Design

Priority #: N/A

Comments:

Endorsed by the Committee on Design.

Submitter Response for 2023-D-11

From:

[email: peter.healey@dot.ri.gov]

Comments:

Thank you for your comments.

Labor productivity is defined by the US Bureau of Labor and Statistics as “the ratio of the output of goods and services to the labor hours devoted to the production of that output”. Unlike product manufacturing, the labor/production time associated with state DOT infrastructure project development is unique to each project because each project is essentially a custom build. The problem statement authors completed a detailed review of the various processes associated with project development (NEPA, plan development, right-of-way acquisition, permitting, etc.) and determined that none are truly consistent between projects. As a result the authors concluded that it would be nearly impossible to develop a meaningful metric to describe productivity in a project development context. The authors therefore suggest that it would be more beneficial to quantify the benefits of procedural changes in terms of savings in time and money as stated in the proposal. While the authors would like to develop a productivity metric, we remain concerned that it inevitably would not be based on an apples to apples comparison and would therefore be of limited use, and possibly be subject to legitimate criticism upon peer review.

The problem statement authors have no objection to increasing the project duration to 24 months and appreciate the reviewers recognition of the effort involved in completing the proposed research work.

Contact Info:

Peter A. Healey, P.E.

Member, AASHTO Technical Committee on Project Management

401-563-4039

peter.healey@dot.ri.gov

Review Date:

1/13/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-D-12

Problem Title

Update AASHTO Guide for Design-Build Procurement

Background Information and Need For Research

The AASHTO Guide for Design-Build Procurement was published in 2008 and is intended to assist state transportation agencies in procuring Design-Build projects, including preparing requests for qualifications (RFQ), proposals (RFP) and selecting the successful proposer. Design-Build procurement procedures continue to rapidly evolve since 2008. Over the past 13 years lessons learned in the procurement processes across the nation have identified better ways to procure and deliver Design-Build highway projects. In particular, a new form of Design-Build procurement, Progressive Design-Build has emerged as an innovative way to procure and deliver highway projects. The current procurement guide is dated and lacks critical information to assist agencies attempting to deliver these types of projects. This problem statement has been ranked as the #3 priority for the AASHTO Committee on Design.

Literature Search Summary

There has been a significant amount of research conducted in relation to Design-Build projects since the publication of the AASHTO Guide for Design-Build Procurement in 2008. A review of the research listed in trid.trb.org identifies over 100 entries identifying research specifically targeting specific facets of Design-Build. Further review has not identified specific publications targeted towards a general procurement guide which includes Progressive Design Build.

It is noted that the Design Build Institute of America (DBIA) has developed resources applicable to this effort. The update of this guide will also collaborate with DBIA and include information, as appropriate, to incorporate best practices and streamline the content development within this guide. This will be focused on procurement of Design-Build Projects by state highway agencies yet adaptable to any governmental or private entity.

This research will update the guide and incorporate the information gathered from this large database of focused and specific publications as a basis for Design-Build procurement for use by states across the nation.

Research Objective

The objective of this research is to update the 2008 AASHTO Guide for Design-Build Procurement and incorporate procurement guidance and considerations for Progressive Design Build.

The major tasks of this research will consist of:

- Develop a work plan.
- Literature search to identify recent and applicable procurement methodologies for inclusion and adaption to this guide.
- Survey states and stakeholder organizations to identify and compile Design-Build procurement best practices implemented or recommended since the publication of the 2008 Guide and currently under consideration or development.
- Draft new chapter outline allowing for the incorporation of Progressive Design Build into the guide.
- Compile research results and draft into guide.
- Coordinate with AASHTO Committees, in particular the Technical Committee for Alternate Project Delivery (TCAPD) regarding recommended updates and inclusions into the guide.
- Revise draft and finalize update to the manual.

Urgency and Potential Benefits

13 years have passed since the publication of the 2008 Guide for Design-Build Procurement. During that interim many states have furthered the use and others have since implemented Design-Build Procurement. This growth in the use of Design-Build for highway projects has resulted in many lessons learned and improvements in the procurement of Design-Build projects. This evolution has diminished the value and rendered the existing guide as somewhat ineffective. Additionally, with the emergence of Progressive Design Build as an innovative adaptation of the delivery method, this guide must be updated to reflect current practice and provide guidance for this new innovative delivery method. All states, including those currently utilizing Design-Build and those considering implementing Design-Build will benefit from a vetted, concise and consistent guideline. As stated above, this problem statement has been ranked as the #3 priority for the AASHTO Committee on Design.

Implementation Considerations

Both states which currently utilize and those considering adding Design-Build to their procurement portfolios will benefit from this update. In particular, alternate delivery staff members in addition to all project managers tasked with the delivery of high dollar, high risk, tight schedule and complex scope projects will benefit from this updated resource to aid in the procurement decisions necessary to deliver these types of projects.

Recommended Research Funding and Research Period

Recommended Funding: \$300,000

Research Period: 1 years

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Kris Peterson, Utah DOT, krispeterson@utah.gov, 801-791-1499

Travis Koestner, Missouri DOT, travis.koestner@modot.mo.gov, 417-493-9135

David B. Benton, Arizona DOT, dbenton@azdot.gov, 602-712-7910

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Kris Peterson, Utah DOT, krispeterson@utah.gov, 801-791-1499

Travis Koestner, Missouri DOT, travis.koestner@modot.mo.gov, 417-493-9135

Others from DOT's and Industry Partners tbd.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Kris Peterson

Chair, AASHTO Technical Committee for Alternate Project Delivery

Project Development Director

Utah Department of Transportation

krispeterson@utah.gov

801-791-1499

NCHRP Review of D-12

Reviewed By:

Christopher T. McKenney

CMcKenney@nas.edu

Comments:

A recommendation would be combining problem statement D-12 with D-02 due to the potential overlap in research with Progressive Design-Build. If these two problem statements are combined, it is recommended to increase the funding to \$400,000 and the duration to 24 months.

If the decision is to keep D-12 as a separate problem statement, it is recommended to increase the funding to \$350,000 and the duration to 24 months.

Review Date:

12/2/2021

FHWA Evaluation of D-12

Reviewed By:

Patrick DeCorla-Souza/HCFB

Comments:

This research project needs to be combined with project D-02. Both projects seek to prepare guidelines for Progressive DB, but this project (D-12) also includes regular DB.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for D-12

Submitted By:

Casey Soneira
AASHTO staff
Committee on Construction

Priority #: N/A

Comments:

The Committee on Construction supports this project.

Submitted By:

Patricia Bush
AASHTO staff
Committee on Design

Priority #: 3

Comments:

Committee on Design ranked #3 of 4.

Submitter Response for 2023-D-12

From:

[email: krispeterson@utah.gov]

Comments:

I have reviewed the comments from both FHWA and NCHRP. I agree with both comments. This research effort should be combined with the comment from NCHRP that it should be combined with D-02 with an increase in funding to \$400k and an increase in duration to 24 months.

Contact Info:

I am retiring today and will no longer be eligible to serve as the Chair for the AASHTO Technical Committee for Alternate Project Delivery. I can be contacted if needed via personal email at krispeterson96@gmail.com

Otherwise, all correspondence should be directed to:
Travis Koestner, P.E.
AASHTO TCAPD - Vice Chair
Travis.Koestner@modot.mo.gov
573-526-0245

Review Date:
12-23-2021

**American Association of State Highway and Transportation Officials
AASHTO Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-D-13

Problem Title

Performance-based Specification for the Application of Ground Modification Methods for Bridges, Retaining Structures, and Associated Geotechnical Features

Background Information and Need For Research

Over the last half century, public transportation agencies have greatly increased the use of ground modification methods due to a need to use marginal sites for new construction purposes and to mitigate the risk of failure or poor performance of constructed facilities. More recently, ground modification has been selected to meet challenges associated with accelerating construction in difficult geotechnical circumstances.

Ground modification methods have been widely used to provide both proactive and reactive geotechnical solutions for a wide range of issues including mitigation of soft or loose ground, or potential geohazards; increasing the speed of construction; and improving efficiencies in design of highway features. Ground modification methods are commonly used in all areas of transportation including structure foundations, pavement subgrades and bases, cut slopes, embankments, and earth retaining structures, and are used to provide practical solutions that mitigate geotechnical risks, remediate poor feature performance, and improve long-term durability of transportation assets.

During this time, the Federal Highway Administration (FHWA) and several state departments of transportation (DOTs) have conducted research and have developed guidance documents and other resources to remove the mystique surrounding these solutions, which have typically been developed by contractors in search of innovative approaches to complex geotechnical issues. Research efforts have successfully summarized design methods and quality assurance (QA) procedures developed for commonly used ground modification methods and have demonstrated the design methods based in accepted geotechnical practice. Design and construction methods, equipment needs, technical feasibility, and acceptance criteria have been widely implemented through products, such as the FHWA Demonstration Project 116, and subsequent reference manual updates that have now become Geotechnical Engineering Circular (GEC) 13 – Ground Modification Methods. Training courses provided through the FHWA's National Highway Institute (NHI) have assisted state DOTs in developing and implementing design manuals to govern the use of ground modification methods regionally and, most recently, the development and deployment of GeoTechTools as a solution-based web tool continues to assist with increased safe, reliable, and cost-effective use.

At present, there is not a home in AASHTO for minimum guidance on the use of ground modification methods for application on bridge and highway projects. This is likely due to the wide applicability of solutions for both structure and earthworks, and large number of methods commercially available for ground modification. For continued promotion and cost-effective use, a guideline specification for the use of ground modification methods would provide agencies with a minimum and consistent standard for the selection, design, construction, and acceptance for commonly used techniques in transportation applications.

Literature Search Summary

As noted, there have been several efforts that have summarized research performed for the development of ground modification methods to group technologies based on function or application, and to remove the mystique from design methodologies and acceptance procedures. There is also a wealth of research to understand and quantify mechanisms for improvement to improve guidance. The development of the GeoTechTools web tool under the Second Strategic Highway Research Program (SHRP2) project R02 provides a venue for vetting and implementation of this technology specific research.

GeoTechTools is an online technology selection tool and resource for construction of ground modification solutions and is available at <http://www.geoinstitute.org/geotechtools/>. The SHRP2 report “Geotechnical Solutions for Soil Improvement, Rapid Embankment Construction, and Stabilization of the Pavement Working Platform” provides an excellent description of how GeoTechTools was developed including how technologies were selected for inclusion. The SHRP2 research effort provides a great resource not previously available but does not drill down to provide complete guidance for agencies.

- Schafer, V.R. and Berg, R.R. (2014) “Geotechnical Solutions for Soil Improvement, Rapid Embankment Construction, and Stabilization of the Pavement Working Platform.” SHRP2 Report S2-R02-RW-1. Transportation Research Board, National Academies of Science, Washington, D.C.
In addition, references below provide additional information about the classification and application of common ground modification methods.
- Schafer, V.R.; Berg, R.R.; Collin, J.G.; Christopher, B.R.; DiMaggio, J.A.; Filz, G.M.; Bruce, D.A.; and Ayala, D. (2016). “Geotechnical Engineering Circular No. 13 Ground Modification Methods, Volume I.” FHWA-NHI-16-028, Federal Highway Administration, Washington, D.C.
- Schafer, V.R.; Berg, R.R.; Collin, J.G.; Christopher, B.R.; DiMaggio, J.A.; Filz, G.M.; Bruce, D.A.; and Ayala, D. (2016). “Geotechnical Engineering Circular No. 13 Ground Modification Methods, Volume II.” FHWA-NHI-16-028, Federal Highway Administration, Washington, D.C.

Research Objective

The objectives of this research are to develop an AASHTO guideline specification to assist public transportation agencies with the selection, design, construction, and

acceptance of appropriate ground modification methods for transportation applications. Guideline specifications have the potential to dramatically increase the efficiency and cost-effectiveness of ground modification solutions by assisting designers with specification language that could help avoid common issues, such as incorrect application of methods, a lack of understanding of mechanisms for improvement, and reliable metrics for acceptance and payment of constructed solutions. A significant problem faced by state DOTs is the lack of a standard for selecting from many methods available and proper application for the problem or issue being addressed.

Tasks:

1. Conduct a comprehensive literature review that at a minimum addresses design philosophies and assumptions, construction procedures, and acceptance rationale for common ground modification techniques.
2. Develop clear, consistent nomenclature related to methods, functions and performance for ground modification as applicable for the design and construction of bridges, retaining structures and associated geotechnical features.
3. Develop an approach for grouping common ground modification methods for common function, application, acceptance procedures, or other that would facilitate development of a guideline specification.
4. Define an approach for method selection based on performance goals, identify state of practice for design and construction methods, and acceptance and payment criteria for common ground modification methods.
5. Develop performance-based specifications for selection, design, and construction of technology based, at a minimum, on groupings for application, time in design life of installation (i.e., during design or in remediation), complexity of the technology, quality assurance (QA), availability of an accepted design methodology, regional availability, cost, or other deemed most appropriate.
6. Publish the final AASHTO guideline specification on recommended practice for ground modification for bridge, retaining structures and associated geotechnical features.

Urgency and Potential Benefits

Implementation of the performance specification guideline will be accomplished through adoption as an AASHTO ballot. This will require presentations to the AASHTO Committees on Bridges and Structures (COBS), Design, as well as the Committee on Materials and Pavements (COMP). Presentations will also be made at various regional and national meetings and conferences, including the TRB annual meeting. Challenges will include aversion to the real or perceived risks by both agencies and contractors, misunderstanding and misapplication of technologies, lack of trained personnel, risk averse cultures and institutional bias to known technology, and perceived high initial costs. Inconsistent terminology related to design and QA will also present challenges by inhibiting effective communication of design and construction intent.

Implementation Considerations

Within a DOT, the design and construction groups would be the main beneficiaries of this research effort. The DOTs would be able to implement the guidance specification into their groups' respective practices in a relatively straightforward manner. In addition, the results of the research could be utilized by the FHWA NHI by integrating the guidance specification into GEC 13 and into their practical training materials (i.e., Ground Modification Methods course; FHWA-NHI-132034).

This funding proposal is being submitted on behalf of the TRB AKG50 Committee on Transportation Earthworks. FHWA and multiple state DOTs (e.g., Caltrans, LADOTD, and WSDOT) have expressed interest and support for this effort.

Recommended Research Funding and Research Period

- Estimated Funding Requirement: \$450,000
- Research Period: 24 months

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

- Antonio Marinucci, PhD, MBA, PE; V2C Strategists, LLC; (347) 670.2006; amarinucci@v2cstrategists.com
- Silas C. Nichols, PE, Principal Geotechnical Engineer, FHWA; (202) 366.1554; silas.nichols@dot.gov

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

N/A

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Kaye Chancellor Davis, P.E.
Alabama Department of Transportation
Deputy Materials and Test Bureau Chief
Materials and Test Bureau
Email: chancellork@dot.state.al.us
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NCHRP Review of D-13

Reviewed By:

Ahmad Abu-Hawash
aabu-hawash@nas.edu

Comments:

This research is suitable for NCHRP. Product of this research is implementable through collaboration with AASHTO COBS. However, the problem statement did not list any endorsement from members of COBS in support of this effort.

Proposed budget for \$450,000 seems high considering that there is no experimental work involved and significant guidance has been provided by previous FHWA and SHRP2 efforts.

Review Date:

12/7/2021

FHWA Evaluation of D-13

Reviewed By:

S.Nichols/HIBS-20

Comments:

This is an important issue. Currently, there is no guidance within AASHTO for selection, design, and acceptance of ground modification methods. The methods are now routinely used highway projects for improving foundation performance, addressing slope and embankment stability and deformation, and facilitating accelerated construction schedules.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for D-13

Submitted By:

Patricia Bush

AASHTO staff

Committee on Bridges & Structures

Priority #: 7

Comments:

Committee on Bridges & Structures #7 of 8.

Submitter Response for 2023-D-13

From:

[email: chancellork@dot.state.al.us]

Comments:

The scope and proposed budget for this effort is in line with similar work recently funded at NCHRP. While there is not experimental work involved in developing the guidelines, all of the information exists as individual technology content. The development of common nomenclature, function and application grouping and method selection are all new in the framework of a specification. Existing information developed with FHWA and SHRP2 only inform this.

Contact Info:

Kaye Chancellor Davis, P.E.
(334) 206-2277
chancellork@dot.state.al.us

Review Date:

February 2, 2022

Submitter Response for 2023-D-13
From:

email: chancellork@dot.state.al.us

Comments:

Thanks for forwarding this to me. This work and the proposed products to be produced by this effort are desperately needed. Here at WSDOT, I was intending to develop some better guidance in our WSDOT Geotechnical Design Manual to be used internally and as a mandatory standard for our design-build projects. But it is unlikely that I will be able to pull that off before I retire at the end of June. So this proposed work will likely meet that need in our own state.

As the AASHTO COBS T15 Technical Committee Chair and State Geotechnical Engineer for WSDOT, I would like to provide my hearty endorsement for this NCHRP problem statement. If you want to add my name to this document as endorsing the proposal, please do.

Contact Info:

Tony M. Allen
State Geotechnical Engineer
State Materials Laboratory
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Sizemore, Jeffery C <SizemoreJC@scdot.org>

Review Date:

1/6/22

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-D-14

Problem Title

Validating and Improving Life Cycle Cost Analysis (LCCA) of Pavements with Geosynthetics Using Real Life Cycle Cost Data

Background Information and Need For Research

Background

Life Cycle Cost Analysis (LCCA) is a subset of benefit-cost analysis (BCA), which is used to compare different design alternatives and determine the optimal design option through life-time cost analysis. It is a forward prediction of the overall project cost. FHWA has pursued a policy of promoting LCCA for transportation investment decisions since the Intermodal Surface Transportation Equity Act of 1991 and, thereafter, FHWA has invested heavily to facilitate the applications of LCCA in pavement design selection process across the nation. In 1996, a technology transfer effort under Demonstration Project 115 was initiated by FHWA, which was titled “Life-Cycle Cost Analysis in Pavement Design” which has successfully engaged more than 40 state DOTs. In 1998, FHWA issued an Interim Technical Bulletin on LCCA - Life-Cycle Cost Analysis in Pavement Design. In 2002, FHWA published a summary report outlining the framework and principles that are used for LCCA. In 2004, FHWA published LCCA software to assist the analysis. Nowadays, LCCA has become a routine analysis to evaluate the overall long-term economic efficiency between competing alternative options.

The core objective of LCCA is to enable the total cost comparison of competing design alternatives by including all the relevant costs of each design alternative throughout the lifetime of the project, not simply the initial cost. The best practice of LCCA should include all the costs accruing to the transportation agency (i.e., agency cost) and the traveling public (i.e., user cost). The agency cost typically includes initial construction cost and maintenance costs. In LCCA, user costs of primary interest include vehicle operating costs, travel time costs, and crash costs.

In recent decades, geosynthetics have been widely used in flexible pavements as reinforcement or separator to extend the service life. As inclusion of geosynthetics is usually associated higher initial construction cost, LCCA becomes an important tool to justify the usage of geosynthetics in pavements. The steps of such LCCA encompass: (1) selecting pavement design alternative with and without geosynthetics, (2) using pavement performance prediction model(s) to quantify the pavement condition at different times over its service life, (3) scheduling maintenance/rehabilitation activities according to the predicted pavement conditions, (4) determining the associated agency and user costs, and (5) calculating the life cycle cost for each alternative.

Need for research

For the application of LCCA in pavements with geosynthetic reinforcement or separator, a major challenge is the accuracy of the pavement performance prediction models, because the maintenance schedule and activities and user activities are dependent on the pavement condition. However, so far, the existing prediction models are derived from limited small- or large-scale testing data or short-term field monitoring data, which makes their accuracy unsure. Some studies have showed that these models sometimes give dramatic different results in LCCA, which is an obstacle of the application of LCCA in pavement with geosynthetic reinforcement. In addition, LCCA is data-intensive and data-sensitive analysis. Its results depend highly on the quality of input data including design, construction, maintenance, and users. To address the uncertainty of the prediction models and input data, a probabilistic approach was introduced into LCCA to quantify the variations.

Since the earliest application of LCCA in pavement design selection in the mid-1990s, many of the then-constructed pavements have gone through a major part of their service life, and some of them are even reaching the end of their designed service life. State DOTs have accumulated significant pavement conditions, maintenance, and users' data, which make it possible to back-calculate the real life-cost of the pavement and validate the original LCCA. This is a data-driven study, which links LCCA with acquired field data, which can fine-tune the LCCA models to promote their further adoption.

Literature Search Summary

The concept of LCCA emerged more than half century ago when economic aspects of infrastructure was evaluated (Winfrey 1969; Curry and Anderson 1972; Peterson 1985). Intermodal Surface Transportation Equity Act of 1991 significantly promoted its awareness and adoption in state DOTs with pursuit and requirement of FHWA (Meyburg et al. 1997 and Walls and Smith 1998). Thereafter, FHWA well documented the framework of LCCA in Life-Cycle Cost Analysis in Pavement Design — Interim Technical Bulletin and standardized the analysis procedure (Walls and Smith 1998). Over the years of application in various projects, the challenges that are still faced by DOT engineers are the uncertainty associated with the LCCA, which has been the focus of study in the past decades (Gillespie 1998 and FHWA 2002).

The uncertainty of LCCA for flexible pavement with geosynthetic reinforcement or separator comes from two sources: the models and data. A few models have been proposed to predict the performance of pavement with geosynthetic reinforcement; for example, Al-Qadi (1997) and Perkins (2001). These models were developed based on small- or large-scale testing, numerical simulation, and short-term field monitoring. The test sections were subjected to repetitive loadings, which were then converted to equivalent single axle loads (ESALs) in the calculation to determine the residual serviceability. Yang (2006) and Yang and Al-Qadi (2006) did a comparison between Al-Qadi's (1997) method, and Perkins's (2001) method and AASHTO method and found

out that the predicted deterioration was noticeably different; as a result, maintenance schedules can be off more than 5 years leading to different life-cycle costs. For the same pavement, the estimated cost can be more than 200% different for some design alternatives. In contrast, the effect of geosynthetic as a separator is less studied. Even though a few studies have confirmed the effectiveness of separation to improve pavement performance (for example, Black and Holtz 1999; Sarsby 2006; Kermani et al. 2018), no long-term performance prediction model is available. Practicó et al. (2010) conducted a LCCA for pavement with geosynthetics in the Mechanistic Empirical Pavement Design Guide (MEPDG) and concluded that the parameters and assumptions needed to carry out LCCA were critical, and the variations of the used parameters can easily conceal the effectiveness of geosynthetics, making the LCCA results questionable.

Besides the pavement prediction models, agency and user costs also bring in significant uncertainty (Walls and Smith 1998; Yang 2006). The uncertainty in LCCA has been widely acknowledged by transportation authorities from different countries (FHWA 2002; Yang 2006; Ayed 2017). To address the uncertainty of LCCA, probabilistic approach is used to quantify the uncertainty so it can be accounted for in the decision system (FHWA 2002). No back analysis of the LCCA based on the real-life cycle cost data for pavements incorporating geosynthetics has been performed.

Research Objective

The major research objectives of this study are to (a) use the real life-cycle cost data from flexible pavements with geosynthetics to validate the LCCA performed at the project design phase, (b) quantify the difference between LCCA results and real life-cycle costs, (c) identify the factors that contribute to the discrepancy(ies) and (d) make recommendations for future LCCA. The major tasks of this study are:

- Interview state DOTs to learn about their standard practices for performing LCCA for their pavement systems find candidates of flexible pavement sections with geosynthetic reinforcement. These candidate pavement sections should have been in service for at least ten years and experienced at least one major rehabilitation. Ideally, the original LCCA data at the design phase would still be available.
- Select a few pavement sections from the candidates, ideally, two or three sections from major highways and two or three sections for low volume roads.
- Compile the real life-cycle cost data from the existing DOTs database.
- Calculate the real life-cycle costs and compare with the original LCCA. Perform analysis to identify contributing factors to the discrepancy(ies) if there is/are any.
- Develop recommendations for future implementation of LCCA for pavements incorporating geosynthetics.

Urgency and Potential Benefits

LCCA is now performed at nearly every state DOT if the total project cost exceeds a certain threshold. But the uncertainty of the LCCA, particularly with respect to the inclusion of geosynthetics, has not been well addressed, which brings significant difficulty to evaluating project decisions. It has been three decades since the 1991

Intermodal Surface Transportation Equity Act. The in-service project shall provide sufficient data to validate and calibrate LCCAs. The success of this study will reduce the uncertainty of existing LCCA, which will have positive impact on every DOTs' practice.

Implementation Considerations

The LCCA is primarily performed in the project design phase to assess different design alternatives. This study will not modify the LCCA framework described in the FHWA bulletin; instead, this study will provide recommendations to state DOTs on how to address the uncertainty in different factors to achieve more realistic results. The above-listed tasks will be completed within 22 months and the remaining two months will be used to prepare training materials for the funding agency, including presentations and a workshop.

Recommended Research Funding and Research Period

The project is expected to cost \$250,000 over a two-year (24 month) period.

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

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Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

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Audrey Moruza, Virginia Department of Transportation,
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Person Submitting The Problem Statement: Name, affiliation, email address and phone.

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 State Geotechnical Engineer
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NCHRP Review of D-14

Reviewed By:

Amir Hanna
ahanna@nas.edu

Comments:

A. The problem may not be solvable through the proposed research as data on performance and cost of pavements with a variety of geosynthetics under a variety of traffic and climatic conditions over the pavement's service life is unlikely to be available.

B. The topic of research should be of interest to a large number of state DOTs but it is unlikely that well-supported findings can be obtained.

C. The objective, as stated in the problem statement, focuses on validating the assumptions used in the LCCA of pavements with geosynthetics. However, the limited availability of relevant data from existing pavements makes achieving this objective unlikely.

D. The stated scope appears to be specific. However, it will unlikely result in information that can be readily used in LCCA.

E. The proposed project duration of 24 months appears adequate as the research will rely on available data.

F. Although the research will rely on data available from state DOTs, a larger budget (e.g., \$300,000) will required to allow for adequate analysis.

G. Several relevant reference are cited. However, the problem statement omits the reference to some relevant publications (e.g., NCHRP Web-Only Document WOD 235, Quantifying the Influence of Geosynthetics on Pavement Performance <http://www.trb.org/main/blurbs/176362.aspx> and NCHRP Report 703, Pavement Type Selection <http://www.trb.org/Main/Blurbs/165531.aspx>).

FHWA Evaluation of D-14

Reviewed By:

N. Sivaneswaran/HRDI-20

Comments:

Several factors contribute to the discrepancy between "design LCC" computed at the project design phase (to help support design alternative selection) and "real LCC" based on actual initial and M&R costs and performance over the life cycle - these include assumed vs. actual performance, assumed vs. actual M&R actions and timing (due to performance, budget constraints etc.), variability and uncertainty in traffic, treatment costs, etc., and it is very much understood that design and real LCC could be and often are different. What is important for LCCA conducted at the design phase is that it adequately accounts for expected performance of different alternatives and is founded on reasonable assumptions and inputs to help select preferred alternative notwithstanding this uncertainty and lack of information. So, lack of agreement between design and real LCC may not necessarily an indication of incorrect design LCC or alternative selection. However, case studies reviewing assumptions during project design phase LCCA with and without geosynthetics, specifically performance of pavement incorporating geosynthetics, and actual performance will shed light if design LCCA are adequately accounting for performance benefits pavement incorporating geosynthetics. Hence, this is a worthwhile project.

Review Date:

December 17, 2021

Submitter Response for 2023-D-14

From:

e-mail: Larry.Jones@dot.state.fl.us

Comments:

We appreciate the reviewers for their insightful and constructive comments. In this letter, we provide our point-to-point responses to the review comments for further consideration. The comments received are presented as italicized while our responses are shown in normal font.

FHWA Evaluation for D-14

Several factors contribute to the discrepancy between "design LCC" computed at the project design phase (to help support design alternative selection) and "real LCC" based on actual initial and M&R costs and performance over the life cycle - these include assumed vs. actual performance, assumed vs. actual M&R actions and timing (due to performance, budget constraints etc.), variability and uncertainty in traffic, treatment costs, etc., and it is very much understood that design and real LCC could be

and often are different. What is important for LCCA conducted at the design phase is that it adequately accounts for expected performance of different alternatives and is founded on reasonable assumptions and inputs to help select preferred alternative notwithstanding this uncertainty and lack of information. So, lack of agreement between design and real LCC may not necessarily an indication of incorrect design LCC or alternative selection. However, case studies reviewing assumptions during project design phase LCCA with and without geosynthetics, specifically performance of pavement incorporating geosynthetics, and actual performance will shed light if design LCCA are adequately accounting for performance benefits pavement incorporating geosynthetics. Hence, this is a worthwhile project. Review Date: December 17, 2021

Response: We agree with the reviewer that this project will provide more certainty for future LCCAs, which will benefit many stakeholders.

NCHRP Evaluation for D-14

A. The problem may not be solvable through the proposed research as data on performance and cost of pavements with a variety of geosynthetics under a variety of traffic and climatic conditions over the pavement's service life is unlikely to be available.

Response: We agree that, as with most any research study, there are a lot of variables involved, which for this project may include different geosynthetic properties and functions, traffic levels, length of service, and climatic conditions. Without first attempting to collect the data, it is unknown whether the datasets will be available, useful, and complete; however, if necessary, different approaches can be used to consolidate these variables so datasets can be merged for analysis.

B. The topic of research should be of interest to a large number of state DOTs but it is unlikely that well-supported findings can be obtained.

C. The objective, as stated in the problem statement, focuses on validating the assumptions used in the LCCA of pavements with geosynthetics. However, the limited availability of relevant data from existing pavements makes achieving this objective unlikely.

Response: We would like to respond to Comments B and C at the same time because both focus on potentially limited datasets. We agree with the reviewer that many state DOTs are interested in this topic. We also agree that availability of reliable data is the key to this project, but without a focused study to collect the data, it is difficult to ascertain beforehand that the datasets available are limited. For statistical analysis, we always hope to obtain as much data as possible. If the data is found to be insufficient, however, statistical methods, such as Monte Carlo, Bootstrapping, etc., can be used to augment the data, and the reliability of the analysis can also be determined.

D. The stated scope appears to be specific. However, it will unlikely result in information that can be readily used in LCCA.

Response: We respectfully disagree with the reviewer on this point and think the results of this study will, at a minimum, provide a framework for LCCA where geosynthetics (and other materials) can be considered and evaluated. The findings should be usable for some DOTs, depending on the applications of geosynthetics in those states.

E. The proposed project duration of 24 months appears adequate as the research will rely on available data.

Response: The suggested duration is based on our best knowledge of the subject matter and think 24 months should be enough time, assuming data from state DOTs are readily available; however, if selected, the project panel can revisit the timeline based on the final scope of the project.

F. Although the research will rely on data available from state DOTs, a larger budget (e.g., \$300,000) will be required to allow for adequate analysis.

Response: We agree with the reviewer that a larger budget may be necessary depending on the quantity and quality of available data. If selected, the project panel can revisit the proposed budget based on the final scope of the project.

G. Several relevant reference are cited. However, the problem statement omits the reference to some relevant publications (e.g., NCHRP Web-Only Document WOD 235, Quantifying the Influence of Geosynthetics on Pavement Performance <http://www.trb.org/main/blurbs/176362.aspx> and NCHRP Report 703, Pavement Type Selection <http://www.trb.org/Main/Blurbs/165531.aspx>).

Response: We appreciate the reviewer's suggestions. If the project is selected, all relevant publications should be reviewed and considered by the project panel and team performing the work to achieve the study objectives.

Contact Info:

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**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-D-15

Problem Title

Guidebook for Developing Effective P3 Project Performance Metrics.

Background Information and Need For Research

NCHRP Synthesis 51-19: P3 Performance Metrics identified a gap in the body of knowledge regarding the implementation of transportation infrastructure public-private partnerships (P3). A P3 is defined as a contract between the public and private sectors for the delivery of a project or service in which the private partner provides the majority of the necessary financing. The synthesis found that no definitive guidance exists on how to quantifying asset performance. The literature reviewed determined that an effective metric is focused on outcomes rather than merely outputs. At the theoretical level, this seems like a simple difference. However, in the world of complex megaprojects, the sheer magnitude of the requirement to develop and deploy metrics that cover everything from administrative procedures to reasonable residual lives for a plethora of asset classes is daunting. Therefore, practical guidance is needed to provide for differentiating between an output and an outcome. The objective of this project is to sample successful P3 projects and determine the types of metrics in use and their relative effectiveness in quantifying asset performance.

The effort would likely consist of sampling a variety of performance metrics for common elements of a given asset, like pavements or incident response, from a variety of P3 projects. The actual performance of each of these would then be measured against the standards found in the concession agreement and the actual payment adjustments to provide a measure of efficacy. Simultaneously, both the agency and concessionaire would be surveyed to furnish perceptual data that could be compared to the quantitative data to identify trends and potential disconnects between actual and perceived effectiveness. In recent years, establishment of the USDOT Build America Bureau and enabling legislation in many states have facilitated implementation of P3 projects in the transportation sector. However, the selection of P3 implementation, just like any other project delivery methods is driven primarily by the goals and objectives of the DOT and the specific project. DOTs are still faced with many challenges in aligning these goals and objectives to the delivery methods of choice. In addition, once a project delivery selection is made, monitoring project performance over the length of the project, given this decision becomes vital for assessing and improving future projects' performance and delivery decisions.

Performance metrics in P3 projects should address the public client's overall strategic plan and mission objectives, overall quality and performance of a given asset, and possibly market-specific outcomes that indicate sustainable delivery models. These

performance metrics should include key indicators that might include travel time reliability, safety, overall project physical condition, as well as other project/contract elements. Despite the importance of performance metrics, knowledge is relatively limited about the most effective practices for selecting metrics, setting metrics performance levels, and reasonable approaches to deductions and/or point systems for failure of the Concessionaire to meet contract requirements, that ultimately align with the DOT's goals and objectives.

The proposed research should address at a minimum the following questions:

- What are the different arrangements of P3s used in the transportation industry? What are the key selection parameters for each, in light of DOTs' project goals and objectives?
- What are the key performance metrics for P3 projects? How can they be measured? How effective are they?
- What are effective ways to tie performance metrics to payment mechanisms (i.e. lane availability, route performance, condition criteria, safety performance, unplanned events, etc.) to the P3 contractor?
- If the P3 concessionaire does not comply with performance standards, what actions (e.g., nonconformance reports, penalty point notices, etc.) should be taken?
- If the P3 concessionaire maintains or exceeds the level of performance specified for the majority of the contract term, what incentives, if any, should be provided?
- What techniques have been used to avoid and resolve disputes? Which have been most effective and which have been less effective?
- What risk sharing approaches appear to have best partnership outcomes?

Literature Search Summary

Gransberg, D.D., DeWitt, S. and Touran A. (2020), P3 Performance Metrics, NCHRP Synthesis 51-19, NAS.

Federal Highway Administration (2009). "Public-private partnerships for highway infrastructure: Capitalizing on international experience." International Technology Scanning Program.

Yuan, J. F., Zeng, A. J. Y., Skibniewski, M. J., and Li, Q. M. (2009). "Selection of performance objectives and key performance indicators in public-private partnership projects to achieve value for money." *Constr. Manage. Econom.*, 27(3), 253–270.

Yuan, J., Skibniewski, J., Li, Q., & Zheng, L. (2009). "Performance objectives selection model in public-private partnership projects based on the perspective of stakeholders." *Journal of Management in Engineering*, 26(2), 89–104.

Research Objective

The objective of this project is, thus, to develop a structured decision-making model for DOTs on implementing an effective P3 project from inception to operations, that is driven by the DOT goals and priorities, and assessed by performance metrics pertinent to the selected P3 arrangement (from availability payments, to sharing revenue, to full privatization, among others). The decision-making model should take into consideration factors such as various P3 arrangements and financing options and resources and time

constraints. Based on the results of this study, a guidebook will then be developed to provide information on practices that may assist in selecting various P3 arrangements, as well as assessing the project using key performance metrics that align with the project goals and objectives.

The purpose of this project is to (1) investigate the different P3s arrangements and risk sharing models used in the transportation industry, and link them to DOTs' project goals and objectives, (2) examine performance metrics for P3 projects used by DOTs, as well as other countries in the delivery of transportation infrastructure; (2) document lessons learned; and (3) make implementation recommendations that will improve U.S. policy and practice. This project will produce an empirical guide based on effective practices regarding selection of performance measures for P3 projects, and provide guidance on selecting different P3 arrangements/structures given DOT goals and objectives, as well as effective practices for implementing performance measures.

Specific tasks of the research to accomplish the main objective include:

- Task 1 – Conduct comprehensive literature review of studies related to P3 arrangements.
- Task 2 – Benchmark the state-of-the-market and practice, across the various transportation agencies, related to P3 selection choices and establishing project performance metrics.
- Task 3 – Prepare a research work plan
- Task 4 – Conduct representative detailed case studies
- Task 5 - Execute the research work plan and prepare an interim research report
- Task 6 - Publish the guidebook performance metrics
- Task 7 - Prepare a final research report detailing the complete results of the research.

Urgency And Potential Benefits

During the development and operation phases of a project, performance metrics will be compared with established performance objectives that serve as a baseline, to determine how successful organizations (and the Private sector partner) have been in attaining project objectives. The payoff of this research will be improved decision making for DOT on various P3 arrangements, as well as administration and control of P3 projects, which ultimately will result in higher public satisfaction. Another benefit is relating to support of P3 Market aspects. The guidelines will become available to transportation agencies through the traditional NCHRP distribution processes.

Implementation Considerations

Outcome will benefit current and future Transportation P3 investments.

Recommended Research Funding and Research Period

The estimated project budget is \$500,000 and the period is 24 - 36 months.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Darryl D. VanMeter, P.E., Georgia DOT and several member volunteers of AKC20,
Project Delivery Methods
dvanmeter@dot.ga.gov
404-694-3511

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

AKC20, Project Delivery Methods
Darryl D. VanMeter, Georgia DOT, dvanmeter@dot.ga.gov

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

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Atlanta, GA 30308

NCHRP Review of D-15

Reviewed By:

David M. Jared
djared@nas.edu

Comments:

Logical follow-up to NCHRP Synthesis 51-19, "P3 Performance Metrics," which underscored the absence of such metrics. The shorter project duration of 24 mos. would be preferable, due to the real-time evolution of alternative delivery in the U.S. The budget seems appropriate to support the shorter duration as well.

Review Date:

12/3/2021

FHWA Evaluation of D-15

Reviewed By:

Patrick DeCorla-Souza/HCFB

Comments:

This research project needs to be combined with project D-16. Both projects seek to develop guidelines and performance metrics, the only difference being that project D-16 focuses on hand back performance, i.e., the last few years of the P3 concession. It seems to me that a lot of the sources and case studies are similar and could be more cost-effectively researched if the two projects are combined into one.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for D-15

Submitted By:

Susan Howard

AASHTO staff

Committee on Funding and Finance

Priority #: N/A

Comments:

This research will be most beneficial if it focuses on performance metrics for common elements of P3 projects.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-D-16

Problem Title

Guidebook for Developing P3 Project Handback Criteria.

Background Information and Need For Research

NCHRP Synthesis 51-19: P3 Performance Metrics identified a gap in the body of knowledge regarding the implementation of transportation infrastructure public-private partnerships (P3). A P3 is defined as a contract between the public and private sectors for the delivery of a project or service in which the private partner provides the majority of the necessary financing. The synthesis found that no definitive guidance exists on how to develop handback criteria when an asset is returned from the concessionaire to the agency. Since very few projects have reached a point where the contractual handback criteria have been tested, it will be more difficult to conduct an empirical study to produce the necessary guidance. However, the synthesis found current P3 projects use an approach where different features of work, e.g. pavements, bridges, lighting, etc. in a single P3 project have different handback periods. Therefore, it might be possible to empirically study the shorter termed features. The World Bank has used build-operate-transfer (BOT) delivery to build toll roads and other infrastructure in developing countries with 5 to 15-year O&M periods and contain a robust set of handback criteria that has been tested. This data might be a good departure point for the effort.

The synthesis also identified the use of residual life as a key component of a number of P3 projects' handback process. While the concept of residual life has been well-researched in the lifecycle cost literature, the concept remains highly theoretical and requires a number of assumptions to be made to conduct the residual life computation, which in turn is highly sensitive to the assumptions themselves. Hence a pragmatic approach to rationally computing residual life that is directly applied to the P3 project handback process is needed to assist in managing this risk by the public agency.

The research would sample a variety of handback criteria for common elements of a given asset, like pavements or incident response, from a variety of P3 projects. The actual performance of each of these would then be measured against the handback standards found in the concession agreement to provide a measure of efficacy. Simultaneously, both the agency and concessionaire would be surveyed to furnish perceptual data that could be compared to the quantitative data to identify trends and potential disconnects between actual and perceived effectiveness.

The proposed research should address the following questions:

- What are the different arrangements of P3s used in the transportation industry and how do handback criteria vary between each arrangement?
- What are the key handback criteria for P3 projects? How can they be measured? How effective are they?
- What techniques have been used to avoid and resolve disputes? Which have been most effective and which have been less effective?

Literature Search Summary

Gransberg, D.D., DeWitt, S. and Touran A. (2020), P3 Performance Metrics, NCHRP Synthesis 51-19, NAS.

Federal Highway Administration (2009). "Public-private partnerships for highway infrastructure: Capitalizing on international experience." International Technology Scanning Program.

World Bank Group, "Concessions, Build-Operate-Transfer (BOT) and Design-Build-Operate (DBO) Projects," Legal Resource Center, 2018, <https://ppp.worldbank.org/public-private-partnership/agreements/concessions-bots-dbos> [September 22, 2019].

Yuan, J. F., Zeng, A. J. Y., Skibniewski, M. J., and Li, Q. M. (2009). "Selection of performance objectives and key performance indicators in public-private partnership projects to achieve value for money." *Constr. Manage. Econom.*, 27(3), 253–270.

Yuan, J., Skibniewski, J., Li, Q., & Zheng, L. (2009). "Performance objectives selection model in public-private partnership projects based on the perspective of stakeholders." *Journal of Management in Engineering*, 26(2), 89–104.

Research Objective

The objective of this project is, thus, to develop a structured decision-making model for DOTs on implementing an effective P3 project handback criteria pertinent to the selected P3 arrangement (from availability payments, to sharing revenue, to full privatization, among others). The decision-making model should take into consideration factors such as various P3 arrangements and financing options and resources and time constraints. Based on the results of this study, a guidebook will then be developed to provide information on practices that may assist in selecting handback criteria for various P3 arrangements, as well as assessing the project using key handback metrics that align with the project goals and objectives.

Specific tasks of the research to accomplish the main objective include:

- Task 1 – Conduct comprehensive literature review of studies related to P3 arrangements, how they are linked to DOTs and projects' goals and objectives, as well as to performance measurement.
- Task 2 – Benchmark the state-of-the-practice, across the various transportation agencies, related to P3 selection choices and establishing handback criteria for P3 projects.
- Task 3 – Conduct representative detailed case studies on current and completed P3 projects to identify handback criteria selection mechanisms and constraints, as well as effective performance measurement practices and lessons learned.

- Task 5 - Execute the research work plan and prepare an interim research report that articulates the data collection and analysis, as well as emerging conclusions, effective practices, lessons learned; develop a proposed outline for the guidebook, the case study report and draft language.
- Task 6 - Publish the guidebook to assist DOTs in implementing an effective P3 project handback criteria development program, and assessed by performance metrics pertinent to the selected P3 framework and based on proven effective practices.
- Task 7 - Prepare a final research report detailing the complete results of the research.

Urgency and Potential Benefits

The increased access to and use of private funding to rectify the nation's crumbling infrastructure has furnish a valuable contribution to the transportation system. P3 projects have fixed concession periods and it is critical that the DOT have the means in place to ensure that the asset is in satisfactory operation condition when it is handed back to the Agency The payoff of this research will be improved decision making for DOT on various P3 arrangements, as well as administration and control of P3 projects, which ultimately will result in higher public satisfaction. The guidelines will become available to transportation agencies through the traditional NCHRP distribution processes.

Implementation Considerations

Careful crafting of P3 Handback conditions in P3 delivery is necessary to protect long term outcomes in these contracts. This research implementation will help by keeping the focus on the best ways to structure contracts for the long-term asset affects current budgets but the future outcomes will be observed and felt by agency interests who have not been present at the outset. The owner / agency will therefore be benefited by this work.

Recommended Research Funding and Research Period

The estimated project budget is \$300,000 and the period is 24 - 36 months.

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Darryl D.VanMeter, P.E., Georgia DOT and several member volunteers of AKC20,
Project Delivery Methods
dvanmeter@dot.ga.gov
404-694-3511

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

AKC20, Project Delivery Methods
Darryl D. VanMeter, Georgia DOT, dvanmeter@dot.ga.gov
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Person Submitting The Problem Statement: Name, affiliation, email address and phone.

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NCHRP Review of D-16Reviewed By:

David M. Jared
 djared@nas.edu

Comments:

This research, like that proposed in D-15, is sensible follow up to NCHRP Synthesis 51-19, "P3 Performance Metrics," but D-15 is likely a higher priority if only one can be chosen. Another concern about this is availability of data: how many state DOT's have actually handed facilities back to private owners? If there's a robust data set, then this might be a good parallel effort to that in D-15.

Review Date:

12/3/2021

FHWA Evaluation of D-16Reviewed By:

Patrick DeCorla-Souza/HCFB

Comments:

This research project needs to be combined with project D-15. Both projects seek to develop guidelines and performance metrics, the only difference being that project D-16 focuses on hand back performance, i.e., the last few years of the P3 concession. It seems to me that a lot of the sources and case studies are similar and could be more cost-effectively researched if the two projects are combined into one.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for D-16Submitted By:

Susan Howard

AASHTO staff

Committee on Funding and Finance

Priority #: N/AComments:

FHWA Office of Innovative Financial Support and the USDOT Build America Bureau published case studies of handback experience with P3s in December 2017. The report examines handback experience in three international highway P3 projects and identifies critical elements for the handback process. This NCHRP research would be most helpful if it could focus on U.S. handback examples. However, U.S. experience in this area has been limited .

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP Problem Statement Outline

Problem Number: 2023-D-17

Problem Title

Update of the AASHTO Practical Guide to Cost Estimating (PGCE)

Background

The PGCE provides state Department of Transportations (DOTs) as well as other transportation agencies with practical guidance on how to develop realistic estimates of project costs. It is based on the draft work of documented best practices from various past AASHTO Technical Committee on Cost Estimating (TCCE) members and their agencies as well as several NCHRP Reports.

Literature Search Summary

The PGCE was originally developed under NCHRP 20-7, Tasks 278 and 308. As mentioned in the Background, it is based on work from previous TCCE members, but it is also based on work performed under NCHRP Reports 574, 625, and 658. Additional references are listed in the PGCE at the end of each chapter. Since then, additional research work has begun or has been completed related to Cost Estimating, such as:

- NCHRP 15-71 (Active): Contingency Factors to Account for Risk in Early Construction Cost Estimates for Transportation Infrastructure Projects
- NCHRP 20-7, Task 344 (Completed): Practical Cost Estimating: Development of Training

Research Objective

The objective of this research effort is to produce a new edition of the PGCE that will not only bring all references up to date, but will also include the following:

- Review mark-ups and comments concerning the original PGCE and incorporate with up to date information.
- Identify new material and training that can be incorporated such as terminology, charts, references, methods, etc.
- Consideration or commentary regarding estimating project cost when projects are delivered using alternative project delivery methods.
- Review and evaluation of the following for inclusion or reference:
 - o NCHRP 15-71: Contingency Factors to Account for Risk in Early Construction Cost Estimates for Transportation Infrastructure Projects
 - o NCHRP 20-7, Task 344: Practical Cost Estimating: Development of Training
 - o NCHRP 821: Effective Project Scoping Practices to Improve On-Time and On-Budget Delivery of Highway Projects, 2016

- o NCHRP 826: Estimating Highway Preconstruction Services Costs, volume 1 Guidebook, 2016
- o Identified best practices as documented by other state agencies
- o Other State sponsored research in cost estimating
- o Regulatory or other compliance information that is relevant to industry practice

Urgency and Potential Benefits

The original PGCE was published in 2013 and since then, newer means and methods of estimating have been identified and need to be considered. The guide also needs to be updated to address estimating as it applies to the newer alternative delivery methods. In addition, various software references, tools, website links, charts and tables need to be updated to maintain the PGCE's relevance to current cost estimators. The PGCE is also the foundation for training, such as that provided by the TCCE as well as Risk-based Estimating Training sponsored by the Federal Highway Administration (FHWA). All of this will help transportation agencies to successfully manage and deliver their programs by providing them with the necessary guidance to develop consistent and reliable cost estimates.

Implementation Considerations and Supporters

The target audience for the PGCE are the State DOT and Local Agency estimators as well as our international supporters, such as the Quebec Ministry of Transportation, who may or may not be design engineers. These estimators will adopt and implement the material in the PGCE with their own specific criteria meeting their own specific policies.

AASHTO and FHWA training material references the PGCM for estimation guidance.

Committee on Design gave this problem statement a ranking of one.

Recommended Research Funding and Research Period

Recommended Funding:

\$250,000

Research Period:

13 months

Problem Statement Author(s)

Charles Nickel, P.E., Cost Estimate & VE Director, Louisiana DOTD
225-379-1078; Charles.Nickel@la.gov

Potential Panel Members

AASHTO Technical Committee on Cost Estimating member:
Charles Nickel, P.E., Cost Estimate & VE Director, Louisiana DOTD
225-379-1078; Charles.Nickel@la.gov

Person Submitting the Problem Statement

AASHTO Technical Committee on Cost Estimating member:

Charles Nickel, P.E., Cost Estimate & VE Director, Louisiana DOTD
225-379-1078; Charles.Nickel@la.gov

NCHRP Review of D-17

Reviewed By:

Christopher T. McKenney
CMcKenney@nas.edu

Comments:

After reviewing the AASHTO PGCE, an update to the guide is recommended. One suggestion would be to investigate electronic bid letting as well as it has become a trend with state DOTs. Under the objectives or tasks, it may be useful to have the research team conduct a survey of relevant stakeholders to find which estimating tools they currently use before evaluating estimating software. Another aspect to consider may be how state DOTs and relevant stakeholders are starting to implement or research digital 2D and 3D models as part of the estimating process. The research period should be increased to 24 months and the funding to \$300,000.

Review Date:

11/23/2021

AASHTO Committee Evaluation for D-17

Submitted By:

Patricia Bush
AASHTO staff
Committee on Design

Priority #: 1

Comments:

Committee on Design ranked #1 (tied) of 4.

Submitter Response for 2023-D-17

From:

Charles Nickel, P.E.

Comments:

The AASHTO Technical Committee on Cost Estimating (TCCE) is interested in having the research panel for this problem statement also consider the following recommendations made by the NCHRP reviewers:

- Investigate how electronic bid letting is used by agencies and contractors.
- Survey of relevant stakeholders to find which estimating tools they currently use before evaluating estimating software.
- Investigate how digital 2D and 3D modeling can be used and implemented as part of the estimating process. (This may even include a survey to see how agencies as well as contractors use these modeling techniques in preparing their estimates.)

The AASHTO TCCE also agrees with the recommendations to increase the research period to 24 months and increase funding to \$400,000.

Contact Info:

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LADOTD Cost Estimate and
Value Engineering Director
Email: Charles.nickel@la.gov
Phone: (225) 379-1078

Review Date:

Comments for review dated 11/23/2021.
Comments sent 1/25/2022.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-D-18

Problem Title

Quality Assurance and Sustainability

Background Information and Need For Research

Transportation agencies across the nation are implementing a variety of measures to meet their environmental, economic, and social sustainability goals. Historically, quality management activities have contributed to the sustainability of transportation projects through quality assurance (QA) programs and quality control (QC) plans, which help improve performance, reduce the quantity of unacceptable product constructed and the associated environmental impacts of rework, increased materials use, and community impacts, among other benefits.

In recent years, green public procurement (GPP) initiatives have become increasingly of interest to agencies hoping to reduce the environmental impact of their infrastructure. GPP initiatives rely on construction materials environmental product declarations (EPDs) to communicate the environmental impacts of a material and to compare choices. Some agencies that have started to use some sustainability-related quality metrics (such as global warming potential, emissions, or gallons of water conserved). But these metrics are not uniform and need to be expanded. Quality metrics could be established for EPD programs to support sustainable procurement for many materials. However, although effectively supporting environmental improvements, there has been concern that PCRs and EPD programs, as currently developed and used by manufacturers, provide a range of comparability and harmonization across sectors. . As a result, the information communicated by EPDs may not meet agency needs for comparing impacts and performance. The level of detail and extent of third-party verification also varies by EPD program., Agencies are interested in using EPDs to support GPP, but guidance to support their use to meet agency sustainability objectives is limited.

FHWA has been supporting work to improve both comparability and harmonization of EPDs. However, agencies still lack guidance on ways to implement strategies to support comparability and harmonization. In addition , there is also the issue of verification of EPD properties (such as when an EPD for a mixture indicates it incorporates a certain percentage of recycled material or supplementary cementitious material (SCM) in production), as the verification processes are not well-established by most agencies . If a sustainable product is required or contractor selection is based on a proposed EPD during procurement, then agencies will need to verify that those products that are proposed to meet the EPD are actually incorporated into the project. For example, if an EPD is proposed that includes a percentage of a recycled material

(such as recycled asphalt pavement (RAP), recycled concrete aggregate (RCA), recycled tire crumb rubber, or a supplementary cementitious material (SCM)), then the approved mixture designs should also require those same percentages and their use should be verified in production. QA programs currently allow such products provided they meet the current acceptance testing requirements, the material usage quantities (or percentages) as indicated on the EPDs are not currently being verified. Additionally, agencies need guidance on how to approach unacceptable materials. Currently, no guidance exists to support agencies in establishing and using QA and metrics as part of GPP to help meet their sustainability goals (e.g., is an agency getting the environmental benefits they are paying for). Guidance on benchmarks for environmental performance is also needed to assist agencies in establishing criteria for sustainable materials procurement.

Ultimately, harmonized PCRs and improved EPDs are needed to ensure accurate life cycle analyses of transportation projects. Research is needed to support harmonization of PCRs for the materials used in transportation construction. PCRs define the system boundaries, impact categories, and methodologies used for developing and using the EPD. Guidance to improve the consistency and comparability of EPDs for transportation materials is needed to support agencies in assessing tradeoffs and making decisions.

Literature Search Summary

California Legislative Information. (2021). Article 5: Buy Clean California Act. https://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=PCC&division=2.&title=&part=1.&chapter=3.&article=5

Colorado Office of State Controller. (2021). Green purchasing. <https://osc.colorado.gov/spco/procurementresources/green-purchasing>

Minnesota Pollution Control Agency. (2021). Sustainable Procurement Charter. <https://www.pca.state.mn.us/sites/default/files/p-p2s1-09.pdf>

Rangelov, M., Dylla, H. Mukherjee, A., and Sivaneswaran, N. (2021). "Use of environmental product declarations (EPDs) of pavement materials in the United States of America (U.S.A.) to ensure environmental impact reductions." *Journal of Cleaner Production*, 283. <https://doi.org/10.1016/j.jclepro.2020.124619>

Research Objective

Develop guidance to support agencies in establishing and using QA and metrics as part of GPP to help meet their sustainability goals. Identify potential future improvements in EPD programs, agency practices, or other areas to maximize the use and benefits from EPDs.

Possible tasks include:

Task 1 – Literature review. Publications and specifications associated with EPDs and LCA should be reviewed. The role of QA in supporting these initiatives should be a focus. Include case studies in industries (such as energy and real estate) that have implemented GPP and EPDs.

Task 2 - Collect information from agencies regarding their sustainability goals, GPP, EPDs, and needs to support LCA. Emphasis should be placed on metrics that could be used from a quality standpoint to support these efforts, as well as needs that could be met by additional guidance, or by changes in EPD programs. The role of agencies in influencing EPD programs should also be documented. Agencies that could serve as champions to implementation will be identified.

Task 3 – Identify existing practices used by transportation agencies and industry to support GPP, and related quality management.

Task 4 – Develop guidance to support agencies in establishing and using QA and metrics as part of GPP to help meet their sustainability goals. Identify further work by industry needed to support PCRs and EPDs to support LCAs. Anticipated topics include:

- EPDs coverage/scope to fully meet transportation agency needs
- Implementation routes and scenarios (such as incentives, benchmarks, go/no-go scenarios, etc.) that are useful in supporting GPP
- Requirements for third-party verification of EPDs
- Benchmarks for environmental performance in materials procurement
- Methods by which agencies can better influence EPD programs
- Methods by which agencies can improve their verification process between the EPD and the as-constructed product
- Expected barriers and challenges to the implementation of EPDs

Task 5 – Publish a guidebook describing the findings of Tasks 1-4. In addition, provide recommendations for both agencies and industry to advance that state of practice.

Urgency and Potential Benefits

Legislation related to sustainable procurement is already being introduced in several states that will impact the way agencies specify and accept construction materials. Agencies would directly benefit from improved use of QA programs to assist them in meeting their sustainability goals, including those associated with net zero greenhouse gas emissions targets. Capturing the economic, environmental, and community benefits associated with improved sustainability through better use of environmental-related quality metrics.

Implementation Considerations

The AASHTO Committee on Materials and Pavements (specifically technical subcommittee 5c, Quality Assurance and Environmental) will be instrumental in supporting implementation of this work. Industry engagement will also be a key component of implementation. It is envisioned that one or more pilot implementation(s) could be performed by a champion state (or states), where contract language/specifications are developed and tested for procurement. This could be a follow-on activity.

Recommended Research Funding and Research Period

\$350,000

24 months

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

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Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Members of AASHTO COMP Technical Subcommittee 5c – Quality Assurance and Environmental, Curt Turgeon (Chair), (651) 366-5535, curt.turgeon@state.mn.us

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

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Rick Bradbury

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Richard.bradbury@maine.gov

NCHRP Review of D-18

Reviewed By:

David M. Jared

djared@nas.edu

Comments:

The research topic is timely and seems to have state DOT support from around the U.S. An initial study on this topic is merited. If, however, there is not enough data for researchers would have to work with, there would be value in capturing that and identifying data gaps. Note that FHWA support is mentioned, but no specifics or citations are provided.

Review Date:

12/1/2021

FHWA Evaluation of D-18**Reviewed By:**

Tim Aschenbrener/HICP-40

Comments:

There is growing interest for including sustainability in procurement of construction products. Guidance on how to do this and making sure the agency "gets what they pay for" is needed. The quality assurance gap needs to be filled. This is very important.

Review Date:

December 17, 2021

Submitter Response for 2023-D-18**From:**

[email: Richard.bradbury@maine.gov;curt.turgeon@state.mn.us]

Comments:

The submitters appreciate the comments. Regarding the availability of information available to researchers, this is a rapidly evolving topic; the number of agencies addressing Green Public Procurement initiatives is increasing, which should provide sufficient information for a successful study.

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**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-D-19

Problem Title

Advancing multi-sensor weigh-in-motion (WIM) technology for improving weight data accuracy and reliability

Background Information and Need For Research

Accurate weigh-in-motion (WIM) data is essential for a multitude of design and management activities related to the pavement and bridge infrastructure in addition to their role in monitoring and enforcing motor carrier truck weights and dimensions. To support these activities during transformational changes, such the pandemic and climate changes, DOTs require the wide use of accurate and cost-effective WIM technology. WIM sensors vary from instrumented metal plates to piezoelectric, quartz, and strain gauge strip sensors. Their accuracy is evaluated with reference to static loads (ASTM E1318) and as a result, it is affected by the interaction between roadway roughness and vehicle dynamics/speed. This affects more the narrow strip-type WIM sensors that sample a smaller part of the dynamic axle loads applied to the road. This shortcoming can be mitigated by utilizing multiple strip sensors (two or more), strategically spaced to capture more data points of the dynamic axle load waveforms. The result will be more accurate estimates of the static axle loads applied. Another benefit will be the improvement in reliability, since failure of one of the sensors will not render the WIM system inoperable.

Literature Search Summary

Cebon, D and C.B. Winkler (1991), "Multiple-sensor weigh-in-motion: theory and experiments", Transportation Research Board Record No. 1311, pp 70-78.

COST 323 (1996). "Portable and Multiple-Sensor WIM System Trial"
http://wim.zag.si/reports/trappes/trappes_report.html (accessed 10-16-2020)

Gonzalez, A., A.T. Papagiannakis and E.O'Brien, (2003) "Evaluation of an Artificial Neural Network Technique Applied to Multiple-Sensor Weigh-In-Motion Systems" Journal of the Transportation Research Board Record No. 1855, pp 151-159.

Qin, T.; Lin, M.; Cao, M.; Fu, K.; Ding, R. (2018) Effects of Sensor Location on Dynamic Load Estimation in Weigh-in-Motion System. Sensors, 18, 3044.

Liu, X., Feng, Z., Chen, Y. and Li, H. (2020), Multiple optimized support vector regression for multi-sensor data fusion of weigh-in-motion system". Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering, Volume 234, Issue 12, 2020, pp 2807-2821

NIST Handbook 44: Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices, 2020.

Traffic Monitoring Guide (2016), Federal Highway Administration,
<https://www.fhwa.dot.gov/policyinformation/tmguide/>

Research Objective

The objective of this project is to determine the feasibility of utilizing multiple (i.e., more than 2) sensors for improving the accuracy and reliability of WIM systems and quantify costs and benefits of multi-sensor arrays. The project should involve the following tasks:

Task 1. Review the literature on work that deals with the use of multi-sensor WIM systems.

Task 2. Perform vehicle-pavement interaction simulations to resolve any issues mentioned in the literature in relation to the optimum number of sensors and their spacing.

Task 3. Develop the methodology for programming controllers to optimize the output and record weights from multiple WIM sensors. This should consider various analytical approaches including weighed average, curve fitting, and/or neural networks. This methodology should include provisions for the case where one or more of the multiple sensors fails or provides erroneous readings and accommodate split sensor (left/right wheel-path) measurements.

Task 4. Test the improved system in the field with at least two strip sensor technologies and establish its potential accuracy in comparison to currently available single/dual threshold sensor systems (i.e., both those equipped with plate and strip sensors).

Task 5. Conduct economic comparisons between system and sensor types. Quantify costs and benefits (i.e., accuracy improvement) associated with multi-sensor arrays WIM systems and compare them with other WIM systems utilizing different sensor types.

Task 6. Develop recommendations for designing optimum sensor array depending on WIM technology, road type and surface condition, length of data collection, and user needs for weight data accuracy and consistency.

Task 7. Document the findings and the methodology developed.

Urgency and Potential Benefits

Reducing the cost while improving the quality of WIM data is an urgent priority for highway traffic monitoring. Multi-sensor WIM are a cost-effective approach for doing so. Reduced system cost will allow more WIM system installations and their improved reliability will reduce maintenance costs and data gaps.

Implementation Considerations

It is anticipated that for Tasks 3 and 4, there will be cooperation between the researchers and one or more of the WIM vendors to ensure that the products of this study are readily implementable. At the study conclusion, the methodology and/or algorithm developed will be placed in the public domain. The research team will provide

a well thought out testing and budget plan for conducting this study within the available budget.

Recommended Research Funding and Research Period

\$450,000 over a 2.5 year period

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Thomas Papagiannakis, University of Texas at San Antonio, (210) 458 7071
AT.Papagiannakis@utsa.edu

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Potential panel members can be drawn from the membership of several TRB committees that have shown keen interest in this statement, e.g., ACP70 (Highway Traffic Monitoring), AED70 (Freight Transportation Data) and AKP50 (Surface properties and Vehicle Interaction). These include:

FHWA, Steven Jessberger, (202) 366-5052, Steven.Jessberger@dot.gov

Kent Taylor, North Carolina DOT, (919) 345 9829, kltaylor@ncdot.gov

Russell Lewis, Wisconsin DOT (608) 516-5754 russell.lewis@dot.wi.gov

Mena Lockwood, Virginia DOT mena.lockwood@vdot.virginia.gov

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Kent Taylor, NCDOT, kltaylor@ncdot.gov , (919) 345 9829

NCHRP Review of D-19

Reviewed By:

Camille Crichton-Sumners
ccrichton-sumners@nas.edu

Comments:

Weigh-In motion data collection accuracy remains a concern for transportation agencies. The topic warrants further study, however, many of the outlined tasks overlap with the scope of NCHRP 20-50(20) "LTPP Data Analysis: Develop Practical Tools and Procedures to Improve WIM Data Quality" which is scheduled to be completed by December 30, 2022. Coordination is required to minimize duplication of effort. Additionally state DOTs must consider the implications of the use of additional sensors which require additional maintenance. The scope and budget are reasonable.

Review Date:

12/17/2021

FHWA Evaluation of D-19**Reviewed By:**

T Tang/HPPI

Comments:

The background information provided is material fact and the need is there and urgent. I recommend the project as it is practical and achievable based on the objective offered and the specific tasks outlined.

Review Date:

December 17, 2021

Submitter Response for 2023-D-19**From:**

[email: kltaylor@ncdot.gov]

Comments:

Problem Statement D-19 aims at testing directly the optimal configuration of multi-sensor array WIM technology and developing techniques for optimizing their output. Preliminary results of the on-going NCHRP project 20-50(20) "LTPP Data Analysis: Develop Practical Tools and Procedures to Improve WIM Data Quality" suggest that multi-sensor WIM arrays improve WIM data quality, especially for linear WIM sensors. However, its findings are limited to the arrays with up to two sensors in each wheel path currently used in the US. Limited literature from Europe suggests that multi-sensor (i.e., 3 or more in each wheel path) arrays further enhance WIM data quality and consistency and hence can potentially be implemented in the US. The proposed study plans to install and test multi-sensor arrays and to evaluate their benefits and costs, so that guidance on using them can be developed for State highway agencies. Its outcome will further expand and enhance the findings and tools (WIM Sensor and Array Selection Tool) developed from the NCHRP 20-50(20) project.

Contact Info:

Kent L. Taylor, North Carolina Department of Transportation, (919) 345-9829 mobile, kltaylor@ncdot.gov

Review Date:

02/07/22

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-D-20

Problem Title

Determine the Accuracy and Bias of Currently Available Portable Technologies for Obtaining Short Term Traffic Volumes for Segments and Intersections.

Background Information and Need For Research

This research will enhance the knowledge of the accuracy and bias of short term traffic counts by documenting the strengths, weaknesses and applications for (1) technology and sensor selection and (2) array type for short term volume counts that are used for segment and intersection use. The short-term counting program provides critical spatial data for a quality traffic monitoring program (TMS) and provides spatial traffic volume data for a given location. In addition, traffic volume data supports decision making, and provides engineers and planners with critical information that enhances safety and mobility for the traveling public.

As sensor detection technologies continue to mature, traffic count programs often rely on these new techniques and modern counting technologies and sensors. Therefore, it is necessary to research and document a most reliable and accurate practices found across different traffic volume data programs that can inform the industry of these methods in a documented research findings report.

During this project, short-term data collection, data quality and availability issues will be researched, and the accuracy and bias determined when using short-term data.

Methods for technology selection, sensor choice, array, and the appropriate duration will be compared for consistency across various agencies and areas of the country. This will help the industry in establishing and updating their practices for collecting, checking, and validating short-term data.

Additionally, short-term counting data has a number of topics that need to be researched and documented, such as:

- Inconsistency in data quality that varies across technologies, sensor types and arrays.
- Effect of site conditions on data quality (weather, arrays, possible occlusion, speed during detection period, congestion and other site-specific conditions).
- Effect of sensor type and sensor array, and benefits of one technology over the other.
- Limitations that exist with one technology over another and documentation of those so agencies can choose the most appropriate detection method for their given local conditions.

Research questions to be addressed include:

1. What is typical accuracy and bias of ADT estimates based on data from existing short term traffic volume locations? The method of obtaining short term traffic counts will be documented. The reasons ADT estimates vary will be documented.
2. What methods of data collection, validation, handling, storage, and QA/QC need to be implemented to obtain the most accurate and unbiased short term traffic volume counts from existing technologies at various locations around the US?
3. What challenges exist in obtaining short term traffic count data (site conditions, traffic flow, traffic volume, sensor technology)?

Literature Search Summary

No specific research was found on the accuracy or bias from short term or portable volume traffic counters through the TRB TRID and other known sources of research. Closely related work, but not directly addressing the accuracy or bias of short-term counts, includes the following:

FHWA. Variability in Traffic Monitoring Data. Contract DE-AC05-96OR22464, Oak Ridge National Research Laboratory, August, 1997.
<https://www.fhwa.dot.gov/ohim/flawash.pdf>

Georgia Institute of Technology for the Georgia Department of Transportation. Accuracy of Traffic Monitoring Equipment, June 1995.
<https://www.fhwa.dot.gov/ohim/atme/atme.htm>

FHWA. This project deals with the duration and frequency of volume counting, but not on the field data collection efforts agencies utilize.
https://www.fhwa.dot.gov/policyinformation/travel_monitoring/pubs/aadt/

Research Objective

The objective is to explore the accuracy and bias of different types of short term portable traffic counts obtained from road tube (single, double and by wheel path), magnetometer, temporary stick down loop, video, ultrasonic, infrared and various non-intrusive technologies such as radar, microwave and sound technologies. Most commonly available commercial short-term technologies currently in the US should be considered. In evaluating accuracy and bias a suitable ground truth method should be used.

Specific tasks are:

- a) Analyze the different count durations such as consecutive 24 hour, 1 day (ie 24 hours will often split over more than one calendar day whereas with 1 day is within the same calendar day), 48 hour, 2 day, 72 hour, 3 day and 7 day counts to determine how the count technology and duration effect the overall accuracy and bias of the short term count. It would be expected that extensive data collection would be required to obtain the needed data sets for this analysis.

- b) Develop recommendations of applications and limitations of the above referenced technologies to allow DOTs to determine type of technology and suitable array (number of sensors and spacing of sensors) to use in a variety of environments (examples include but not limited to high speed/low speed, occlusion, high volume/low volume, all weather [sunny, fog, rain and snow], congestion levels [including stop and go], velocity changes and lane changes).
- c) Develop alternatives to mitigate the equipment and sensor limitations described above.
- d) Prepare a final report documenting the results of this study in a form suitable for a best practice for collecting accurate and unbiased short term traffic volume counts.

Urgency and Potential Benefits

This need was first identified by the TRB Traffic Monitoring Committee ACP70 in 2016. Although there have been advancements in this area since then, the need still exists and is even more prevalent with advanced technology and the development of new data sources from vendors, for example, using video recognition with AI and machine learning technologies.

Being able to obtain high-quality short term traffic count data equipment is paramount for traffic volume count programs and allows for safety and facility improvements to be implemented based on traffic volume data that shows demand and user facility needs. Those benefiting from this research include state, county, MPO, and city traffic program managers; signal operating agencies; and the public at large (due to resource saving and increased safety and mobility due to improved data and decision-making).

Implementation Considerations

The following state DOT offices will be involved in implementing the results of this research: Planning, Programming, Traffic Operations, Transportation System Management and Operations (TSM&O), and Design.

States will be able to implement the research by adopting lessons learned from other entities. Implementation will be supported with communication methods such as webinars, training, and peer exchanges. The AASHTO Committee on Data Management and Analytics will be a key benefactor of these results.

Recommended Research Funding and Research Period

Funding Requested: \$350,000, Research Period: 24 months.

Successful proposers need to come up with a project plan that fits within the budget specified and could include vendor provided equipment or equipment provided from DOTs or local agencies. This project plan needs to be approved by the NCHRP project manager.

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

- Liz Stolz, Marlin Engineering, (303) 369-5570, estolz@marlinengineering.com

- Olga Selezneva, Applied Research Associates, (410) 203-2285, oselezneva@ara.com
- Steven Jessberger, Federal Highway Administration, (202) 366-5052, steven.jessberger@dot.gov
- Tom Papagiannakis, University of Texas at San Antonio, (410) 203-2285, Papagiannakis@utsa.edu
- Andrew Nichols, Marshall University, (304) 696-3203, andrew.nichols@marshall.edu

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

- Kent Taylor, NC DOT, kltaylor@ncdot.gov, (919) 345-9829
- Robert Blankenship, AL DOT, blankenshipr@dot.state.al.us, (334) 242-6393
- Ian Vaagenes, MN DOT, ian.vaagenes@state.mn.us, (651) 366-3869
- Kurt Matias, NY DOT, Kurt.Matias@dot.ny.gov, (518) 457-1965

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

- Kent Taylor, NC DOT, kltaylor@ncdot.gov, (919) 345-9829

NCHRP Review of D-20

Reviewed By:

Camille Crichton-Summers
ccrichton-summers@nas.edu

Comments:

Advances in portable traffic counting technologies warrant study. The research will be of interest to transportation and local government agency Traffic Operations and Maintenance offices and aims to study/improve the accuracy of portable traffic counters that collect short term traffic volume data using various technologies. Identification, prioritization, and purchasing various new portable traffic counters for study and identifying test locations will likely require additional time. The acquisition of traffic counters will likely require additional funds. A 30 month timeframe is suggested along with a 450K budget.

Review Date:

12/17/2021

FHWA Evaluation of D-20

Reviewed By:

T Tang/HPPI

Comments:

This is a highly desired project (Combine D20 and D21) as it has significant implications to the adoption and acceptability of new technology for traffic data collection. The objective of the effort is very clear and the product is needed.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for D-20
Submitted By:

Chad Baker
Research Subcommittee Chair
Data Management and Analytics

Priority #: 15

Comments:

Deployment of typical short term count machines is dangerous business for field technicians. The use of and demand for more count data on all roads will require innovative techniques for collection. The use of 'big data' could also be a consideration for this research.

Submitter Response for 2023-D-20
From:

[email: kltaylor@ncdot.gov]

Comments:

Thank you for your supportive comments. In regard to comments made in the D-21 review about combining it with D-20, we believe each problem statement has merit on its own and they should be considered separately. Problem Statement D-21 deals with establishing a practical methodology and tools for obtaining ground truth (i.e., quantification of accuracy, precision, and bias) of raw traffic volume counts obtained either from portable or permanent automated traffic counters. Its outcome will inform the update of ASTM E2532-09. On the other hand, D-20 focuses on field testing of different equipment used for short-term counts and establishing the accuracy of various technologies currently available for obtaining short term counts. As such, it utilizes ground truth accuracy counts (obtained either from permanently installed continuously counting equipment, video, or manual counts) as a reference for calculating accuracy and establishing bias of equipment used for short-term counts.

We agree with the reviewers' comment and recommendation about the budget and period of performance and recommend the following update:

Funding Requested: \$450,000. Research Period: 30 months.

Contact Info:

Kent L. Taylor, North Carolina Department of Transportation, (919) 345-9829 mobile, kltaylor@ncdot.gov

Review Date:

02/07/22

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-D-21

Problem Title

Practical Ground Truth Method and Tools for Evaluating Accuracy, Precision, and Bias of Traffic Volume Counting Equipment

Background Information and Need For Research

Traffic data accuracy is fundamental to many critical functions of highway and transportation agencies. As traffic monitoring and detection technologies continue to mature and third-party traffic data sources become more widely available, traffic count programs are asked to evaluate these alternatives. Inconsistency in data quality varies across vendors and technologies. In addition, traffic data quality change over time due to equipment aging and environmental effects on equipment performance. Thus, the ground truth about traffic count accuracy obtained immediately after equipment installation may not remain representative over time due to equipment issues or intermittent environmental effects on sensor performance. The FHWA Traffic Monitoring Guide recommends calibration of all permanent and portable traffic counter each year. Several ASTM standards and methods (E 177–20, E 2300–09, E 2532–09, E 2759–10) address the topics related to evaluating accuracy, precision, and bias of traffic volume counts. However, some of the methodologies may require updates to incorporate new technologies and statistical methods and their effect on the procedures described in the standards. In addition, highway agencies have developed their own methods and procedures. The lack of uniformity or consistency in methods used by different agencies to evaluate the accuracy of traffic counts leads to challenges with analyses of national traffic data sets, comparison of traffic trends between different agencies, or even using traffic data within a given agency, if different technologies have been used to collect traffic data. The lack of consistency in methods to obtain ground truth data about traffic volume counts also creates challenges in evaluating accuracy of traffic volume estimates obtained using analytical tools.

To address the need to know how accurate traffic counts are upon equipment installation or at any time during equipment operation, equipment performance validation methodologies and standard specifications, which are widely accepted and implemented into practical supporting tools, are critically needed to objectively evaluate and quantify accuracy of traffic counts obtained by different technologies. This is a fundamental step to assure soundness of the decisions made based on the data and statistics derived from the traffic counts. This research focuses specifically on practical methods to determine the accuracy of traffic monitoring devices commonly used for collecting data to compute highway traffic statistics.

Research questions or tasks to be addressed include:

1. What are technological, operational, and environmental challenges with obtaining accurate traffic count data from automated traffic counters used for highway traffic statistics? Understanding of these challenges will help in identifying sound and practical methods, testing conditions, and limitations of the existing methods for determining accuracy of traffic counts.
2. What practical ground-truth methods are currently available and used to determine accuracy, precision, and bias of traffic counts collected by automated traffic counters? What criteria are currently used to validate traffic count data accuracy, precision, and bias? Are the existing methods still relevant? What are the obstacles or limitations in implementing these methods in practice? This should include methods for evaluating traffic counter technology itself, as well as implementation of this technology at a particular traffic monitoring site. Both accuracy and reliability (i.e., consistent accuracy over time) of traffic counts should be considered.
3. Develop guidance how the existing ground-truth methods (how long of a count to make, how many lanes should be counted, how many vehicles to count, what accuracy criteria and parameters to include with each method to be detailed) could be improved and/or made more practical. Select or enhance an existing method or propose a new method that best meets the needs of highway agencies for testing and accepting installation of automated traffic counters commonly used to collect data for highway traffic statistics or for accepting traffic data collected by portable traffic counters.
4. Are the selected existing or the proposed new method(s) universally applicable and practical? Test automated traffic counters commonly used to collect data for highway traffic statistics and document findings. Consider a permanently installed traffic counting site and 2–3 commonly used portable traffic monitoring technologies installed and tested side-by-side. A minimum of four test sites is recommended. Practicality and potential implementation of selected methodology(s) on roads with different traffic and site characteristics should be evaluated (including roadways with throughputs over 2,000 vehicles per hour per lane and medium/low traffic volume of 500 to 5,000 AADT) under prevailing conditions during typical equipment installation or data collection season). Consider practicality and limitations of implementing the selected ground truth testing methodology(s) at remote or very low volume locations, as well as urban locations, including test duration, safety, and vandalism considerations. Document findings and technologies tested.
5. Adjust, as necessary, finalize, and document the recommended practical ground truth method(s) for evaluating accuracy, precision, and bias of traffic volume counts.
6. Develop practical tools, such as guidance document, specification, and/or supporting software to apply the ground truth method to evaluate accuracy, precision, and bias of traffic volume counts.
7. Prepare a final report documenting the results of this study which will include references methods and the limitations when utilizing these methods that may exist (such as weather, through put limits, congestion limitations or minimum numbers of vehicles needed) and traffic monitoring technologies tested.

The potential research results are of national interest and necessary to address strategic objectives of state DOTs because traffic volume data is a key input into

management and decision support systems implemented at the national and state-level (such as those systems mandated by Title 23 Sec. 303 - Management systems), including HPMS, pavement and bridge management and maintenance, congestion, and safety management systems. Ability to quantify the accuracy of traffic counts is critical for the effective and informed use of these data in management systems, as well as for road and bridge design and transportation planning projects.

The seven research tasks listed above identify the scope needed to help assure that the research objectives can be successfully achieved within the constraints of the proposed time and funds. The goal of the proposed research is to produce implementation-ready ground truth method(s) and practices in the form of standard specifications, detailed practical procedures that states' personnel could follow, and/or practical software tools to assure ease of implementation of the research results in practice.

Literature Search Summary

Several ASTM standards address topics relevant to evaluating accuracy, precision, and bias of traffic volume counts, including the following: E 177-20 Standard Practice for Use of the Terms Precision and Bias in ASTM Test Methods, E 2300-09 Standard Specification for Highway Traffic Monitoring Devices, E 2532-09 Standard Test Methods for Evaluating Performance of Highway Traffic Monitoring Devices, E 2759-10 Standard Practice for Highway Traffic Monitoring Truth-in-Data. In addition, highway agencies have developed their own methods and procedures. Different approaches need to be reviewed and analyzed and potential best practices and limitations need to be identified for different road and traffic conditions. The reasons why the current standards have limited implementation and why the implemented methodologies vary from agency to agency need to be explored and documented.

Research Objective

The objectives of this research are (1) develop a new or enhance an existing practical ground truth method for evaluating accuracy, precision, and bias of traffic volume counts obtained from portable and permanent automated traffic counters commonly used to collect data for highway traffic statistics and (2) develop practical procedures, specification, and/or software tools, to help with practical implementation of the selected methodology. The results of this research may lead to the update of ASTM E 2532 – 09 Standard Test Methods for Evaluating Performance of Highway Traffic Monitoring Devices. See 7 potential tasks in Section 2 above.

Urgency and Potential Benefits

This need was first identified by the TRB Traffic Monitoring Committee ACP70 survey of professionals in 2016. All highway agencies use traffic count data, but it is rarely known how accurate said data are. The need is even more relevant with the development and deployment of new traffic data collection technologies, such as using video recognition with artificial intelligence and machine learning technologies. Common standards and procedures are necessary to quantify accuracy of traffic counts and assure informed uses of traffic data and improved data sharing practices between transportation

agencies. Application of such methods will allow uniform and unbiased quantification of traffic data accuracy coming from different data sources.

Those benefiting from this research include federal, state, county, MPO, and city traffic program managers; and the public at large (due to improved data quality for transportation decision-making).

Implementation Considerations

The state DOT offices involved in traffic data collection and data use will be involved in implementing the results of this research, including: Planning, Programming, Traffic Operations, Transportation System Management and Operations (TSM&O), and Design.

States will be able to implement the research findings by adopting the recommended ground truth methods, procedures, specifications, and tools. Implementation will be supported with communication methods such as webinars, training, and peer exchanges. The AASHTO Committee on Data Management and Analytics will be a key benefactor of these results. The results of this project may lead to revision and update of ASTM E 2532 – 09 or a development of a new AASHTO specification. In addition, the practical methods and support tools developed in this project (implementing the proposed methodology) will further assure the ease of implementation of the research results in practice.

Several issues arise with some of the procedures described in ASTM E 2532 – 09. The most critical one appears in Sections 7.2.9 and 7.3.7, which state “If any specified TMD data item is not output or its difference as calculated in 7.2.8 (for all values of the data item measured) exceeds the specified tolerance, declare the TMD nonfunctional or inaccurate and record that it failed the Type-approval Test.” By including the words “for all values of the data item measured” the standard does NOT make provision for random errors through the specification of a confidence interval along with the accuracy value. Including a confidence interval would also allow for precision and bias to be determined, contrary to what is now stated in Sections 7.2.10 and 7.3.8 of the standard. Other issues are the omission of the mention of alternative ground-truth methods.

Recommended Research Funding and Research Period

Funding Requested: \$400,000. Research Period: 30 months.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

- Olga Selezneva, Applied Research Associates, oselezneva@ara.com, (410) 203-2285
- Lawrence A. Klein, Klein & Associates, larry@laklein.com, (714) 356-2275
- Steven Jessberger, Federal Highway Administration, steven.jessberger@dot.gov, (202) 366-1874

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

- Aaron Moss, Traffic Analyst, CDOT, aaron.moss@state.co.us
- Chris Medina, Program Admin Specialist III, VDOT, Chris.Medina@VDOT.Virginia.gov, 804-786-2956

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Kent L. Taylor, NCDOT, kltaylor@ncdot.gov (919) 345-9829

NCHRP Review of D-21

Reviewed By:

Camille Crichton-Summers
ccrichton-summers@nas.edu

Comments:

The findings of this research would improve the accuracy of traffic volume counts obtained from permanent automated traffic counters that collect data for highway traffic studies. The results of this research may produce findings that may inform the update of ASTM E 2532 – 09 Standard Test Methods for Evaluating Performance of Highway Traffic Monitoring Devices. Field testing of permanent traffic counters, data collection, the development of updated procedures to be used to inform decisions related to standard test method updates, and tool (software) development will likely require additional resources. Suggested budget should be 500K and timeline of 36 months.

Review Date:

12/17/2021

FHWA Evaluation of D-21

Reviewed By:

T Tang/HPPI

Comments:

This project could be integrated with D20 (D20 and D21 combined) is a highly desired project as it has significant implications to the adoption and acceptability of new technology for traffic data collection. The objective of the effort is very clear and the product is needed.

Review Date:

December 17, 2021

Submitter Response for 2023-D-21

From:
[email: kltaylor@ncdot.gov]

Comments:

Thank you for your supportive comments. We believe each Problem Statement D-20 and D-21 has merit on its own and they should be considered separately. Problem Statement D-21 deals with establishing a practical methodology and tools for obtaining ground truth (i.e., quantification of accuracy, precision, and bias) of raw traffic volume counts obtained either from portable or permanent automated traffic counters. Its outcome will inform the update of ASTM E2532-09. On the other hand, D-20 focuses on field testing of different equipment used for short-term counts and establishing the accuracy of various technologies currently available for obtaining short term counts. As such, it utilizes ground truth accuracy counts (obtained either from permanently installed continuously counting equipment, video, or manual counts) as a reference for calculating accuracy and establishing bias of equipment used for short-term counts.

We agree with the reviewers' comment and recommendation about the budget and period of performance and recommend the following update:

Funding Requested: \$500,000. Research Period: 36 months.

Contact Info:
Kent L. Taylor, North Carolina Department of Transportation, (919) 345-9829 mobile, kltaylor@ncdot.gov

Review Date:
02/07/22

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-D-22

Problem Title

Life-Cycle Soil-Structure Modeling of Bridge Abutment, Approach Embankment, and Pavement Structure Interaction Behavior

Background Information and Need For Research

- Computational modeling tools provide improved analysis of complex soil-structure-interface problems, yet few have been explored in detail from a complete project life-cycle timeline perspective, examining long-term outcomes from differences in initial construction conditions. An improved understanding of the force and deformation behaviors at the bridge-embankment interface modeled through several different construction and life-cycle representative scenario events can provide an improved understanding of the roles of compaction, drainage, cyclic loading, thermal effects, foundation support type, reinforcement, and material selection. Understanding the influence of geometry, material properties, reinforcement, construction events, and life cycle changes and subsequent impact on structure and pavement performance has immediate relevance to system resilience, maintenance and asset management, sustainability and foundation re-use, and design, construction and inspection practice improvement.
- The settlement of bridge approaches over time, and the development of the “Bump at the End of the Bridge” is a complex problem and a significant maintenance and safety concern. Performance, risk, reliability, and safety need to be explored in more detail at the bridge/pavement interface to ensure that performance is similar to that of the bridge (LRFD framework) and the pavement and pavement structure (Life-Cycle Cost Analysis in Pavement Design). NCHRP Synthesis 234 (1997) noted that of the many factors that can contribute to bump formation, the most common are: compression of the fill, settlement of the natural soil under the fill, poor construction practices, poor drainage, poor fill material, and loss of fill material by erosion. Some of these problems are construction issues, and others are life-cycle degradation issues which can be modeled to determine their relative significance, and the effectiveness of remediation options explored.
- The problem statement relates to the strategic plan for the Committee on Bridges and Structures Goal 5, Accelerated Bridge Delivery and Construction and Goal 6, Optimize Structural Systems. It is also relevant to the strategic plan for the Committee on Design Goal 3, Continually improve the quality and cost effectiveness of projects.

Literature Search Summary

A literature search found studies examining lateral pressures and other considerations at the bridge embankment interface. Examples include:

- “Abutment Interface Experiments for Integrated Approaches” (FHWA-PROJ-12-0004)
- “Passive Force-Displacement Relationships for Skewed Abutments” TBF-5(264)
- “Settlement of Bridge Approaches (The Bump at the End of the Bridge)” (NCHRP Synthesis 234)
- “Leading Practices for Detailing Bridge Ends and Approach Pavements To Limit Distress and Deterioration” Scan Team Report NCHRP Project 20-68D, Scan 19-01. Several field research projects are underway by State DOTs to investigate behavior or instrumented bridges. There are, however, limited parametric studies on the relative benefits of mitigation strategies during construction and over the life-cycle of structures from a modern computational modeling perspective where the performance outcomes of mitigation strategies can be evaluated to aid in determining the most cost effective and broadly applicable solutions.

Research Objective

- Apply computational modeling tools to investigate construction and life cycle effects at the bridge, approach embankment, and pavement structure interface with time. Compare performance outcomes associated with variable parameters to determine which strategies appear most quantitatively successful. Study the impact of material properties, construction sequence, geometry, cyclic loading and similar conditions and behavior. Provide graphical output and descriptions of relevant performance values such as forces, stress/strain profiles, deflection (settlement), and measures of effectiveness of mitigation strategies.
- Major tasks will be creation of 2D and 3D computational models to investigate several common abutment treatments. Cases with real-world parameters will be created to model construction or life-cycle sequencing to compare impacts of changes in geometry, material properties, time, deformation, reinforcing and structural elements, foundation types, and sensitivity to site changes over time (e.g., settlement, compaction, erosion, drainage performance, thermal effects). Modeling scenarios include:
 - o Assessment of soil stresses/deformations/settlement on ‘typical’ bridge abutment details (taken from NCHRP Project 20-68D, Scan 19-01) during construction and service. Factors studied will include variable initial compaction, differential settlement, drainage, foundation type, soil reinforcement, rigid inclusions, cellular concrete inclusions, seepage, ice-formation, soil loss, and changes in system geometry (such as edge lateral confinement). Model three embankment geometries, each with two foundation cases (shallow and deep foundations). Model 3 cases of compaction, settlement, drainage, material types.
 - o Assessment of soil stresses/deformations/settlement with respect to time (construction sequencing and life cycle environmental loading and effects (temperature, freeze-thaw, potential drainage clogging, hydrostatic increases, and material degradation). Simulate at least 2 possible modes of failure related to soil strength or stiffness loss or erosion.
- Present results as case-study scenarios/vignettes, providing computational “digital twin” models of real-world cases showing the performance impact/outcomes of the parametric variation and evaluating the relative benefit/severity of the conditions investigated. Create animations which show mechanisms responsible for performance

deterioration. Evaluate outcomes and provide commentary on parameters or conditions which appear most important for best performance outcomes, which can be used in support of targeted practice for improving designs, construction practice, or inspection and acceptance.

- Through computational modeling, examine the causal issues noted in NCRHP Synthesis 234, the current state of practice of State DOT responses NCHRP Project 20-68D, Scan 19-01 and evaluate which conditions and which mitigations appear most relevant for promoting long-term performance.

Urgency and Benefits

- “The Bump at the End of the Bridge” continues to be a persistent problem (in terms of maintenance, safety, public perception, and user inconvenience when repairs are made) despite a variety of designs adopted in an effort to mitigate poor performance. State DOTs are focusing attention on sustainability, re-use, resilience, and life-cycle cost effectiveness. Even modest performance improvements through design, materials, construction, inspection, or maintenance, could provide a significant return on investment. Comparative computational modeling analysis of the soil-structure interaction and response to both initial design and construction and life-cycle influences is needed to better understand the comparative significance of the complex aspects of the design space at the intersection of the bridge and approach embankment, and its associated pavement structure. Improved understanding can lead to greater confidence in the value of implementing design, construction, inspection, or maintenance solutions, and address accompanying risk reduction and related reductions in conservatism and cost.
- Changes in geometry, materials, drainage, foundation type, and construction process, will be examined to evaluate the significance of interrelationships of force, deflection, settlement, creep, pore-water-pressure dissipation and structural interaction. Improved understanding using advanced and efficient computational modeling tools, will provide a valuable basis for improvements to the AASHTO code, DOT guidance, and policy for design and construction.

Implementation Considerations

- Research results will be used by design, materials, construction, structural, and geotechnical engineers and practitioners. The research can provide immediate support for policy and guidance and serve as a basis for additional studies for improvements in design, construction, inspection, or maintenance procedures in support of consistent levels of risk and reliability. Implementation can be supported through organizations: AASHTO, ASCE, TRB, FHWA, others.
- Additional products, such as presentations, video animations, and web-based tools, and activities (training workshops, peer exchanges) can help create awareness and facilitate use of the research results and adoption as a basis for design improvements, further research, or policy changes.
- Research results and implementation support could be provided by:
 - o AASHTO COMP Technical Sub-Committee 1b [various members]
 - o ASCE Geo-Institute, TRB, and other organizations [various members]

Recommended Research Funding and Research Period

Research Funding: The estimates of the total funds needed to accomplish (a) the modeling research objective(s) is \$400,000. The cost estimate (b) for initial activities for communication and implementation of key research products (models, evaluations, animations, visualizations, report) is \$75,000.

Research Period: The estimate of time to perform the tasks (a) computational modeling with review and preparation of deliverables is 24 months. The time to (b) for communication and implementation of results to stakeholders is estimated at an additional 6-12 months.

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Derrick Dasenbrock, P.E., D. GE, F. ASCE
Geotechnical Engineer, Geotechnical and Hydraulic Engineering Team
Federal Highway Administration Resource Center, 202.923.0972,
derrick.dasenbrock@dot.gov

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

- NDDOT, Matt Kurle, P.E., Bridge Inspection Engineer, (701) 328-4448, mkurle@nd.gov
- MnDOT Office of Materials & Road Research, Raul Velasquez, P.E., Ph.D., Geomechanics Research Engineer, 651-366-5533, Raul.Velazquez@state.mn.us

Person Submitting The Problem Statement: Name, Affiliation, Email Address And Phone.

Matt Linneman, PE, State Materials & Research Engineer
North Dakota Department of Transportation
mlinneman@nd.gov, (701) 328-6904

NCHRP Review of D-22

Reviewed By:

Ahmad Abu-Hawash
aabu-hawash@nas.edu

Comments:

Significant progress has been made to address bridge approach settlement problems by state DOTs using simple implementable solutions. It is not clear from the problem statement how the results of this research will be implemented by practitioners and AASHTO. There is no evidence of any buy-in from the relevant AASHTO committees.

Review Date:
12/7/2021

FHWA Evaluation of D-22

Reviewed By:
S.Nichols/HIBS-20

Comments:

Good idea, but aspects of this are already being worked on in FHWA and future work will address scope items with data currently being collected. I don't think this is our highest priority at this time.

Review Date:
December 17, 2021

Submitter Response for 2023-D-22

Comments:

The authors of the proposal believe "Life-Cycle Soil-Structure Modeling of Bridge Abutment, Approach Embankment, and Pavement Structure Interaction Behavior" contains aspects of new and previously unexplored construction sequence and time-domain life-cycle factors that could deliver new insight from a computational modeling perspective to a problem that persists and continues to demand time and expense from State DOTs nationwide. While indeed there may be 'implementable solutions,' these often come in the form of maintenance retrofits and post-construction remediation at considerable time, expense, and public inconvenience. This is as opposed to a solution which prevents the mechanisms which lead to the "bump at the end of the bridge" at the time of construction or with potentially non-invasive preventative maintenance measures. Indeed a recent webinar suggested that States have been implementing a wide variety of remedies in search of solutions.

The initial findings of the NCHRP domestic scan (19-01 - Leading Practices for Detailing Bridge Ends and Approach Pavements to Limit Distress and Deterioration) noted that "Due to the variety of geological, geotechnical and climate conditions each state is faced with, there is no "one size fits all" solution to resolving the 'bump at the end of the bridge.' " <https://www.domesticscan.org/19-01-leading-practices-for-detailing-bridge-ends-and-approach-pavements-to-limit-distress-and-deterioration> It is also noted that there are a wide variety of elements: Abutments, Joints, Approach Slabs, Embankment Treatments, and Drainage which make up components of this complicated soil-structure interaction area. Computational modeling can provide significant advantage to a problem of this nature.

The purpose of the proposed study is to allow the benefits of a computational modeling approach to be applied where parameters can be adjusted and studied to determine which aspects have the most significant response on the system. This approach provides an opportunity to narrow the focus of ongoing and future studies, or those working on revisions to design codes, to concentrate on conditions/parameters which have the greatest potential to improve performance.

The authors do, however recognize and concur that there are indeed efforts by others in this area (where we had imagined this work would be helpful and indeed complementary) and understand that this is not a "highest priority" item. The Implementation Considerations section in the proposal should have been better written to describe the application of the results to directing DOT resources to areas with the most influence/impact on performance, recognizing the end-user utility and agency needs more directly.

Based on the comments from a previous proposal, the authors did conduct additional AASHTO committee outreach in support of this proposal. This topic, among others of "geotechnology" nature is not directly related to pavements, structural materials, or significant structural components of bridges and structures. In our experience, it has been somewhat challenging for TRB committees to form Research Problem Statements for areas where AASHTO committees do not have a primary interest or where committees overlap in scope. Personal experience suggests "buy-in" from relevant committees is therefore challenging for topics related to embankments, roadway support, subgrade drainage, and performance of 'orphan' elements such as bridge approach panels and ground improvement for structural support.

We appreciate the time and consideration of NCHRP and the proposal reviewers.

Contact Info:

Derrick Dasenbrock, P.E., D. GE, F. ASCE Geotechnical Engineer Geotechnical and Hydraulic Engineering Team Federal Highway Administration Resource Center
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www.fhwa.dot.gov/resourcecenter

Review Date:

Monday, December 20, 2021 1:54 PM

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-D-23

Problem Title

Development of Field Test to Determine Actual Percent Embedment of Chip Seal Aggregate

Background Information and Need For Research

Chip seal aggregate embedment has a significant influence on long-term chip seal performance. Too little embedment can cause raveling, revealing bare asphalt (safety and performance are compromised), and too much embedment can lead to bleeding (safety is compromised). Ensuring proper chip seal aggregate embedment should be evaluated as a critical factor when considering the proposed design of a chip seal project. However, there is no method to measure chip seal aggregate embedment quickly and accurately in the field.

Literature Search Summary

ASTM E965, "Standard Test Method for Measuring Pavement Macrottexture Depth Using a Volumetric Technique"

This is the sand patch test. It is used to determine surface texture, but not the aggregate embedment depth into the asphalt.

Ugurcan Ozdemir, et. al.; "Quantification of Aggregate Embedment in Chip Seals Using Image Processing"; Journal of Transportation Engineering, Part B: Pavements; © ASCE; ISSN 2573-5438

This paper detailed the analysis of three different methods of determining percent embedment of chip seal aggregate. An image processing algorithm was used to determine percent embedment, but this process required a cross-section of the chip seal mat (from cores) to analyze. A sand patch method was also used, but, as noted above, this method determines surface texture and not embedment. Lastly an Ames device was used to determine texture depth, and this device could potentially be used to determine quasi-embedment depth. Note that the Ames device is a lab-based instrument, not a field instrument.

Satyavati Komaragiri, Angelo Filonzi, Ramez Hajj & Amit Bhasin; "Three-dimensional Profiler for Performance Evaluation of Chip seals"; Advances in Materials and Pavement Performance Prediction; 2018 Taylor & Francis Group, London, ISBN 978-1-138-31309-5

This paper describes the process of using a laser scanner mounted on a cart to generate a point cloud that can, in turn, be analyzed to quantitate embedment depth, bleeding, raveling, and void ratio.

Research Objective

To develop a rapid, in-situ method to determine the embedment depth of chip seal aggregate soon after placement. This information could then be used to address any contractor workmanship issues that may be occurring on the project in near real-time (vs. having to wait until essentially after the project is entirely completed), as well as an indicator of performance relative to the initial chip seal design (target emulsion and aggregate application rates, percent embedment range, etc.)

Urgency and Potential Benefits

Measuring aggregate embedment in chip seal surface treatments can be incorporated into an incentive and disincentive program as part of the project contract to actively encourage contractors to construct chip seals to meet the design embedment depth and aggregate spread targets. These are directly related to the total life cycle and overall performance of the chip seal surface treatment in-place. For example, it has been calculated that in Texas' approximately \$300 million annual chip seal program, adding only one additional year of life on only 20% of the lane-miles that are sealed can save over \$9 million per year.

Implementation Considerations

The results of this work could be used as an objective measure to evaluate initial acceptance of the chip seal project. In addition, the research results could be incorporated into the construction specifications to provide an incentive for contractor workmanship. Specific incentives and disincentives would need to be studied based on percent embedment.

Recommended Research Funding and Research Period

Time: 3 years

Funding: \$400,000

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Colin A Franco, RIDOT Associate Chief Engineer; Co-Chair – AASHTO TSP2 Emulsion Task Force; Member – AASHTO RAC; TRB -State Representative

Chris Lubbers, Kraton Polymers US, LLC; Technical Sales and Market Development Manager – Emulsions; Co-Chair – AASHTO TSP2 Emulsion Task Force

Darren Hazlett, University of Texas – Center for Transportation Research; Member – AASHTO TSP2 Emulsion Task Force

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

- a) Members of the AASHTO TSP2 Emulsion Task Force
- b) Members of the AASHTO Pavement Preservation Regional Partnerships (PPP's)
- c) Members of the AASHTO COMP TS 2a and TS 5b

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Colin A Franco, RIDOT Associate Chief Engineer; Co-Chair – AASHTO TSP2 Emulsion Task Force; Member – AASHTO RAC; TRB – State Representative

NCHRP Review of D-23

Reviewed By:

Amir Hanna

ahanna@nas.edu

Comments:

- A. The problem is likely solvable through the proposed research.
 - B. The topic of research should be of interest to the majority, if not all, state DOTs.
 - C. The objective, as stated in the problem statement, provides a clear intent of the research.
 - D. The scope is clearly defined, it aims at developing rapid, in-situ method to determine the embedment depth of chip seal aggregate soon after placement.
 - E. The estimated duration of 36 months seems adequate.
 - F. The estimated budget of \$400,000 seems adequate.
 - G. Several publications are cited but further literature review, surveys, and other information gathering should be performed as part of this research.
-

FHWA Evaluation of D-23

Reviewed By: Morgan Kessler/HRDI; Tim Aschenbrener/HICP-40

Comments:

Morgan Kessler - This is needed research that is a component of the larger preservation topics recently performed by NCHRP specific to emulsion-based treatments. Correct chip seal embedment is key to the success or failure of the treatment, and directly related to public acceptance or rejection of this technique.

Tim Aschenbrener - There has been a lot of chip seal research lately. Following best practices has dramatically improved chip seal performance. It is unknown how much improvement this will provide as best practices are working well.

Review Date:

December 17, 2021

Submitter Response for 2023-D-23

From:

[email: colin.franco@dot.ri.gov]

Comments:

I am responding to the comments made by Mr Tim Aschenbrener stated below.

As chair of the AASHTO TSP2- Emulsion Task Force (ETF) I can categorically state that currently ,there is no field test that can determine the embedment (or percent embedment)of a stone chip in a chip seal.

Yes, there has been a great deal of improvement in the performance of chip seals , this is largely due to a) Chip Seal research by NCHRP and State Dot's b) the efforts of the ETF working with AASHTO COMP and AASHTO Maintenance in developing , Materials , Quality Assurance(QA) and Construction specifications- and also through the Chip seal Best Practices recently published by the ETF.

This QA field test for chip embedment will go a long way in improving the durability and long term performance of a chip seal as proper embedment reduces the probability of raveling , or bleeding when the embedment is too deep.

We further believe that the results of this test could be used for incentives/disincentives within an agency's QA program that if utilized ,would go a long way in improving the overall workmanship and hence performance for chip seals.

Colin Franco PE
RIDOT

COMMENTS BY T IM ASCHENBRENER { " There has been a lot of chip seal research lately. Following best practices has dramatically improved chip seal performance. It is unknown how much improvement this will provide as best practices are working well. Review Date: December 17, 2021"}

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-D-24

Problem Title

Performance-Based Tests for Asphalt Emulsion Treatments as part of Agency Acceptance Programs

Background Information and Need For Research

AASHTO, the AASHTO Committee on Materials and Pavements (COMP), and the AASHTO TSP2 Emulsion Task Force (ETF) have worked together to develop agency-approved materials specifications and design practices for a wide range of asphalt emulsions and asphalt emulsion-based treatments. But tests (Laboratory and Field) that could be used to determine the in-service performance and expected life cycle of these treatments applied according to these new AASHTO-approved material specifications and design practices are largely unavailable.

Many DOTs have ready access to Hot Mix Asphalt (HMA) tests and specifications that can be used to measure key characteristics that have been empirically shown to correlate with field performance. These agencies have also used these same tests and specifications to develop incentives/disincentives programs for the contractor. Examples of the types of HMA tests that have been used in DOT-based incentive/disincentive programs are lab molded density, in-place density, asphalt content, and gradation.

These same types of performance-based tests and specifications need to be determined for asphalt emulsion treatments to allow for these same types of incentive/disincentive programs to be developed by agencies for use with the emulsion contracting community.

The various asphalt emulsion treatments and their associated, approved AASHTO standards are listed below in Table 1.

Emulsion Treatments	Material M	Design Practices R	Construction Guide Specs	Quality Assurance Guide Specs
Chip Seal	MP27-16	PP82-16	Approved	Approved
Micro Surfacing	MP28-17	PP83-16	Approved	Approved
Fog Seal	MP33-17	PP88-17	Approved	
Asphalt Rejuvenators				
Bonded Surface Treatments (Nova Chip)	MP44-20	PP100-20		
Cold Recycled Mixtures	MP31-17	PP86-17		
Foam Asphalt Stabilization		PP38-18		
Sand Seal	MP34-18	PP90-18		
Scrub Seal	MP43-20	PP91-18		
Slurry Seal	MP32-17	PP87-17		Approved
Tack Coat	MP36-18	PP93-18		
Emulsified Asphalts	Material M			
Emulsified Asphalt	M140-16			
Cationic Emulsified Asphalt	M208-16			
Polymer-Modified Cationic Emulsified Asphalt	M316-16			

Table1-Asphalt Emulsion Treatments and Approved AASHTO Standards

Literature Search Summary

Per Table 1, approved AASHTO specifications now exist for the individual materials, design, construction, and quality assurance (QA) relative to each of the specific asphalt emulsion treatments listed.

As an example for the chip seal emulsion treatment, see below:

M 140, Standard Specification for Emulsified Asphalt

AASHTO M 208, Standard Specification for Cationic Emulsified Asphalt

AASHTO M 316, Standard Specification for Polymer Modified Emulsified Asphalt

AASHTO MP 27, Standard Specification for Materials for Emulsified Asphalt Chip Seals

AASHTP PP 82, Standard Practice for Emulsified Asphalt Chip Seal Design

A similar grouping of specifications is also available for the micro surfacing, slurry seal, fog seal, scrub seal, sand seal, tack coat, cold recycling, and bonded surface treatments.

What is not readily available are the tests and specifications limits required to determine whether these treatments are manufactured correctly, constructed properly, and ultimately will perform as-expected in the field.

As a result, some DOTs have chosen to resort to short-term warranty programs to cover their chip seal (Idaho) and micro surfacing (Texas) projects. However, these are difficult to enforce without being able to rely on specific tests and specification limits that

objectively measure properties that have been shown to correlate with the specific area(s) of interest relative to field-performance of the composite treatment.

Research Objective

This research would lead to the identification and/or development of various tests and specification limits related to the field performance of the selected asphalt emulsion-based treatments. In turn, this will allow DOT's to develop performance-related acceptance criteria in conjunction with their quality assurance (QA) programs. Furthermore, incentive/ disincentive programs could also be developed for use with the emulsion contracting community that could lead to even longer in-service life for these treatments.

Urgency And Potential Benefits

Development of performance-based tests and specification limits for these asphalt emulsion-based treatments will enable DOTs to validate whether the design criteria are being met by the contractor. These can then also become the basis for incentives and disincentives programs included in contracts that will further help to insure better construction methods and quality of materials and workmanship. The project then has the best chance of being constructed as intended, so it will ultimately last longer. For example, it has been calculated that in Texas' approximately \$300 million annual chip seal program, adding only one additional year of life on only 20% of the lane-miles that are sealed can save over \$9 million per year.

Implementation Considerations

Performance-based tests and specification limits must be identified and/or developed and then included in bid construction specifications. The performance-based tests need to have a direct effect on loss or gain relative to in-service life of the selected treatments to also allow for development of adequate incentive and disincentive programs.

Recommended Research Funding and Research Period

Time: 3 years

Funding: \$400,000

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Colin A Franco, RIDOT Associate Chief Engineer ; Co-Chair – AASHTO TSP2 Emulsion Task Force; Member – AASHTO RAC; TRB State Representative

Chris Lubbers, Kraton Polymers US, LLC; Technical Sales and Market Development Manager – Emulsions; Co-Chair – AASHTO TSP2 Emulsion Task Force

Darren Hazlett, University of Texas – Center for Transportation Research; Member – AASHTO TSP2 Emulsion Task Force

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Members of the AASHTO TSP2 Emulsion Task Force

Members of the AASHTO Pavement Preservation Regional Partnerships (PPP's)

Members of the AASHTO COMP TS 2a and TS 5b

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Colin A Franco, RIDOT Associate Chief Engineer ; Co-Chair – AASHTO TSP2 Emulsion Task Force; Member – AASHTO RAC; TRB State Representative.

NCHRP Review of D-24

Reviewed By:

Edward T. Harrigan
eharriga@nas.edu

Comments:

This problem statement is solvable through research. It is a component of a program under the aegis of the AASHTO Committee on Materials and Pavements (COMP) and the AASHTO TSP2 Emulsion Task Force (ETF) to develop a complete set of material, design, construction, and acceptance specifications for the various asphalt emulsion treatments. Due to the widespread use of these treatments, the problem is likely of interest to the majority of the DOTs. Potential deliverables will provide objective tools for developing incentive/disincentive programs and enforcing warranties.

I suggest rewriting the problem objective as: "The objective of this research is to identify and/or develop tests and specification limits for acceptance of the field performance of the selected asphalt emulsion-based treatments." There are no suggested tasks, but these can be developed by the project panel and NCHRP staff.

The proposed period of performance is reasonable. Due to uncertain scope of the necessary laboratory testing, an increase in the funding to \$500,000 is recommended.

Review Date:

12/9/2021

FHWA Evaluation of D-24

Reviewed By:

Morgan Kessler/HRDI; Tim Aschenbrener/HICP-40

Comments:

Morgan Kessler - This RNS reflects a longtime discussion about transforming the testing of emulsion-based treatments to performance-based metrics. Such testing would be an improvement over current practices, where testing is specification-based, or not tested at all.

Tim Aschenbrener - A lot of work has already been done in this area and there has already been a lot of progress. It is not clear what the specific next steps would be. The objective seems vague.

Review Date:

December 17, 2021

Submitter Response for 2023-D-24
From:

[email: colin.franco@dot.ri.gov]

Comments:

I am responding to the FHWA comments in reference to RNS D-24.

1) I am in total agreement with Mr Kessler who has been involved for a long time with Pavement Preservation and emulsion technology as a (former) member of the ETG for Pavement preservation and a Liaison to the AASHTO -TSP2 Emulsion Task force (ETF) of which I am the chairman.

2) I acknowledge Mr T Aschenbrener as an expert in HMA and Hot Binders and have a high regard for his knowledge and experience in that field-However I must digress when he states that "A lot of work has already been done in this area (sic -emulsion technology) and there has already been a lot of progress".

I would agree with that statement if it just alluded to NCHRP research on Emulsion treatments and drafting of Emulsion treatment specifications. (BTW- This NCHRP "Emulsion" research was in large part initiated by the ETF whose mission is to progress the state of Emulsion technology).

It would also be worth noting that most of the Emulsion/ Emulsion treatment tests were developed when emulsions were made from straight PEN graded asphalt, now with the advent of PG graded asphalt, modifiers, rejuvenators etc. these test may or may not be up to the task? Hence the need for new tests-preferably Performance based/ Related.

The goal of this RNS is to come up with Performance Based/Related test that would lead to better performance for the respective emulsion treatments and to come up with

meaningful incentives /disincentives based on performance - these tests are sorely lacking.

Colin Franco PE
RIDOT

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-D-25

Problem Title

Synthesis of Tests and Associated Methods for Asphalt Emulsion-Based Pavement Preservation (P P) Treatments

Background Information and Need For Research

This synthesis should include tests and their associated methods required for the characterization of component materials, design of composite materials, placement process conformance, performance testing, and post placement condition assessment, initially and over time in the field. All DOT's that specify and actively use asphalt emulsion-based pavement preservation (PP) treatments have specification requirements for component materials, and some may even incorporate tests on the finished, composite product. These asphalt-emulsion based PP treatments include chip seals, micro surfacing, slurry seals, scrub seals, tack coats, fog seals, sand seals, and cold recycling.

Literature Search Summary

All DOT's reference AASHTO, ASTM, or DOT-developed and approved tests to measure suitability of component materials, as well as suitability and design of composite materials used to create an asphalt emulsion-based PP treatment. A literature search is one of the main tasks and deliverable of any synthesis project.

Research Objective

Synthesize all tests and associated methods used to characterize and determine the suitability of the component materials, as well as the design and performance of the composite end-products, for the asphalt-emulsion based PP treatments. These end-products should include chip seals, micro surfacing, slurry seals, scrub seals, tack coats, fog seals, sand seals, and cold recycling.

Urgency and Potential Benefits

This synthesis is specifically being requested so as to a) identify tests that are available, b) tests that are performance related and most importantly c) gaps in testing that highlight areas where additional testing development is urgently needed to help to improve the overall performance of these major asphalt emulsion-based PP treatments.

Implementation Considerations

This synthesis will determine if additional research is needed to better characterize the component materials, the design of the treatment, and/or evaluate the performance of the end-product for these major asphalt-emulsion based PP treatments. Additional

research in these areas would improve performance and increase the service life of these treatments.

For example, it has been calculated that in Texas' approximately \$300 million annual chip seal program, adding only one additional year of service life on only 20% of the lane-miles that are sealed can save over \$9 million per year.

Recommended Research Funding and Research Period

Time: 1 year

Funding: \$45,000

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Colin A Franco, RIDOT Associate Chief Engineer ; Co-Chair – AASHTO TSP2 Emulsion Task Force; Member – AASHTO RAC; TRB- State Representative

Chris Lubbers, Kraton Polymers US, LLC; Technical Sales and Market Development Manager – Emulsions; Co-Chair – AASHTO TSP2 Emulsion Task Force

Darren Hazlett, University of Texas – Center for Transportation Research; Member – AASHTO TSP2 Emulsion Task Force

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

- a) Members of the AASHTO TSP2 Emulsion Task Force
- b) Members of the AASHTO Pavement Preservation Regional Partnerships (PPP's)
- c) Members of the AASHTO COMP TS 2a and TS 5b

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Colin A Franco, RIDOT Associate Chief Engineer; Co-Chair – AASHTO TSP2 Emulsion Task Force; Member – AASHTO RAC; TRB – State Representative

NCHRP Review of D-25

Reviewed By:

Amir Hanna

ahanna@nas.edu

Comments:

A. The proposed problem does not entail research; it requests a synthesis report.

B. The topic of the synthesis report should be of interest to the majority, if not all, state DOTs.

C. The objective, as stated in the problem statement, is clear, i.e., to prepare a synthesis report on the tests and associated methods for asphalt emulsion based pavement preservation treatments..

D. The scope of the synthesis report is clearly defined,

E. The estimated duration is adequate for preparing the synthesis report.

F. The estimated budget is adequate for preparing the synthesis report.

G. No references are cited. The consultant will identify and review relevant publications.

FHWA Evaluation of D-25

Reviewed By:

Morgan Kessler/HRDI; Tim Aschenbrener/HICP-40

Comments:

Morgan Kessler - This is a good synthesis topic where the results will feed directly into other proposed and ongoing NCHRP work on emulsion-based treatments.

Tim Aschenbrener - This is written as a synthesis but submitted as a research problem statement. It does not fit this category of submittals. It should be submitted as part of the synthesis program.

Review Date:

December 17, 2021

Submitter Response for 2023-D-25

From:

[email: colin.franco@dot.ri.gov]

Comments:

I agree that this should be a synthesis project and have forwarded it to the synthesis program.

Contact Info:

see above

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT OUTLINE

Problem Number: 2023-D-26

Problem Title

Update to the AASHTO LRFD Bridge Construction Specifications

Background

In 2020, the AASHTO Committee on Bridges and Structures (COBS) completed a project that investigated the use and effectiveness of the current AASHTO LRFD Bridge Construction Specifications (BCS). This project included a questionnaire to each state to determine the use of the document, a review of the document contents, the development of a prioritized approach for reorganization and maintenance of the document, and the development of prioritized recommendations for re-writing of the document. The results of the study were as follows:

1. The questionnaire provided very good feedback. The number one takeaway is that the BCS is being used by many STAs on a regular basis. This justifies maintaining the *AASHTO LRFD Bridge Construction Specifications*.
2. The COBS may want to consider converting the document to a guide specification. There has been anecdotal evidence that contractors are using the BCS as a basis for claims against STAs, since it is considered the “National Standard Specification”.
3. Some reorganization of the sections is in order. Newer sections seem to have been simply tacked on to the end of the document. Several reorganization options were developed, each with its advantages and disadvantages.
4. Most sections in the document have very little commentary. The addition of commentary to the *AASHTO LRFD Bridge Design Specifications* had been a significant improvement over the original *Standard Specifications*. The BCS could benefit from a similar effort.
5. Many of the sections need updating to current standards and practices and reformatting to be consistent with industry and STA specifications. Some sections require more attention than others as some have been maintained by certain technical committees since adoption of the document in the late 1990s.
6. The questionnaire identified several potential new provisions that should be added to the specifications.

Literature Search Summary

There has not been a cover to cover re-write of this specification since the late 1990's when it was converted to LRFD format. That re-write did not include a section-by-section update and did not include the development of quality commentary text for each provision.

Research Objective

The purpose of this proposed research is to execute the recommendations from the first project. The goal is to bring the document up to current standards and construction practices, which will make it more useful to bridge owners. The final products will be an updated document that can be adopted by the AASHTO Committee on Bridges and Structures.

Major tasks include:

1. Review of the final report published as part of the project completed in 2021.
2. Review of each section and recommendations for addition/changes/deletions. This will require researching other specifications including industry publications, international specifications, and specifications developed by member states. This may also include engaging with industry and COBS technical committees as needed.
3. Development of draft specification language based on the research of each section. Development of a template for the sections and consistent terminology. The format shall meet the current AASHTO formatting guidelines.
4. Submission to the project panel for review and comment.
5. Address panel comments and develop the final draft document for submission to the overall COBS.
6. Address final comments from COBS and prepare the document for balloting.
7. Address any minor last-minute comments and forward the final document to AASHTO for publishing (if accepted by COBS).

The first project identified that the current is useful to bridge owners. A conversion of the document into a guide specification was recommended. The wholesale adoption of a national construction specification is not realistic; however, a guide specification can be a useful document in the development of state specific standard construction specifications. Having a national construction specification guide specification as the basis for state specifications will help to foster uniformity of construction specification across state lines.

Urgency and Potential Benefits

There is a need to provide uniformity of construction practices and specification as many contractors work across state lines. A revised AASHTO LRFD Bridge Construction Specification document will help to improve quality, durability and uniformity of bridge construction.

Implementation Considerations and Supporters

An updated AASHTO LRFD Bridge Construction Specification can be implemented through the normal AASHTO document adoption procedures. This will be a valuable tool for each state to update their own construction specifications.

Recommended Research Funding and Research Period

The funding for this work was estimated as part of the previous study. The values were developed based on a rough estimate of the amount of re-work required for each section. Some sections require minor changes, other require major re-write, and others need to be written from scratch. The estimated cost for this work was set at approximately \$800,000.

The previous project developed a prioritized rewrite schedule that addressed the most used sections first. If funding is limited, this top priority work could be completed to remain within budget.

The estimated timeframe to complete this project is 24 months.

Problem Statement Author(s)

Michael P. Culmo, P.E.
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Member of TRB Committee AKB20
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Others Supporting the Problem Statement

This project is supported and endorsed by the AASHTO Technical Committee T-4 Construction.

Cheryl Hersh Simmons, S.E.
Chair, AASHTO COBS Committee T-4 Construction
Chief Structural Engineer
Utah Department of Transportation
801-557-7846
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Carmen Swanwick, S.E.
Chair, AASHTO COBS
Project Development Director, Director of Construction
Utah Department of Transportation
801-232-7802
cswanwick@utah.gov

Potential Panel Members

Members of AASHTO COBS Technical Committee T-4
Other members of AASHTO Technical Committees

Person Submitting the Problem Statement

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Chief Structural Engineer
Utah Department of Transportation
801-557-7846
cherylhersh@utah.gov

NCHRP Review of D-26

Reviewed By:

Ahmad Abu-Hawash
aabu-hawash@nas.edu

Comments:

AASHTO specification update and development work is very appropriate research topic for NCHRP. The product of this research is implementable through collaboration with AASHTO COBS. T-4 (COBS Technical Committee on Construction), the committee responsible for bridge construction specification. T-4 initiated this problem statement after the completion of preliminary work in Phase I of a project using funds from AASHTO.

Review Date:

12/7/2021

FHWA Evaluation of D-26

Reviewed By:

Derek Soden/HIBS-10

Comments:

Of interest is the statement regarding "anecdotal evidence that contractors are using the BCS as a basis for claims against STAs" since it is considered the ?National Standard Specification?. The BCS is incorporated by reference into 23 CFR 625 and is the minimum standard for the approval of Federal Aid PS&Es. Nevertheless, a full update to current state-of-the-practice specifications would be welcomed.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for D-26

Submitted By:

Patricia Bush
AASHTO staff
Committee on Bridges & Structures

Priority #: 6

Comments:

Committee on Bridges & Structures #6 of 8.

Research Field E

SOILS AND GEOLOGY

**American Association Of State Highway And Transportation Officials
Special Committee On Research And Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-E-01

Problem Title

Development Of Machine Learning Algorithms For Geotechnical Applications And Assembly Of A Quality Database Of Deep Foundation Load Tests

Background Information And Need For Research

Machine Learning (ML) Is An Approach For Developing Empirical Relationships That Allows Computer Systems To Learn From Data Without Knowing The Laws That Govern The Phenomenon From Which The Data Were Obtained And Collected. Nowadays, With The Availability Of Previously Unseen Amounts Of Data, Cloud Storing Capabilities, And The Continuously Increasing Computing Power, ML-Based Techniques Have Become A Suitable Tool For A Number Of Applications In Many Areas, Including Geotechnical Engineering. Despite The Increasing Interest In ML Within The Engineering Community, Applications Within The Realm Of Geotechnical Engineering In NCHRP And TRR Libraries Are Scarce.

The Major Resource Needed To Develop Predicting Tools Using ML Are Data. State Departments Of Transportation (DOTs) Manage Large Amounts Of Geotechnical Data Associated With Public Infrastructure. These Data Represent An Asset For Applications Of ML To Classical Geotechnical Problems Such As The Bearing Capacity Of Deep And Shallow Foundations, Settlement Estimation, Landslide Susceptibility, Liquefaction Susceptibility, And Others. However, The Lack Of A Standard Format Or Structure Limits The Usefulness Of Those Databases. In This Regard, The Efforts Of The Data Interchange For Geotechnical And Geoenvironmental Specialists (DIGGS) Project Is Relevant Since It Provides A Standard Format To Store And Share Geotechnical Data. The DIGGS Protocols Should Be Followed For Assembling Databases. Thus, Later Development And Updates Of Statistical Regressions, Reliability-Based Calibration, And ML Applications Use The Same Basis.

Quality And Complete Deep Foundation Load Test Databases, Among Other Databases, Are Needed By Researchers In Performing Reliability-Based Calibrations And By Practitioners In Evaluating And Improving The Geotechnical Design. Datasets Regarding Deep Foundation Load Tests Are Typically Generated When Initial Site Characterization Information Is Combined With Foundation Performance Testing To Provide A Comprehensive And Complete Record Of Site Character, Predicted Performance, And Measured Performance Of Foundation Systems. Complete Load Testing Datasets Include Three Types Of Information: (1) Soil/Rock Information (Geotechnical Site Characterization Data, Foundation Design Parameters, SPT Hammer Energy, Sample Extraction, And Lab Testing, CPT, DMT, PMT, Etc.). (2) Test Foundation Information (Location, Layout, Dimensions, Type, Construction And

Installation Information, And Quality Control); And (3) Load Testing Information: Test Procedure, Duration, Rates Of Loading, Test Data, And Results)

Literature Search Summary

Artificial Intelligence (AI) And Machine Learning (ML) Techniques Have Been Used In A Number Of Disciplines Within Science, Engineering, Economics, And In Many Topics Of Public Interest, Such As Healthcare, Transportation, And Finance. Several Applications Of ML To Classical Geotechnical Problems Such As Bearing Capacity Prediction, Settlement Estimation, The Load-Settlement Response Of Pile Foundations, Liquefaction Susceptibility, And Landslide Susceptibility Can Be Found In The Literature.

Three Factors Have Helped Lead To The Growing Popularity Of AI And ML: (1) Availability Of Data, (2) Increases In Computer Power, And (3) Maturity Of The Algorithms Used To Process The Data. ML Toolboxes And User-Friendly Software Are Now Available To Engineers To Train Their Own Models And Make Predictions From Their Collected Data. Numerous ML Techniques Have Been Developed In The Past Several Decades, Theoretically And Practically. Among All These Techniques, Tree-Based Methods, ANN, And Svms Have Been Used For Studying Geotechnical Engineering Problems. Several Applications And Reviews About ML In Geotechnical Engineering Can Be Found In The Following List:

Aguilar, V., Wu, H., & Montgomery, J. (2020). Machine Learning In Foundation Design And More. TRB Centennial Circular, 103.

Ahmed, A., S. Khan, S. Hossain, T. Sadigov, And P. Bhandari. Safety Prediction Model For Reinforced Highway Slope Using A Machine Learning Method. Transportation Research Record. <https://doi.org/10.1177/0361198120924415>.

Breiman, L., J. H. Friedman, R. A. Olshen, And C. J. Stone. Classification And Regression Trees. Belmont, CA: Wadsworth. International Group, Vol. 432, 1984, Pp. 151–166.

Goetz, J. N., A. Brenning, H. Petschko, And P. Leopold. Evaluating Machine Learning And Statistical Prediction Techniques For Landslide Susceptibility Modeling. Computers & Geosciences, Vol. 81, 2015, Pp. 1–11. <https://doi.org/10.1016/j.cageo.2015.04.007>.

Goh, A. T. C., And S. H. Goh. Support Vector Machines: Their Use In Geotechnical Engineering As Illustrated Using Seismic Liquefaction Data. Computers And Geotechnics, Vol. 34, No. 5, 2007, Pp. 410–421. <https://doi.org/10.1016/j.compgeo.2007.06.001>.

Harandizadeh, H., M. M. Toufigh, And V. Toufigh. Different Neural Networks And Modal Tree Method For Predicting Ultimate Bearing Capacity Of Piles. 2018, P. 18.

Khan, S. Z., S. Suman, M. Pavani, And S. K. Das. Prediction Of The Residual Strength Of Clay Using Functional Networks. *Geoscience Frontiers*, Vol. 7, No. 1, 2016, Pp. 67–74. <https://doi.org/10.1016/j.gsf.2014.12.008>.

Kordjazi, A., F. P. Nejad, And M. B. Jaksa. Prediction Of Load-Carrying Capacity Of Piles Using A Support Vector Machine And Improved Data Collection. 2016, P. 9.

Kordjazi, A., F. Pooya Nejad, And M. B. Jaksa. Prediction Of Ultimate Axial Load-Carrying Capacity Of Piles Using A Support Vector Machine Based On CPT Data. *Computers And Geotechnics*, Vol. 55, 2014, Pp. 91–102. <https://doi.org/10.1016/j.compgeo.2013.08.001>.

Momeni, E., R. Nazir, D. Jahed Armaghani, And H. Maizir. Application Of Artificial Neural Network For Predicting Shaft And Tip Resistances Of Concrete Piles. *Earth Sciences Research Journal*, Vol. 19, No. 1, 2015, Pp. 85–93. <https://doi.org/10.15446/esrj.v19n1.38712>.

Samui, P. Support Vector Machine Applied To Settlement Of Shallow Foundations On Cohesionless Soils. *Computers And Geotechnics*, Vol. 35, No. 3, 2008, Pp. 419–427. <https://doi.org/10.1016/j.compgeo.2007.06.014>.

Samui, P. Vector Machine Techniques For Modeling Of Seismic Liquefaction Data. *Ain Shams Engineering Journal*, Vol. 5, No. 2, 2014, Pp. 355–360. <https://doi.org/10.1016/j.asej.2013.12.004>.

Shahin, M. A. Load–Settlement Modeling Of Axially Loaded Steel Driven Piles Using CPT-Based Recurrent Neural Networks. *Soils And Foundations*, Vol. 54, No. 3, 2014, Pp. 515–522. <https://doi.org/10.1016/j.sandf.2014.04.015>.

Shahin, M. A. State-Of-The-Art Review Of Some Artificial Intelligence Applications In Pile Foundations. *Geoscience Frontiers*, Vol. 7, No. 1, 2016, Pp. 33–44. <https://doi.org/10.1016/j.gsf.2014.10.002>.

Song, Y.-Y., And L. U. Ying. Decision Tree Methods: Applications For Classification And Prediction. *Shanghai Archives Of Psychiatry*, Vol. 27, No. 2, 2015, P. 130.

Tarawneh, B. Pipe Pile Setup: Database And Prediction Model Using Artificial Neural Network. *Soils And Foundations*, Vol. 53, No. 4, 2013, Pp. 607–615. <https://doi.org/10.1016/j.sandf.2013.06.011>.

Tarawneh, B. Predicting Standard Penetration Test N-Value From Cone Penetration Test Data Using Artificial Neural Networks. *Geoscience Frontiers*, Vol. 8, No. 1, 2017, Pp. 199–204. <https://doi.org/10.1016/j.gsf.2016.02.003>.

The Federal Highway Administration (FHWA) Has Led The Development Of The Deep Foundation Load Test Database (DLFTD) (Version 1.0 2007) That Led The Development Of The First Generation Of AASHTO LRFD Factors In The NCHRP

Report 507. In 2017, The FHWA Released The Updated FHWA Deep Foundation Load Test Database (DFLTD V.2). The DFLTD V.2 Replaces The Previous DFLTD (V.1) And Also Adds New Information On Over 150 Load Tests On Large Diameter Open-End Piles. In Addition, Several State Dots And Researchers Have Developed And Are Now Developing Their Own Foundation Load Test Databases (E.G., Florida, Iowa, Louisiana, California, Nevada ([Https://Trid.Trb.Org/View/1393456](https://Trid.Trb.Org/View/1393456)), New Mexico And Illinois,).

Additional Research Efforts Include:

Load And Resistance Factor Design (LRFD) Pile Driving Project -Phase Two Study (Paikowsky Et Al. 2014).

Developing A Resistance Factor For Mn/DOT's Pile Driving Formula, (S. Paikowsky Et Al. 2009)

Capacities And Resistance Factors For Driven Piling In Illinois, (J. Long, A. Anderson, W. Kramer, 2014)

Improved Design For Driven Piles Based On A Pile Load Test Program In Illinois: Phase 2, (J. Long, A. Anderson, 2014)

Application Of LRFD Geotechnical Principles For Pile Supported Bridges In Oregon: PHASE 1, Final Report, OTREC-TT-09-0, (Trevor D. Smith, Peter Dusicka, Portland State University, 2009)

Updating Florida Department Of Transportation's (FDOT) Pile/Shaft Design Procedures Based On CPT & DTP Data, (D. Bloomquist, M. Mcvay, Zhihong Hu, 2007)
Published 2007

Improving Agreement Between Static Method And Dynamic Formula For Driven Cast-In-Place Piles In Wisconsin, (J. Long, 2013)

Evaluation Of FHWA Pile Design Method Against The FHWA Deep Foundation Load Test Database Version 2.0, (Nikolaos Machairas, Gregory A. Highley, M. Iskander, 2018), Transportation Research Record.

Databases For Other Subjects Are To Be Explored By Surveying Academia, State Dots, Practitioners And Consultants, Federal And Local Agencies. The International Society For Soil Mechanics And Geotechnical Engineering Lists Publicly Available Databases (See [Https://Www.Issmge.Org/Committees/Technical-Committees/Impact-On-Society/Risk](https://www.Issmge.Org/Committees/Technical-Committees/Impact-On-Society/Risk)).

Research Objective

The Objective Of This Research Is To Collect And Assemble Quality And Complete National And/Or Regional Axial Load Test Databases In The USA For Small And Large Diameter Deep Foundations (Driven Piles And Drilled Shafts) From The State

Departments Of Transportation, The Federal Highway Administration, And Other Sources. This Effort Should Be In Agreement With The Finalization Of The DIGGS Protocol For Load Test Data Entry.

The Databases Will Be Used For Developing Software That Uses Artificial Neural Networks, Support-Vector Machines, Random Forests, And Other ML-Based Techniques That The Research Team Sees Fit For Predicting Deep Foundation Axial Capacity. Additionally, A Wide Search For Available Geotechnical Databases Should Be Performed, And ML-Based Algorithms Should Be Developed For Classical Geotechnical Applications.

Specific Tasks Of The Research To Accomplish The Main Objective Include:

- Task 1. Survey Of State Dots For Deep Foundation Load Testing Information
- Task 2. Identify And Locate Other Deep Foundation Load Testing Sources
- Task 3. Prove Recommendations For The Completion Of The DIGGS Protocol For Load Test Data
- Task 4. Develop A Criterion For Completeness And Accuracy Such That The Load Tests Can Be Classified On These Quality Measures
- Task 5. Assemble A Quality And Complete Database Which Contains The Load Tests Collected In Task1 And Task 3, Which Meet The Criterion Developed In Task 4.
- Task 6. Characterize And Summarize The Information From The Quality And Complete Load Tests Assembled In The Previous Tasks.
- Task 7. Develop Software That Uses ML Algorithms For Predicting Deep Foundation Axial Capacity (For Instance:
Artificial Neural Networks, Support-Vector Machines, Random Forests, Bayesian ML, And Other ML-Based Techniques That The Research Team Sees Fit)
- Task 8. Explore Among State Dots And Other Sources For Databases That Can Be Assembled To Study Relevant Geotechnical Problems.
- Task 9. Develop And Train ML Algorithms Applicable To The Data Collected In Task 8.

Urgency And Potential Benefits

There Is Knowledge And Technology With Tremendous Potential That The Discipline Is Not Currently Taken Advantage Of. ML Can Help Solve Complex Problems In Geotechnical Engineering, As Well As Provide Engineers With New Tools For The Design And Evaluation Of Foundations.

Furthermore, Relatively Few Reliability-Based Resistance Factors For Deep Foundations Have Been Developed By AASHTO And State Dots. This Is Likely Due To The Expense Associated With A Comprehensive Load Testing Program Or A Lack Of Data. Therefore, A Quality And Complete Database Is Most Warranted.

Quality And Complete Databases Would Allow For The Development Of ML Algorithms And Reliability-Based Calibrations, Which Ultimately Lead To Efficient And Safe Geotechnical And Foundation Designs.

Implementation Considerations

The Research Can Be Implemented Through Collaboration Between National And State Transportation Agencies (AASHTO, FHWA, State Dots) And Professional Organizations (ASCE, DFI, ADSC, And PDCA) To Aid In The Expansion Of The Database With Additional Datasets And To Explore For New Relevant Databases.

As Currently, ML Algorithms Are Not In Use By Public Agencies Nor Practitioners, The Implementation Of The Research Results, As New Tools For Analysis Or Design Based On ML, Might Require Application Examples To Facilitate The Transition To These New Modern Alternatives.

List The AASHTO Committee(S) And/Or Council(S) – And Any Other Organization – That Might Be Interested In The Research Results And Could Help Support Implementation.

- Organization, Contact Person, Phone Number And Email Address

TRB Committee On Foundation Of Bridges And Other Structures, (AKG 70)
 TRB Committee On Geotechnical Instrumentation And Modeling Committee, (AKG60)
 TRB Committee On Soil And Rock Properties And Site Characterization Committee, (AKG20)
 California Department Of Transportation (Caltrans)

Recommended Research Funding And Research Period

Research Funding Recommended Funding For The Project Is \$600,000.-

Research Period: It Is Estimated That 36 Months Will Be Required To Perform The Research.

Problem Statement Author(S): For Each Author, Provide Their Name, Affiliation, Email Address And Phone.

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Potential Panel Members: For Each Panel Member, Provide Their Name, Affiliation, Email Address And Phone.

- Organization, Contact Person, Phone, And Email Address

If This Problem Statement Is Submitted By An AASHTO Committee Or Council, Please Recommend Committee Or Council Members As Potential Panel Members.

- Member Name, State, AASHTO Committee Or Council, Phone, And Email Address

Person Submitting The Problem Statement: Name, Affiliation, Email Address And Phone.

Provide Contact Information For The Individual Submitting This Problem Statement.

- Name Of Individual : Sharid K. Amiri
 - Phone Number : (949)-371-3817
 - Email Address: Sharid.Amiri@Dot.Ca.Gov
 - Affiliation : California Department Of Transportation (Caltrans)
-

NCHRP Review of E-01

Reviewed By:

Ahmad Abu-Hawash
aabu-hawash@nas.edu

Comments:

How will the final product be used by practitioners? Will there be a ready to use tool at the end of this project? The problem statement is focused on the development of the machine learning algorithms and the assembly of databases of deep foundation load tests which are important steps. However, to help with implementation, how the new analysis and design tools will be developed should be explained.

Implementation will require collaboration with the relevant AASHTO committees, however, the submitter did not list any endorsements from AASHTO committee members. Proposed budget for \$600,000 seems high.

Review Date:

12/7/2021

FHWA Evaluation of E-01

Reviewed By:

S.Nichols/HIBS-20

Comments:

ML and AI is certainly a direction that research should be headed, however it is unclear as to how all of this fits together. Diggs does not require a centralized database, and moving all available datasets to one location does not seem to be a good use of research funding. Also, protocols for collection and presentation of data exist, and mapping for performance tests has been previously completed by FHWA. This isn't a high priority.

Review Date:

December 17, 2021

**American Association Of State Highway And Transportation Officials
Special Committee On Research And Innovation****FY2023 NCHRP PROBLEM STATEMENT TEMPLATE****Problem Number: 2023-E-02****Problem Title**

Hydrologic-Based Design Guidance for Selecting, Sizing, and Placing Temporary Erosion and Sediment Control Practices used in Highway Construction

Background

In 1972, the Clean Water Act (CWA) set forth expectations to enhance the waters of the U.S. by regulating discharges of pollutants (1). On the eve of the 50th anniversary of the CWA, stormwater quality management continues to be a high priority across agricultural, urban, and construction sectors (2). In its inaugural inclusion, the stormwater infrastructure category received a letter grade of “D” in the 2021 Report Card for America’s Infrastructure, highlighting below standard conditions (3). The USEPA lists sediment as the second highest cause of impairments to our nation’s rivers and streams (4). Construction operations are regulated through the National Pollutant Discharge Elimination System (NPDES) of the Clean Water Act (CWA). Regulations require construction operators file for a Construction General Permit (CGP) and develop Stormwater Pollution Prevention Plans (SWPPP) and implement temporary erosion and sediment control (E&SC) practices during land disturbing activities to minimize the transport and discharge of sediment that may impact downstream waterbodies. E&SC is a considerable cost that has been estimated to be as high as 8% of the total budget for highway construction projects (5). Several state DOTs have recently faced penalties, fines, and legal actions due to inadequate design and implementation of SWPPPs on highway projects. This is in part due to lacking engineering-based design guidance for proper selection, sizing, placement, and maintenance of E&SC practices.

To appropriately determine the selection, sizing, and placement of E&SC practices, designers should consider expected runoff rate, volume, and sediment loads based on site-specific design storm characteristics and hydrologic soil conditions. However, the existing technical resources required for the successful development of SWPPPs lack engineering-based design guidance. The development of a project specific SWPPP is often described as an “art”, with engineers relying on “rules of thumb” for the design and selection of E&SC practices. Without an adequate hydrologic assessment, temporary E&SC practices sometimes fail because stormwater volumes and flow rates are higher than the installed practice or product was originally intended to treat. Conversely, many E&SC practices are overdesigned for the actual encountered runoff or specified for placement in locations and in a manner that creates inefficiencies and unnecessary additional cost. This proposed project would seek to provide an optimized approach for temporary E&SCs to meet the performance expectations of the USEPA or state CGPs by developing hydrologic-based

engineering guidance on the design, selection, and placement of E&SC practices. Design-based guidance will lead to more effective and efficient SWPPPs, leading to improvements in the water quality of our navigable waterways and result in considerable cost savings for FHWA, state DOTs, and taxpayers.

Literature Search Summary

The USEPA CGP specifies that the operator of a construction site must account for three factors in designing stormwater controls: (1) expected amount, frequency, intensity, and duration of precipitation; (2) nature of stormwater runoff and run-on at the site, and (3) soils and range of soil particle sizes expected to be present. All three factors are related to hydrologic-based design guidance. However, limited guidance is given on how to determine, quantify, or consider these three factors. Most DOTs and state and federal environmental protection agencies have developed guidance for the implementation of E&SC practices. However, few of these guides provide hydrologic-based design standards for engineers to follow when developing SWPPPs during the design process.

The only mention of a hydrologic-based design within the USEPA CGP is with regards to sediment basins which call for one of two sizing options: (1) volumetric storage of the 2-yr, 24-hr design storm, or (2) volumetric storage based on 3,600 ft³ per contributing acre (or roughly 1 in. of runoff per acre). While both design approaches are acceptable by the CGP, they lead to vastly different sediment basin sizes depending on a site's precipitation and soil conditions. For example, a sediment basin designed in Alabama using the 2-yr, 24-hr design approach would result in a storage capacity of over three times that of one designed using the 3,600 ft³/ac "rule of thumb".

Often, temporary E&SC practices are the final step in design during the development of construction plans. This sometimes leads to inadequate right of way acquisition, and conflicts where proper consideration has not been given to how these practices will interact with other features on the jobsite. For example, sediment basins are often placed within detention basins that are intended to serve as a post-construction stormwater application. However, proper modifications to the designed outlet control structure are typically not considered to provide the appropriate detention time required to capture suspended construction-generated sediment through the process of sedimentation, and to consider the probability and risk of overflow through an auxiliary spillway that discharge highly turbid runoff with other pollutants.

In another example, the USEPA CGP recommends storm drain inlet protection be limited to drainage areas of no more than one acre. Since the precipitation quantity for a 2-yr, 24-hr design storm event varies drastically across the country, there is no one-size-fits-all approach. For example, in the state of California alone, the 2-yr, 24-hr design storm event can vary in precipitation from 0.6 in. to 9.0 in. (6). This vast irregularity in precipitation quantity subjects various E&SC practices to a wide range of runoff volumes and flow rates. Furthermore, soil conditions vary vastly throughout the country in physical and chemical composition, leading to a range of erosion

potentials. Soil grain size distribution can create disparity in suspended sediment concentrations and settling times from site to site and within a single site.

Often claims of E&SC product performance are based on manufacturer's assertions or simple field observations where installed practices or products are monitored over time and during naturally occurring rain events. However, recent advances in full-scale testing of E&SC practices have provided knowledge on the performance and limitations of common practices that can be used towards the development of effective design guidance.

Research Objective

The primary objective of this proposed project is the development of a comprehensive hydrologic-based guide or set of standards to use in the design of temporary E&SC practices used in highway construction. The project will identify and evaluate appropriate hydrologic approaches, as well as develop guidance on the selection, sizing, placement, and maintenance of non-proprietary practices commonly used in SWPPPs. Researchers will examine the applicability of a variety of hydrologic design approaches such as (1) Soil Conservation Service design storm approach, (2) rational method, (3) risk-based analyses, and (4) percentile storm event and determine potentially effectiveness and drawbacks for implementation in SWPPP designs. This will allow highway agencies to better understand design-based methods intended to be used for SWPPP development. Below is a list of tasks that could be included in the research.

Task 1: Literature Review and State-of-the-Practice Survey. Complete a literature review and survey to identify current design standards being used nationally and internationally and identify most commonly used E&SC practices that would benefit from hydrologic-based design standards. The findings of the literature review and survey will serve as the basis for the subsequent tasks in the research.

Task 2: Identify and Assess Hydrologic-Based Design Approaches. Develop a list of hydrologic design approaches and develop a matrix for selecting the most appropriate methodology to use in the design of E&SC practices. Selection should be based on the needs identified in Task 1, along with consideration for DOT implementation. Method(s) should complement those used during the design of other stormwater features on a highway project.

Task 3: Develop Design Guidance for Common E&SC Practices and Prepare Case Study. The research team will apply the findings from Task 2 to develop detailed design approaches for the most common E&SC practices (informed by Task 1). At a minimum, design guidance should be prepared for sediment barriers, sediment basins, check dams, inlet protection, diversion berms, and slope drains. To demonstrate application of the developed guidance, the researchers should employ the developed design guidance towards the development of SWPPP case studies for a highway construction sites.

Task 4: Final Report and Outreach. Prepare a final report that includes recommendations for implementing developed design guidance. Publish the final report and provide a list of recommended future studies or recommended research

needed to further advance DOTs towards meeting E&SC related water quality standards in highway runoff. The research team will provide outreach and education on the implementation of the developed design resources. This will include at a minimum, a 2 to 4 hr prerecorded webinar and presentation at the Annual TRB meeting

Urgency and Potential Benefits

The urgency for this project has been increased in recent years as environmental commitments have become increasingly important in the work and missions of state DOTs. The stringency of federal and state stormwater regulations continues to grow, alongside environmental stewardship expectations from the general public. This research will provide DOTs with the tools to utilize construction stormwater program resources in a cost-efficient manner by implementing better design approaches upfront, which will ultimately reduce ineffective E&SC practices and minimize maintenance needs over the life of a highway construction project.

Implementation Considerations and Supporters

AASHTO Committee on Design has endorsed this research. AASHTO Technical Committee on Hydrology and Hydraulics (TCHH) also recommends this research. Research results will be used by a variety of individuals within state DOTs including project designers, stormwater coordinators, SWPPP inspectors, and contractors working to complete construction projects. Results of this work are expected to be immediately implementable and will allow DOTs to advance E&SC design guides and resources. Proposed Tasks 3 and 4 will include case studies and outreach materials to facilitate the implementation of research results. The AASHTO committee on Environment and Sustainability would be interested in research results and could help support implementation. Others supporting the problem statement include TRB Standing Committee on Hydrology, Hydraulics, and Stormwater (AKD50), International Erosion Control Association, Standards and Practices Committee

Recommended Research Funding and Research Period

Recommended Funding: \$500,000, Research Period: 36 Months

Problem Statement Author(s)

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Potential Panel Members

Steve Sisson, P.E., Delaware Department of Transportation, AASHTO TCHH, Phone (302) 760-2553 Steven.Sisson@delaware.gov

Jeff Syar, P.E., Ohio Department of Transportation, Office of Hydraulic Engineering Administrator, AASHTO TCHH, Phone (614) 275-1373 Jeffrey.Syar@dot.ohio.gov

Person Submitting the Problem Statement

Brad McManus, P.E. State Roadway Hydraulics Engineer, Georgia Department of Transportation, AASHTO Committee on Design, Technical Committee on Hydrology and Hydraulics. Phone 470 848 2358, bmcmanus@dot.ga.gov

References

1. U.S. Congress. Clean Water Act. Federal Pollution Control Act. Washington, D.C., 1972, p. 33 U.S.C. 1251.
2. Nayebar, S. R., L. R. Wilson, D. O. Carpenter, D. M. Dziewulski, and K. Kannan. A Review of Potable Water Accessibility and Sustainability Issues in Developing Countries - Case Study of Uganda. *Reviews on Environmental Health*, Vol. 29, No. 4, 2014, pp. 363–378. <https://doi.org/10.1515/reveh-2013-0019>.
3. American Society of Civil Engineers. *Report Card for America's Infrastructure*. Washington, D.C., 2021.
4. United States Environmental Protection Agency. National Summary Tables and Charts for Available Water Quality Data Reported by the States to EPA under Section 305(b) and 303(d) of the Clean Water Act. https://ofmpub.epa.gov/waters10/attains_nation_cy.control. Accessed Jun. 14, 2021.
5. Mitchell, G. F., T. Guo, and N. Igiz. How Much Does Erosion and Sediment Control for DOT Projects Cost? *Stormwater*. <https://www.stormh2o.com/erosion-control/article/13001956/how-much-does-erosion-and-sediment-control-for-dot-projects-cost>. Accessed Jun. 21, 2021.
6. National Oceanic and Atmospheric Administration's National Weather Service. NOAA Atlas 14 Precipitation Frequency Estimates in GIS Compatible Format.

NCHRP Review of E-02

Reviewed By:

Ahmad Abu-Hawash
aabu-hawash@nas.edu

Comments:

Erosion and sediment control on highway construction projects is relevant and of interest to all state DOTs. Product of this research is implementable through collaboration with the relevant AASHTO committees. This research is suitable for NCHRP.

Review Date:

12/7/2021

FHWA Evaluation of E-02

Reviewed By:
JSKrolak/HIBS-20

Comments:

Erosion is a result of forces exerted on the soil. Not sure this RNS captures this element well.

Review Date: December 17, 2021

AASHTO Committee Evaluation for E-02

Submitted By:
Patricia Bush
AASHTO staff
Committee on Design

Priority #: N/A

Comments:

Endorsed by the Committee on Design.

Submitter Response for 2023-E-02

From:
[email: bmcmanus@dot.ga.gov]
I appreciate Ahmad Abu-Hawash statement of support and we agree with Joe Krolak's comments on the problem statement. Below is the form for responses to Joe's comments on problem statement 2023-E-02. Also included is our recommendation for modifying the problem statement to address Joe's comments.

Comments:
In response to Joe Krolak's comments from his December 17th 2021 review:
Erosion is certainly a result of forces exerted on soil. Construction activities are prone to higher rates of erosion during periods of land disturbances where poor vegetative cover is in place to protect exposed soil. Forces that affect erosion on construction sites may be from rainfall (splash erosion), runoff (exceeding allowable shear forces), and from wind (saltation and creep). This proposed research aims to develop sizing and selection guidance for practices that are used on construction sites. Researchers will develop guidance that will allow designers to use site-specific parameters (i.e., climate, design storms, soils, etc.) in their approach to adequately account for forces exerted on soil and protect it from eroding.

Recommended change to the 2023-E-02 problem statement: Please add the following text to the beginning of the second paragraph under section 2. Background:

Erosion is a result of forces exerted on soil. Construction activities are prone to higher rates of erosion during periods of land disturbances where poor vegetative cover is in place to protect exposed soil. Forces that affect erosion on construction sites may be from rainfall (splash erosion), runoff (exceeding allowable shear forces), and from wind (saltation and creep).

I appreciate Ahmad Abu-Hawash statement of support and we agree with Joe Krolak's comments on the problem statement. Below is the form for responses to Joe's comments on problem statement 2023-E-02. Also included is our recommendation for modifying the problem statement to address Joe's comments.

Contact Info:

Brad McManus
600 W. Peachtree Street, Atlanta, GA 30308
Phone: 470 848 2358

Review Date:

Brad's response December 30, 2021 to comments made on December 17th 2021

Research Field F

MAINTENANCE

Withdrawn by submitter**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation****FY2023 NCHRP PROBLEM STATEMENT TEMPLATE****Problem Number: 2023-F-01****Problem Title**

Protecting Bridge Approaches during Flooding Events

Background Information and Need For Research

Flooding can cause significant damage to bridge structures and has for many years been associated with coastal areas as a result of hurricanes and cyclones. Recent trends have shown an increase in both the frequency and the intensity of storms worldwide. At the Southeast Bridge Preservation Partnership meeting, Texas reported on 6 major flooding events in 13 months. Other states, including Louisiana, Georgia, West Virginia and Florida also reported on flood impacts on their structures. Significant flooding events have been reported in North and South Carolina, New York, New Jersey, California and in many Midwest states. Many PowerPoint slides from the Southeast states meeting showed the piers and abutments in place but the bridge approaches washed away. This damage triggers significant societal safety and financial difficulties in terms of road closure-user delay, disabling emergency responders during and immediately after the event, costly repairs, and economic trauma. While this repair is less costly than a bridge replacement, it is often handled by state work force working 24-7 to reopen the bridge. This approach becomes unsustainable if many structures are affected by the same storm event, or if several events happen in a short period of time.

This research will suggest methods and designs that could protect the approaches of structures from damage during flood events. How would we design and construct a bridge that we could not allow to fail in flooding? No doubt the answer to this question would be cost-prohibitive to use on all structures, but it may point to methods that could be used by bridge designers to greatly reduce this type of flood damage while being practical and cost effective.

This project would support the asset management (10-year risk-based asset management plan) and research strategic focus areas of the Maintenance Committee Bridge Technical Working Group.

Literature Search Summary

An abbreviated literature review using TRID was conducted using keywords “bridge approach flood failure.” The majority of the responses related to scour at the bridge piers. Three related items were returned:

1. "Reducing Flood Vulnerability of Communities with Limited Road Access by Optimizing Bridge Elevation" is funded by Research and Innovative Technology Administration, University Transportation Centers Program. FHWA-DTRT13-G-UTC38 448. The work is focused around a bridge failure in Colorado that resulted in residents of a small town being airlifted out of the flood zone. It speaks to using limited access as a design criterion.
2. Greenlee, Neil T., "Design/build Replacement of Beaufort & Morehead Railroad Trestle over Newport River, Morehead City, N.C." AREMA proceedings of 2000 Annual conference, Dallas, Texas. This paper indicated that the western approach was raised 4 feet to be above the 100-yr flood.
3. Cruikshank, J, "Seven-A-Side", Highways, Volume 62, pp 18-20. This article outlined multiple approaches for very poor soils at the second Severn crossing. Are there designs or remediation other than raising the elevation of the bridges and the approaches that can protect the approach area and reduce the amount of approach reconstruction following flooding?

Research Objective

This research will suggest methods and designs that could protect the approaches of structures from damage during flood events. It is anticipated that the research will provide agencies with several methods to improve the robustness of their bridge approaches with regard to flooding. The work will include case studies and may include modeling results to support the recommended approaches. Relative costs will be provided so that agencies can weigh the cost of the treatment against the vulnerability of flood damage and the importance of the route.

The following tasks should be included in the work:

1. Literature search regarding damage to approaches during flooding, design methods for bridge approaches, models of the process of bridge approach wash-out, known methods of preventing bridge approach failure during flooding.
2. Identify the features required to assure that approach failure would be at the same level of risk as the structure. Identify benefit-costs associated with this "structure risk" design. Identify how to quantify benefits of protected approaches.
3. Identify modifications to current designs that would reduce the risk of approach wash-out and estimate benefit-costs for each approach. Relate the risk levels to current hydraulic risk assessments such as the 10, 50, 100 or 500 year storm event. Select the three most promising modifications.
4. Identify agencies that are using any of the most promising modifications or designs. Describe their experience and performance in case studies. Include relative benefit-costs.
5. If a model exists for approach slab washouts during flooding, model the three most promising modifications using real bridge data collected in task 4 above. Suggest further modifications that could improve performance. If actual flooding has occurred, report the structures performance.
6. Prepare final report outlining all work, the most promising methods of preventing bridge approach washout, the relative benefit-costs and performance estimates, and recommendations for implementation.

Urgency and Potential Benefits

Tools to assist states in maintaining their bridges in working condition following flood events are increasingly needed. The recent flooding over a broad area of Texas, and Superstorm Sandy in New York, demonstrate the occurrence of extreme events and the costs. It is not anticipated that the tools developed in this project would be applied to every structure but would be applied to critical structures and to structures leading to towns with limited road access.

Implementation Considerations

This research will aid agencies in improving the resilience of their structures. With the MAP21 10-year risk-based asset management plan, states and local agencies who own or maintain bridge structures will need methods to mitigate damage from adverse weather.

If the research is successful, it would be presented in a variety of forums including Transportation Research Board annual meeting, AASHTO Committee on Maintenance, TSP2 regional bridge partnerships, and the National Association of County Engineers.

Recommended Research Funding and Research Period

Recommended Funding: \$300,000

Research Period: 24 months

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Judith Corley-Lay, Ph.D., PE
Retired Director, National Center for Pavement Preservation
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Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

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NCHRP Review of F-01

Reviewed By:

Ahmad Abu-Hawash
aabu-hawash@nas.edu

Comments:

This research is of interest to many state DOTs as extreme weather events and flooding are becoming more frequent and is suitable for NCHRP. Product of this research is implementable through collaboration with the relevant AASHTO committees and regional and local agencies. Proposed budget of \$300,000 is appropriate for this work.

Review Date:

12/7/2021

FHWA Evaluation of F-01 Reviewed By: JSKrolak/HIBS-20 Comments: AASHTO and FHWA have a great deal of existing information on such practices. Suggest using those. Also, this seems as a synthesis rather than a research issue. Review Date: December 17, 2021

Withdrawn - Submitter Response for 2023-F-01

From: [email: Kathy.ahlenius@wyo.gov]

Comments: At the request of the AASHTO Committee on Maintenance Bridge TWG, please pull this problem statement from consideration.

Contact Info: Kathy Ahlenius
kathy.ahlenius@wyo.gov
307.777.4264

Review Date: 8Feb22

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-F-02

Problem Title

Validating and communicating the long-term effects of aging Government Fleet Asset

Background Information and Need For Research

Agencies are often faced with difficult decisions on how to prioritize transportation investments, State DOT Fleet managers need to get better at communicating the business case to replace Fleet Assets on time. Fleet managers are facing enormous challenges as government budgets get tighter due to stagnant or decreasing tax revenue. As budgets decrease and decisions are made to extend the life of fleet assets, it is more important than ever to efficiently communicate the long-term effects of that decision. When vehicles age, more maintenance issues arise resulting in higher annual operating costs and lower operational availability. Vehicle and equipment downtime are a monetary and safety issue, especially if vehicles and equipment cannot respond to an emergency.

With capital fleet budgets and maintenance budgets typically separate, the relationship between the two are normally overlooked. In certain circumstances, these budgets may be monitored by different managers. Therefore, it is not always obvious or easily presentable that retaining a vehicle over a long period of time may be a costly decision.

Retaining equipment beyond the optimal replacement period will drive up maintenance costs and increase downtime. This will result in a need to increase agency funding for fleet operations and potentially lowering of the level of service provided by the agency as fleet availability is reduced.

Determining the increased cost of delayed equipment replacement and communicating that impact to agency managers will better equip decision makers with the information necessary to prioritize agency needs appropriately.

This research supports a key focus area of the Maintenance Committee regarding Asset Management and Safety. Vehicle and equipment downtime is a monetary and safety issue, especially if vehicles and equipment cannot respond to an emergency. This research will be used to effectively communicate the impacts of investment decisions related to Fleet Assets.

Literature Search Summary

A comprehensive literature review was conducted on aging fleet and transportation asset management and Life Cycle Cost Analysis (LCCA). The search yielded several significant references. These references can be grouped into three general categories:

current decision on whether to replace or repair, a guide for long range plans and budgets for replacement, and how to optimize equipment life cycles. For example, Category 1 has a project titled, "Guideline for Decision-Making for Repair vs. Replacement of Highway Maintenance Equipment" which will investigate the present. Category 2 will aim towards the future and Category 3 will investigate optimized equipment life cycles. The existing literature does not contain an easy method of validating and communicating the effects of aging government fleet or transportation assets, nor does it have a budget presentation that includes references to research and data from experts on aging fleet or transportation assets. The existing literature does not have a ready and easy to use tool to effectively communicate the long-term effects.

Research Objective

The objective of this research to provide references to estimate the cost of delayed replacement of DOT Fleet Assets beyond the optimal replacement period and to develop a presentation "plug and play" template to effectively communicate the long-term effects of aging the Fleet Assets. The presentation should include references to research and data from experts that effectively estimate the long-term effects of aging fleet assets. In addition, the presentation shall include at least the following components:

- A "plug and play" PowerPoint template which includes auto fill boxes linked to other documents such as:
 - o Budget Needs
 - o Age of Fleet
 - o Cost to Defer
 - o Link to Research Literature explaining pros and cons of deferring replacement of Fleet Assets
- Training and written guide on presentation and use of PowerPoint template to support management and budgeting decision making and communication with stakeholders.
- Identification of fleet and equipment performance measures that may be used to communicate impacts of aging Fleet Assets
- Guidance for data collection to show cost impacts of deferring Fleet Assets
- Adaptable to communicate long-term aging of non-fleet assets as well

Urgency and Potential Benefits

State DOTs are faced with difficult decisions prioritizing transportation investments. Without an effective communication tool, fleet assets may not get funded. With an effective communication tool, leadership will be provided with the information necessary to maximize available funding and properly prioritize fleet funding among the long list of agency needs.

As capital budgets decrease and decisions are made to extend the life of fleet assets, it is more important than ever to efficiently communicate the long-term monetary effects of those decisions.

Benefits may include:

- Increase in funding for fleet assets
- Lower overall fleet costs
- Increased reliability and safety
- Better communication and understanding of long-term impacts without funding

Implementation Considerations

Fleet Managers, Governmental and Administrative leaders, making transportation funding investment decisions, will likely be responsible for using the research results.

With a “plug and play” tool, implementation would be straight forward provided state DOTs track data elements such as costs, lifecycles and budgets.

To support implementation, training workshops and presentations could take place during the Committee on Maintenance along with regional and national Equipment Management Technical Services Program meetings.

Any AASHTO Committee dealing with asset management could use this tool to better communicate the condition of their assets and the long-term effects of deferring maintenance or replacement. Instead of inserting Fleet Asset Data, you could use Bridge, Pavement or any other asset data.

Recommended Research Funding and Research Period

Research Funding: Estimated \$200,000

Research Period. 18 months

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Greg Hansen Retired WSDOT Fleet Administrator

Doug Burke ODOT Transportation Engineer 614-351-2836 Doug.Burke@dot.ohio.gov

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Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

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Tim Cunningham KDOT Equipment Engineer 785-296-3853 tim.cunningham@ks.gov

Dennis Halachoff Fleet Consultant 480-440-3422 halachof@egr.msu.edu

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Kathy Ahlenius, P.G., Field Operations – Winter Research, WYDOT, 5300 Bishop Blvd, Cheyenne, WY 82009, 307-777-4264, kathy.ahlenius@wyo.gov

NCHRP Review of F-02

Reviewed By:

Amir Hanna
ahanna@nas.edu

Comments:

A. The problem does not appear to be research oriented. It calls for developing marketing/ communications tool based on completed research.

B. The proposed topic, although not a research topic, should be of interest to the majority, if not all, state DOTs.

C. The objective, as stated in the problem statement, calls for "a presentation "plug n play" template that DOT fleet managers can use to effectively communicate the long-term effects of aging the Fleet Assets?. This objective appears to be suited for an implementation activity under NCHRP Project 20-44.

D. The scope is clearly defined. It calls for a "plug and play" PowerPoint template which includes auto fill boxes linked to other documents such as budget needs, age of fleet, cost to defer, and link to research literature explaining pros and cons of deferring replacement of fleet assets?.

E. The estimated duration of 18 months seems adequate.

F. The estimated budget of \$200,000 seems adequate.

G. A few references are noted but further literature review and other information gathering would be helpful in developing the proposed communications tool.

Note: This problem statement is one of 3 problem statements submitted by the AASHTO Committee on Maintenance; it was ranked third (lowest priority) by the committee.

FHWA Evaluation of F-02

Reviewed By:

Morgan Kessler/HRDI

Comments:

Another key piece of the fleet asset management NCHRP work that has been ongoing over the past couple years. This is an important topic, and ports well into the much larger discussion of how an agency should handle aging their (very expensive) fleet assets.

Review Date:
December 17, 2021

Submitter Response for 2023-F-02

From:
[email: Kathy.ahlenius@wyo.gov]

Comments:

Comments from Tim Cunningham, Chair of the Committee on Maintenance Equipment TWG:

I would like to respectfully offer the following comments to several of the observations made by the NCHRP reviewer.

- A. *The problem does not appear to be research oriented.*
 - The underlying research necessary for this problem statement is to determine the most effective way to estimate, and validate the cost to the Agency to own and maintain the DOT Fleet Assets as the replacement of those assets are deferred. Along with that research, a tool will then need to be developed to communicate the cost to the Agency for deferring the replacement of assets.
- B. *The proposed topic, although not a research topic, should be of interest to the majority, if not all, state DOT's.*
 - The principles of this research should be translatable to other assets outside of fleet such as facilities, bridges, and pavements.
- C. *...This objective appears to be suited for an implementation activity under NCHRP Project 20-44.*
 - The AASHTO Maintenance Committee's research coordinator contacted the Implementation Research Coordinator with NCHRP over a year ago and was told that this Problem Statement would not be a "viable fit" and that the 20-44 program provides funding to implement "completed or soon to be completed research".

Thank you for the opportunity to respond to the comments.

Contact Info:
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**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-F-03

Problem Title

Guide for Pavement Preventive Maintenance Inspector Training

Background Information and Need For Research

The construction and preservation of highway infrastructures requires considerable skilled labor and specialized equipment. Historically, this construction / preservation consisted of the owner being responsible for the R/W acquisition, roadway design, establishing materials requirements and contract specifications, contract procurement, and inspection of the awarded project during and after construction. The contractor provided the equipment, materials, labor, and expertise to construct the project. The agency then provided the preservation of the infrastructure either through in-house methods or through outsourcing.

Both the agency and contractor had to staff according to project schedules, volume of and quantity of work items, and expected environmental conditions. Although in the design phase, more latitude was often allowed as schedule slippage could more easily be tolerated by the owner. However, once a contract is awarded, on-time performance becomes a high priority. As such, agencies had to ensure a properly qualified workforce was available to ensure a final product in accordance with project specifications and the contractor's schedule. This is considered part of an agency's fiduciary responsibility.

Literature Search Summary

Is to accelerate the integration of innovative ideas into practice by information sharing and technology exchange among state transportation agencies. Experience has shown that personal contact with new ideas and their application is a particularly valuable means for sharing information about practices.

The review entails a literature search of agency and private sector who have implemented practices of interest and who can disseminate knowledge of the practices inspecand procedures for establishing project staffing levels, training requirements, qualification / competency standards, inspector deployment strategies, and management oversight procedures.

Research Objective

The objectives of this research are to develop methodologies for establishing the necessary inspector staffing levels, deployment strategies, and training and competency requirements for each of the typical pavement preservation strategies. The potential costs and risks associated with inadequate inspection should also be determined.

Urgency and Potential Benefits

While contractors can better accommodate shorter completion times by adjusting their original bids, agencies have traditionally been limited by legislative restrictions on the sizes of their work forces and permitted overtime allocations. In recent times, use of consultant inspection and alternate bidding methods such as Design Build, Bid Build, CMAR, etc. have created more competition for procuring highly trained agency inspectors. Concurrently, agencies have tended to down-size staffing and many are facing a loss of up to 50% of their DOT personnel through retirement in the next 5 years. The loss of trained inspectors, competition from the private sector for inspectors, and administrative downsizing is putting more and more pressure on an agency's ability to properly inspect its construction activity.

A key first step towards increasing the acceptance and awareness of pavement preservation among transportation infrastructure practitioners is to provide a guide for preventive maintenance inspector training. The typical civil engineering student in the U.S. receives only cursory foundational knowledge related to pavements and bridges. Such educational training generally focuses primarily upon aspects of design and construction - affording scant coverage of the importance of preserving the infrastructure investment through preservation strategies and treatment techniques. Indeed, it is widely recognized in the transportation infrastructure community that preservation education receives far less emphasis than its performance benefits should warrant. The long-term impact of deficient educational preparation in preservation strategies and techniques is widely evident amongst even seasoned transportation practitioners, many of whom lack even basic knowledge of preventive maintenance concepts.

There is a need to have an effective means for establishing the number of and quality of trained inspectors and the best management practices for deployment of these resources.

Implementation Considerations

At a minimum, the following tasks will be accomplished based on findings of the literature search:

- (1) Develop a targeted survey of both agency and private sector organizations to acquire the necessary data needed to accomplish the objectives.
- (2) Prepare an interim report that estimates the costs and risks to an agency for inadequate inspection and its impact on pavement preservation performance.
- (3) Prepare a final report documenting the efforts, findings, and conclusions in fulfillment of the objectives.

The advancement of the review findings will be accomplished through the following dissemination activities:

- Post review products (or links to these products) on maintenance websites
- Conduct a series of webinars to promote review findings

- Present finding at technical meetings and conferences
- Conduct a technology showcase

Recommended Research Funding and Research Period

\$100, 000 and one year period.

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

- Heath Patterson: AASHTO MaC Pavement TWG Chairman
- Jason Dietz: FHWA

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

- Anita Bush: AASHTO MaC Vice Chairman
- Mark Woods: AASHTO MaC Pavement TWG Vice Chairman
- Heath Patterson: AASHTO MaC Pavement TWG Chairman

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

- Heath Patterson: AASHTO MaC Pavement TWG Chairman

NCHRP Review of F-03

Reviewed By:

Amir Hanna

ahanna@nas.edu

Comments:

- A. The problem is solvable through the proposed research.
- B. The topic of research should be of interest to the majority, if not all, state DOTs.
- C. The objective, as stated in the problem statement, is unclear. However, it appears to deal with the requirements for training inspectors in the different pavement preventive maintenance treatments and the need for developing related materials.
- D. The scope is not clearly defined. However, it appears to focus on the material required for training of pavement inspectors to ensure their familiarity with processes associated with the different preventive maintenance.
- E. The estimated duration of 12 months seems inadequate; should be increased to 24 month

F. The estimated budget of \$100,000 seems inadequate; should be increased to \$250,000.

G. No publications are cited but further literature review, surveys, and other information gathering should be performed as part of this research.

Note: This problem statement is one of 3 problem statements submitted by the AASHTO Committee on Maintenance; it was ranked second by the committee.

Submitter Response for 2023-F-03

From:

[email: Kathy.ahlenius@wyo.gov]

Comments:

From: Pavement Technical Working Group Chair, Heath Patterson, P.E.:

I would respectfully like to offer the following comments to several of the observations made by the NCHRP reviewer:

- A. Agreed
- B. Agreed
- C. The comment seems ambiguous as to whether the objective unclear to the point of needing revision. I feel like it presents an adequate goal.
- D. The comment seems ambiguous as to whether the scope is unclear to the point of needing revision. I feel like it presents an adequate outline while not limiting the best way to attack the problem.
- E. Agreed, the estimated duration should be increased but 18 months should be adequate.
- F. Agreed, It should be increased to \$250,000
- G. Agreed

Contact Info:

Heath Patterson, P.E.

hpatterson@mdot.ms.gov

601-359-7113

Review Date: 02/07/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-F-04

Problem Title

Durable and Compatible Repair of Historic Concrete Bridges

Background Information and Need For Research

Many bridges that have been determined eligible for the National Register of Historic Places possess concrete components in need of repair. Repairs commonly needed on historic bridges are related to cracks, spawls and larger fractures in concrete piers, beams, railings and decks, due to collisions, load stress, water and road salt infiltration, temperature contraction or expansion, or other types of weathering. To preserve bridges for transportation use and to extend their service life, transportation departments endeavor to make repairs that will last several years. Concrete repair technology continues to advance, resulting in materials and methods that provide more durable repairs, which have proven effective and have become preferred by state departments of transportation (DOTs).

Many historic bridges possess concrete components that are considered character defining or contribute to the integrity of materials and design. Frequently, in Section 106 of the National Historic Preservation Act reviews of repair projects on concrete bridge elements, the Secretary of the Interior's (SOI) Standards for Concrete Repair are referenced as the preferred method for repair to minimize effects to the integrity of historic bridges. Briefly stated, concrete repairs meeting the SOI standards will be of similar material, texture, and color. The intent is to provide a repair as visually and texturally similar to the original concrete material as possible. Additionally, the SOI standards call for preservation treatments of exposed metal reinforcement, intending to limit corrosion and further deterioration.

While perhaps appropriate for concrete repairs on many historic buildings, the SOI standards may not be compatible with the otherwise preferable, more modern concrete repair methods. Buildings and bridges are subjected to material expansion and contraction factors due to changes in temperature and various types of weathering. However, concrete structural elements of a building are often under a more or less constant load or tension stress, whereas concrete bridge components are exposed to varying load and tension stress, increasing the importance of flexibility of the repaired concrete. Additionally, metal preservation products may impede the bonding of concrete repair material to the reinforcing metal and surrounding concrete, limiting the effectiveness and longevity of the repair. This results in a situation where the need to make the lasting repairs competes with the need to preserve the historic integrity of the bridge, which in turn requires DOT, FHWA, and SHPO staff time to investigate and negotiate a reasonable compromise. Reconciling the need for durable concrete repairs

on historic bridges while making them compatible in appearance with adjacent historic materials will attend to both transportation and historic preservation goals. A comprehensive study of the issue and subsequent guidance would benefit all state DOTs who have an ever-increasing number of repair projects involving the concrete portions of their historic bridges. It would also be a beneficial resource for SHPOs, allowing them to more quickly provide Section 106 review and comment on relevant projects.

Literature Search Summary

No research projects were found in the Research in Progress Database meeting the search criteria Historic Concrete Bridge Repair or Historic Concrete Bridge Maintenance. There were numerous items related to concrete bridge repair and maintenance, however none addressed repair compatibility with the SOI Standards for Concrete Repair. The Transportation Research Integrated Database yielded results from the same search criteria but the results related to historic bridges featured repair discussions of specific bridges, including several in Europe, and included repair to concrete features but did not address comparisons with SOI standards for concrete repair. The search did locate an historic bridge repair handbook, *Conservation of Bridges: A Guide to Good Practice* (2002 Gifford Partners, London) which provided a comprehensive guide to the conservation of older bridges, particularly in the United Kingdom. One paper, "Refurbish and Renovate" (Structural Engineer, 1996 Vol 64A Issue 2) reviewed classic examples of historic bridge refurbishment, considered difficulties arising from the refurbishment of the postwar concrete and steel bridges and identified needs for research and development on the assessment of deterioration and repairs.

Research Objective

The study should consist of three phases:

A. Survey of concrete repair methods utilized by state DOTs: \$50,000

The survey of state DOT concrete bridge repair methods could begin by obtaining repair standards employed by each DOT for historic concrete repairs. While it may be possible to gather most state DOT repair standards from published resources, it will be important to contact as many DOTs as possible to discover if there are instances where there are deviations from those standards. Some states may have repairs they specifically apply to historic bridges, which should be a question posed to the DOTs, in a survey questionnaire. As some state DOTs have engaged in such specialized repair projects for historic bridges, gathering the methods used and noting where they differ from standard concrete repair practices will be important to detail, revealing the reasons. Geographic and climate related factors that affect the appropriateness of some repair techniques should be taken into consideration.

B. Comparison of concrete repair methods with Secretary of the Interior's Standards: \$100,000. Once the survey information regarding repair method is compiled, the practices can be assessed in terms of how they met the Secretary of the Interior's Standards for Concrete Repair and their effectiveness, longevity and cost. This part of the research will require more intense scrutiny which may involve site visits to specific

bridge locations. It will also require gathering input from SHPOs, the NPS, architectural historians and others familiar with historic bridge concrete repair and specific case studies to identify gaps between SOI Standards for Concrete Repair and specific repair techniques needed for concrete on historic bridges.

C. Historic Bridge Concrete Repair Recommendations: \$100,000

From this above comparison, recommendations can be developed, again, taking geographic and climate conditions into consideration. The resulting report will present the results of the survey information with the specific examples of case studies and the recommendations for best practices for historic bridge concrete repair, with geographical considerations, if warranted. The report will be made available to state DOTs through the Transportation Research Board publications and available to the public via online downloadable PDF available through TRB. The results should be organized into a guide that can be readily incorporated into the bridge repair manuals for state DOTs and quickly put to use.

Urgency and Potential Benefits

Many state DOTs possess historic bridges with concrete components in need of repair, making the issue extremely common nationally. Historic bridges are subject to increasing transportation demands and continue to deteriorate. As DOTs make provisions to repair historic bridges, either due to historic preservation goals or simply because repair is more feasible than replacement, the method of repair will become increasingly of concern. Providing comprehensive assessment and guidance to this ubiquitous issue will allow state DOTs and their transportation partners to quickly adopt lasting repair techniques for historic bridge concrete components and save much time that would otherwise be spent researching and negotiating repair techniques on a per case basis. The time and costs spent researching and coming to an agreement with historic preservation interests is great, especially multiplied by the dramatically increasing number of repairs by the number of historic bridges in each state. State DOTs, SHPOs and historic preservation interests reaching consensus regarding concrete bridge assessment guidance and acceptable SOI-compliant repair techniques will reduce money and time spent in the Section 106 process.

Failure to address this quickly growing concern will result in costly delays to project development while the issue is addressed within the realm of Section 106 on a state by state, or more likely, a case-by-case basis. Many state DOTs and SHPOs do not possess the in-house expertise to assess the issue, compounding the time it would take to come to an agreement. As the recognition that repair is needed is often quickly followed with mobilization to make the repair, time needed for case-by-case analysis is frequently longer than what DOTs can accept. This could culminate in concrete repairs to historic bridges being carried out without a Section 106 nexus and to less favorable standards with decreases to historic integrity, both of which can be avoided with a comprehensive study and subsequent guidance.

Implementation Considerations

The resulting research recommendations will largely be used by state DOT and municipality maintenance and rehabilitation project staff and consultant contractors.

State DOTs can determine which recommendations will be appropriate for their geographic locations and can adopt the recommendations into their maintenance and rehabilitation standards and specifications, when a historic bridge is concerned. Dissemination through the Transportation Research Board and AASHTO, through online publication and conferences would introduce the recommendations to all state DOTs for consideration. State DOTs may test the recommendations for applicability through their testing labs and facilities and adjust specific techniques accordingly. State DOTs may hold training workshops for relevant staff and consultants to convey specific methods and materials they determine most effective. This will also be useful to SHPOs by giving them a resource that specifically addresses repair of historic bridges with concrete components that will greatly aid them in carrying out their Section 106 review and commenting obligations more quickly, especially if they lack expertise in the subject.

Recommended Research Funding and Research Period

- A. Survey of concrete repair methods utilized by state DOTs: \$50,000; 6 months
 - B. Comparison of concrete repair methods with Secretary of the Interior's Standards: \$100,000; 12 months
 - C. Historic Bridge Concrete Repair Recommendations: \$100,000; 14 months
- Total Research Cost and Time: \$250,000; 32 months

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Carey Coxe, Louisiana Department of Transportation and Development,
carey.coxe@la.gov, 225-242-4520

Kristina Thompson, Pennsylvania Department of Transportation, Krthompson@pa.gov,
610-871-4459

Robert Hadlow, Oregon Department of Transportation,
Robert.W.HADLOW@odot.state.or.us, 503-731-8239

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

N/A

Person Submitting the Problem Statement: Name, Affiliation, Email Address And Phone.

N/A

NCHRP Review of F-04

Reviewed By:

Ahmad Abu-Hawash
aabu-hawash@nas.edu

Comments:

This is an area of increasing importance to states, and there is a need to understand what states are doing and how effective their practices are. There is no mention of the recent AASHTO publication "Historic Bridge Preservation Guide, 1st Edition, 2020" which has a section on concrete structures. The publication may not go as far as this problem statement proposes to, but it should be considered so as not to duplicate effort. The focus of problem statement is on how well state practices compare to existing concrete repair methods contained in the "Secretary of the Interior's Standards for Concrete Repair". Care would need to be taken to ensure that the scope of this needed research does not cross over into an evaluation of the Secretary of Interior's standards.

Product of this research is implementable through collaboration with the relevant AASHTO committees and historic preservation agencies.

Review Date:

12/7/2021

FHWA Evaluation of F-04
Reviewed By:

Derek Soden/HIBS-10

Comments:

It's not clear whether this project has been developed or coordinated with the AASHTO Committee on Bridges and Structures.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for F-04
Submitted By:

Tim Hill

Vice Chair

AASHTO Committee on Environment and Sustainability

Priority #: 6Comments:

Here are the two comments we received. From NCHRP Reviewer: This is an area of increasing importance to states, and there is a need to understand what states are doing and how effective their practices are. There is no mention of the recent AASHTO publication "Historic Bridge Preservation Guide, 1st Edition, 2020" which has a section

on concrete structures. The publication may not go as far as this problem statement proposes to, but it should be considered so as not to duplicate effort. The focus of problem statement is on how well state practices compare to existing concrete repair methods contained in the "Secretary of the Interior's Standards for Concrete Repair". Care would need to be taken to ensure that the scope of this needed research does not cross over into an evaluation of the Secretary of Interior's standards. Product of this research is implementable through collaboration with the relevant AASHTO committees and historic preservation agencies. From FHWA Reviewer: FHWA Evaluation of F-04 Reviewed By: Derek Soden/HIBS-10 Comments: It's not clear whether this project has been developed or coordinated with the AASHTO Committee on Bridges and Structures. Review Date: December 17, 2021 Research Proposal Submitters Response AASHTO's 2020 Historic Bridge Preservation Guide, Section 5: Concrete Structures discusses strengthening and repair options and potential ramifications to character-defining features and should definitely be considered pertinent when developing the focus of this research. The AASHTO guidance advises on the technical aspects of concrete repair and replacement and treatments of the issues that lead to deterioration. There are a few sections in the guidance that would benefit from more intensive analysis. Generally, while the guidance does include a reference to the Secretary of the Interior Standards, the guidance does not seem to specifically link, by reference or specific repair topic, to the National Park Service Preservation Brief 15 on Preservation of Concrete (NPS Brief 15) (<https://www.nps.gov/tps/how-to-preserve/briefs/15-concrete.htm#preservation>). For a more specific example, the visual aspects of repairs, the guidance advises, where necessary, that a matching surface preparation may be done according to a separate guidance. As the visual aspect is a large part of historic preservation, this is one example of concrete repair that could use more in depth attention. Similarly, NPS Brief 15 itself does not specifically mention bridges, though it does discuss the damage that concrete under heavy loads can sustain. The brief is largely geared toward historic concrete buildings, rather than encompassing the different concrete components of historic bridges. This illustrates the information gap this research could fill between the guidance given by NPS and that offered by AASHTO. The intent of the research project would not be to duplicate or contradict either the NPS Brief 15 or the AASHTO guide. Rather, it could inform subsequent editions of either publication or could simply stand between them as a supplement to both. This research topic was not developed in coordination AASHTO Committee on Bridges and Structures, but the research project should be. The topic emerged out of an ongoing effort to collaborate between historic bridge preservation experts and bridge engineers on specific repairs proposed for the concrete components of historic bridges in Louisiana.

Submitter Response for 2023-F-04.

Billo, Jennifer <jbillo@aaashto.org>

Subject: FW: Evaluation of NCHRP Problem 2023-F-04

Submitter Response for 2023-F-04. This project is Ranked #6.

From:

[email: Tim.Hill@dot.ohio.gov]

Comments:

Here are the two comments we received.

From NCHRP Reviewer:

This is an area of increasing importance to states, and there is a need to understand what states are doing and how effective their practices are. There is no mention of the recent AASHTO publication "Historic Bridge Preservation Guide, 1st Edition, 2020" which has a section on concrete structures. The publication may not go as far as this problem statement proposes to, but it should be considered so as not to duplicate effort. The focus of problem statement is on how well state practices compare to existing concrete repair methods contained in the "Secretary of the Interior's Standards for Concrete Repair". Care would need to be taken to ensure that the scope of this needed research does not cross over into an evaluation of the Secretary of Interior's standards. Product of this research is implementable through collaboration with the relevant AASHTO committees and historic preservation agencies.

From FHWA Reviewer:

FHWA Evaluation of F-04 Reviewed By: Derek Soden/HIBS-10 Comments: It's not clear whether this project has been developed or coordinated with the AASHTO Committee on Bridges and Structures. Review Date: December 17, 2021 Research Proposal

Submitters Response

AASHTO's 2020 Historic Bridge Preservation Guide, Section 5: Concrete Structures discusses strengthening and repair options and potential ramifications to character-defining features and should definitely be considered pertinent when developing the focus of this research. The AASHTO guidance advises on the technical aspects of concrete repair and replacement and treatments of the issues that lead to deterioration. There are a few sections in the guidance that would benefit from more intensive analysis. Generally, while the guidance does include a reference to the Secretary of the Interior Standards, the guidance does not seem to specifically link, by reference or specific repair topic, to the National Park Service Preservation Brief 15 on Preservation of Concrete (NPS Brief 15) (<https://www.nps.gov/tps/how-to-preserve/briefs/15-concrete.htm#preservation>). For a more specific example, the visual aspects of repairs, the guidance advises, where necessary, that a matching surface preparation may be done according to a separate guidance. As the visual aspect is a large part of historic preservation, this is one example of concrete repair that could use more in depth attention. Similarly, NPS Brief 15 itself does not specifically mention bridges, though it does discuss the damage that concrete under heavy loads can sustain. The brief is largely geared toward historic concrete buildings, rather than encompassing the different concrete components of historic bridges. This illustrates the information gap this research could fill between the guidance given by NPS and that offered by AASHTO. The intent of the research project would not be to duplicate or contradict either the NPS Brief 15 or the AASHTO guide. Rather, it could inform subsequent

editions of either publication or could simply stand between them as a supplement to both.

This research topic was not developed in coordination AASHTO Committee on Bridges and Structures, but the research project should be. The topic emerged out of an ongoing effort to collaborate between historic bridge preservation experts and bridge engineers on specific repairs proposed for the concrete components of historic bridges in Louisiana.

Contact Info:

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Administrator-OES
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Columbus, OH 43223
(614) 644-0377
Transportation.ohio.gov

Review Date:

2/7/2022

Research Field G

TRAFFIC

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-01

Problem Title

Development of an Updated Warranting System for Roadway Lighting

Background Information and Need For Research

Warranting is used by many State and local DOTs and safety practitioners to define the need for lighting. Currently there are two main warranting systems for roadway lighting: one in the AASHTO Roadway Lighting Design Guide, which defines lighting warrants for freeways and highways, and the other in The Transportation Association of Canada (TAC) Guide for the Design of Roadway Lighting, which defines warranting for streets, highways, freeways, and intersections. The majority of the warranting in TAC is based on a weighted point score system developed in the 1970's and derived from an early 1970's NCHRP Report and the late 1970's FHWA - Federal Highways Lighting Handbook. The AASHTO warranting system was developed in the early 1980's and has not changed significantly since then. Although the AASHTO and TAC publications are relatively current, the warranting system contained within them have not been updated in at least over 30 years.

The existing warrants for lighting were developed for before the recent development of active safety systems in vehicles, solid state lighting and the implementation of the use of crash modification factors in roadway safety analysis. With the advancement of application of LED lighting system for new or replacement of existing lighting fixtures, there is a significant requirement to create new data associated with the needs for new lighting. In addition, warrants do not address safety-based alternatives to roadway lighting, which include retroreflective pavement marking and roadside delineators. The FHWA safety initiative to enhance visibility for pedestrians include various alternatives with roadway lighting one of the several solutions for consideration.

Further, there is also a growing pressure to reduce potential environmental impacts of roadway lighting. Jurisdictions often must balance the safety benefits of roadway lighting while aiming to reduce potential environmental impacts, such as energy use and impacts to wildlife.

Roadway lighting can also be expensive to install and operate. Over-lit and unwarranted lighting luminaires can result in excessive glare, lighting trespass in the adjoining neighborhood, and sky glow. Additionally, current warranting systems do not address the cost-benefit of roadway lighting as a safety measure as compared to other safety alternatives, resulting in inconsistency as to where and when roadway lighting is applied.

Literature Search Summary

As noted above, there was research in the 1970's on this topic but nothing recent is currently relevant.

Research Objective

The objective of this research is to develop an updated warranting system that provides linkages to Crash Modification Factors (CMF's), assess roadway lighting as compared to other roadway safety treatments and consider the safety impacts on modern vehicle technology along with new lighting technologies. The goal would be to develop a system, which is easy to use and creates consistency with respect to how roadway lighting is applied as a safety countermeasure. In addition, other safety measure frameworks to access the benefit of roadway lighting to other road safety measures would also be discussed.

As a part of existing NCHRP 05-22A, guidelines for developing CMFs for Solid State Lighting are being studied. The proposed research will leverage this current research effort.

Urgency and Potential Benefits

Most of the Crash Modification Factors (CMF) in the CMF Clearinghouse are over 20 years old, and some are not based on good data, and none are based on modern lighting technologies such as LED lighting systems. There is an urgent need to develop appropriate CMFs for state-of-the-art lighting system as most State and local agencies are relying on Crash Modification Factors (CMF) to justify the safety benefits of installing roadway lighting. There is at least one state is in the process of removing roadway lighting because the old warranting methodology may allow them to do so and once removed could potentially lead to additional nighttime crashes. An updated lighting warrant system would also be expected to have a significant benefit to vulnerable road users and may have environmental benefits as well.

Implementation Considerations

The updated warranting system should include an abbreviated Literature Search on work related to Lighting CMFs taking into account the work currently being developed by NCHRP 5-22A. The new warranting system should consider adding new warrants that are missing today but are needed. The CMFs developed will build upon the work from 5-22A utilizing advanced statistical methodology such as Empirical-Bayes analysis. The work should include the development of a document suitable for easy adoption by the latest AASHTO Roadway Lighting Design Guide as an appendix to the main document. Additionally, state and/or local agencies may use the research results directly.

Recommended Research Funding and Research Period

Research Funding Level should be in the amount of \$350,000.00 with a research period of 18 to 24 months.

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

Joseph Cheung, FHWA Office of Safety, joseph.cheung@dot.gov

Mark Luszcz, DelDOT, Chair, AASHTO Joint Technical Committee on Roadway Lighting, mark.luszcz@delaware.gov

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Joseph Cheung, FHWA Office of Safety, joseph.cheung@dot.gov

Members of the AASHTO Joint Technical Committee on Roadway Lighting

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Mark Luszcz

Chair, AASHTO Joint Technical Committee on Roadway Lighting

302-760-2356

Mark.luszcz@delaware.gov

NOTE: This problem statement was Ranked #2 by the AASHTO Committee on Traffic Engineering, and endorsed by the AASHTO Committee on Design.

NCHRP Review of G-01

Reviewed By:

David M. Jared

djared@nas.edu

Comments:

This research, jointly supported by FHWA and AASHTO, complements NCHRP 5-22A, "Gaps and Emerging Technologies in the Application of Solid-State Roadway Lighting" and could provide a timely update to warranting systems for roadway lighting (RWL) that links to CMF's, assesses RWL compared with other roadway safety treatments, and considers the safety impacts of both conventional and innovative roadway lighting on modern vehicle technology.

Review Date:

12/8/2021

FHWA Evaluation of G-01

Reviewed By:

Roadway Departure and Data & Analysis

Comments:

It is very important to get this underway as the warrants used by agencies are over 20 years old and no new warrants have been developed. In the current environment (some DOTs want to turn off light as they question the need for lighting), it is crucial that a set of new warrants be developed or the existing warrants updated with more recent research. We encourage the authors to investigate beyond AASHTO and TAC and seek out what is being done in other countries (EU, UK, Japan, Korea for example). NCHRP Report 152 (1974) outlines review of warrants in European countries. Apparently, at that time, there were only a few European countries with formal warranting systems. The authors should include in their review: ANSI/IES RP-8-21, Recommended Practice: Lighting Roadway and Parking Facilities. The controllability that solid-state lighting offers e.g., dimming, on/off, and interaction with advanced vehicle lighting to provide the 'best solution' in terms of safety, energy, and environmental factors for the given context at a 'particular time/ instant', is new and something to address.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for G-01
Submitted By:

Patricia Bush
AASHTO staff
Committee on Design

Priority #: N/AComments:

Endorsed by the Committee on Design.

Submitted By:

Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/AComments:

Recommend considering the needs of active transportation users under different contexts. New report from FHWA.
https://safety.fhwa.dot.gov/roadway_dept/night_visib/docs/StreetLightingPedestrianSafety.pdf

Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: N/A

Comments:

Will this research cover an evaluation of effectiveness of speed management techniques that can then be used in a guidebook for policy development? Or is the focus more on developing a guidebook on speed management policies?

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-02

Problem Title: 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 been found to be effective at lowering speeds. However, incompatible land uses are often placed next to high speed roadways, and solutions for traffic-speed management along arterials and higher-speed roadways, 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. However, 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 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 in 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 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>
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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 context driven roadmap to speed management on arterial and higher-speed roadways, and how this can be balanced with appropriate safety improvements for pedestrians and bicyclists on these arterial and high-speed roadways. The successful completion of this project, at the minimum, will consist of the following tasks:

- Task 1 – Review literature and state-of-the-practice inventory and information and establish the range of needs and possible case studies regarding development of a context-driven roadmap to speed management on arterial and higher-speed roadways, and how this can be balanced with appropriate safety improvements for pedestrians and bicyclists.
- Task 2 – Develop proposed case studies and information effort covering all aspects of context-driven speed management - roadway design, enforcement, speed limit setting, use of coordinated signal timing in higher speed corridors, self-enforcing roadways, signs, and traffic calming that are appropriate for a range of speeds and road classifications. Also include in the proposal, context-driven case studies and information on safety improvements for pedestrians and bicyclists on arterial and high-speed roadways, including improvements used at varying speeds and improvement costs. Realistically, on some roadways,

effective solutions will require greater separation of the modes and this should be addressed in the case studies. Identify the need for any new or additional data.

- 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 draft case study toolbox of specific recommendations and guidance to implement effective context-driven speed management efforts on arterial and higher-speed roadways, and how these should be balanced with appropriate safety improvements for pedestrians and bicyclists on these arterial and high-speed roadways. This should include details on policies and strategies implemented, how much speeds were reduced, how to balance level of service and safety, safety improvement measures for pedestrian and bicyclists, evidence of improved safety (both perceived and actual), documentation of how travel volumes and delays have changed for all modes.
- 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.

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

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 context-driven and strategic approach. Reducing speeds, in addition to improving safety, will make many routes more attractive for active transportation. 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.

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

AASHTO Council on Active Transportation

Potential Panel Members

Persons Submitting the Problem Statement

Toks Omishakin, Caltrans Director, and Chair of the Council on Active Transportation

References

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<http://www.trb.org/Main/Blurbs/179827.aspx>

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Accident Analysis & Prevention, 50, 871–878. <https://doi.org/10.1016/j.aap.2012.07.022>

NCHRP Review of G-02

Reviewed By:

Richard A. Retting
 rretting@nas.edu

Comments:

The authors quote Sanders et al., 2019 (“higher speeds lead to higher injury severity for vulnerable road users”), but fail to note in their brief Literature Search Summary that Sanders also identifies proven strategies and effective practices related to improving pedestrian safety speed management, and also provides case studies; these are tasks proposed for the problem statement.

Examples of existing, relevant research not cited in the brief Literature Search Summary includes:

- *Best Practices in Arterial Speed Management (City of Pasadena, 2009).*
- *Speed Management Techniques for Collectors and Arterials (Parham and Fitzpatrick, 2000).*
- *Arterial Speed Management with Control Measures: The Case of San Francisco (Halkias et al, undated)*
- *Speed Management in Small Cities and Towns—Guidelines for Indiana (Tarko et al., 2020).*
- *Effect of Various Speed Management Strategies on Bicycle Crashes for Urban Roads in Central Florida (Ugan et al., 2021).*
- *Factors Contributing to Operating Speeds on Arterial Roads by Context Classifications (Mahmoud and Abdel-Aty, 2021), which identifies speed management countermeasures to reduce speed-related crashes and enhance the safety of vulnerable road users.*

In terms of research currently underway the authors note a relevant NHTSA research study (Impact of Lowering Speed on Pedestrian and Bicyclist Safety) but fail to note other important work in progress, including two FDOT projects (Improving Multimodal

Traffic Safety for Multi-Lane Arterials; Development of Crash Modification Factors for Speed Management of Traffic Signal Progression). FHWA also manages a robust Speed Management program with active research activities.

In short, although this problem statement addresses an important highway safety issue, the authors' apparent unfamiliarity with existing literature and relevant work in progress would result in research activities and guidance that is largely redundant with past and current research efforts. A better use of limited NCHRP funds might be to update NCHRP Report 500, Vol. 23: A Guide for Reducing Speeding-Related Crashes, which provides guidance on strategies to reduce crashes involving speeding, but is dated.

Review Date:
12/11/2021

FHWA Evaluation of G-02

Reviewed By:
Do/HRSO; Redmon/HSA; Darren Buck/HEPH-10

Comments:

Do/Redmon - The topic is very important FHWA, as both speed and pedestrian safety are high priorities. FHWA has been focusing on crashes on arterials roadways as a leading cause of pedestrian fatalities around the U.S. In fact, there is a Global Benchmarking Program that focuses on this topic. The proposed problem appears to be appropriate for NCHRP, and it is well thought out and comprehensive. The potential payoff from research is estimated to be high. Speed has been a very important factor for pedestrian and bicyclist safety, especially on arterial roadways. There is an urgent need for more study on this area where speed management on arterial and higher-speed roadways can be applied to ped/bike safety. The funding level of \$550,000 and timeframe are appropriate for the study.

Darren Buck - We see benefit in this research. The proposal is relevant to FHWA's interests in improving safety in this context, and is notable for its case-study approach, including a workbook deliverable of treatments by context. However, there is not an identified linkage to guidance used in practice, such as the Green Book or HSM. Further, the linkage between speed management and active transportation safety is unclear and should be better described. Managing speed improves active transportation safety, but the specific method of how active transportation safety outcomes are used as a measure of efficacy of a speed management study is slightly unclear.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for G-02

Submitted By:
 Bud McDonald
 AASHTO staff
 Council on Active Transportation

Priority #: 1

Comments: N/A

Submitted By:
 Kelly Hardy
 AASHTO staff
 Safety

Priority #: N/A

Comments:

Will this research cover an evaluation of effectiveness of speed management techniques that can then be used in a guidebook for policy development? Or is the focus more on developing a guidebook on speed management policies?

Submitter Response for 2023-G-02

Comments:

- Combine with C-11 to ensure that AT needs and opportunities are adequately addressed in both high-speed rural highways and arterial roadways.
- The objective of this research is to produce a guidebook that can be used as a context driven roadmap to speed management on arterial and higher-speed roadways, and how this can be balanced with appropriate safety improvements for pedestrians and bicyclists on these arterial and high-speed roadways.
- The guidance in this proposal would be a roadmap, while case studies would provide information regarding the pros and cons of various applications. This proposal appropriately ties to case studies where we can examine evidence of outcomes of specific applications.
- FHWA indicated that this topic is very important- “both speed and pedestrian safety are high priorities.” FHWA has been focusing on crashes on arterials roadways as a leading cause of pedestrian fatalities around the U.S. and there is a Global Benchmarking Program that focuses on this topic. There is an urgent need for more study on this area where speed management on arterial and higher-speed roadways can be applied to ped/bike safety. The proposal is notable for its case-study approach, including a workbook deliverable of treatments by context.
- Any additional research that has been completed or is underway since development of the research roadmap will be included in the literature search.

- Through NCHRP 20-123, a research Roadmap was developed to assist the Council on Active Transportation implement the research components of its 2018 Strategic Plan. To identify and define research priorities, the team reviewed existing and on-going research; conducted a survey of practitioners, including AASHTO councils and committees, TRB committees, state DOTs, and ITE, APBP, and NACTO members; and conducted a series of practitioner workshops. The Roadmap contains active transportation research that will address the most important needs of state DOTs. The priority level of research identified in the Roadmap 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. Of the 110 research topics identified, this was the #1 (tied) priority for CAT.

Contact Info:

Bud McDonald

bmcdonald@ashto.org

Review Date:

2/3/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-03

Problem Title

Enhancing Highway Safety Manual Guidance on Pedestrian and Bicyclist Countermeasures (CMF/SPF Development)

Background Information and Need For Research

The Highway Safety Manual (HSM) 1st edition provides analytic tools and techniques for estimating the effect of changes to the roadway environment on motor vehicle crash frequency, but provides almost no information on their effects on pedestrian and bicyclist crash frequency. NCHRP Project 17-84, Pedestrian and Bicycle Safety Performance Functions for the Highway Safety Manual, is in the process of developing crash modification factors (CMFs) and safety performance functions (SPFs) for pedestrians and bicyclists in support of a future HSM 2nd edition. However, NCHRP 17-84 is not comprehensive, and the safety benefits of many (especially newer) pedestrian and bicycle countermeasures will still be unknown after the project is completed. Furthermore, established CMFs focused on vehicle-vehicle collisions do not properly account for possibly adverse safety effects for pedestrians and bicyclists or others outside of the vehicle. In addition, the HSM's CMFs for roadway lighting generally require updating. Without quantifiable safety prediction methods, it can be difficult to justify countermeasure installation, compare and contrast different countermeasure options, or evaluate tradeoffs in vehicular and multimodal safety (e.g., as part of road cross-section reallocation efforts).

Literature Search Summary

The recommendations for future research developed by NCHRP Project 17-84 are expected to be an important input to prioritizing the safety countermeasures to study as part of the work conducted under this activity statement. FHWA's CMF Clearinghouse contains an up-to-date collection of CMFs, including some that may have been developed by other research being conducted at the same time 17-84 was being conducted. Additionally, NCHRP Project 17-102 focuses on exposure models and safety performance factors that can also serve as input to this project, but are distinct. NCHRP Project 17-72 has developed a CMF rating system that will be used to determine which CMFs come from rigorous-enough studies to be included in the HSM 2nd Edition. This activity should coordinate with ongoing AASHTO and NCHRP research to produce the HSM 2nd edition to avoid duplication of effort. Other work potentially relevant to this research activity includes:

- NCHRP Report 841: Development of CMFs for Uncontrolled Pedestrian Crossing Treatments
- NCHRP Report 893: Systemic Pedestrian Safety Analysis

- NCHRP Report 926: Guidance to Improve Pedestrian and Bicyclist Safety at Intersections
- FHWA-HRT-06-125: Pedestrian and Bicyclist Intersection Safety Indices
- FHWA Proven Safety Countermeasure Program
- TFHRC Crash Modification Factors of Separated Bike Lanes
- Studies and guidance related to ped/bike data quality improvement.
- Ongoing NHTSA research (see reference list)

Research Objective

For alternatives and tradeoffs analyses, continue efforts to quantify 1) the safety performance (crash-reduction effects) of pedestrian and bicyclist safety countermeasures and 2) the pedestrian/bicyclist crash reduction (or expansion) effects of vehicle safety countermeasures, specifically focusing on the highest-priority countermeasures not addressed by NCHRP 17-84 or other research conducted in parallel with 17-84.

This project will produce a guidebook that will include consideration of how treatments focused on addressing the safety or operational needs of one set of roadway users may have different effects on travelers with vision or mobility impairments. Crash-reduction performance is highly important, but not the only factor governing decisions about the specific countermeasure(s) to be installed at a given location. Other guidance documents (e.g., forthcoming NCHRP guidebooks on pedestrian analysis [Project 17-87] and roadway cross-section reallocation [Project 15-78]) will discuss bigger-picture trade-offs involved in decision-making and can be used in conjunction with the findings from this study for countermeasure selection.

Potential tasks include:

- Review the findings and recommendations from NCHRP Project 17-84, when ready, relating to future research priorities for developing CMFs and SPFs for pedestrian and bicyclist safety countermeasures. Review the 17-84 report to identify data collection lessons-learned that should be considered when developing this project's data collection plan. Review the literature on emerging methodologies that aim to address the limitations of linear models (GLM) in predicting crashes, e.g. systems dynamics models and agent based models
- Conduct a focused literature review on relevant new research published after the 17-84 literature review was developed to help identify what is available and what is still needed. Review pedestrian and bicyclist CMFs added to the CMF Clearinghouse after the 17-84 literature review was developed.
- Prioritize needs for additional CMFs and SPFs for pedestrian and bicyclist safety countermeasures, as well as new methodologies to predict ped/bike safety outcomes, based on what is available and what is still needed.
- Prepare a data collection plan for the selected countermeasures, including consideration of the NCHRP 17-72 rating system, that will maximize the potential that the project will develop CMFs and SPFs with high-enough ratings for inclusion in the HSM. Consider the use of surrogate safety measures to augment sample size.
- Conduct the data collection plan.

- Develop CMFs/SPFs for inclusion in the CMF Clearinghouse and a future HSM update.
- Prepare a final project report summarizing the research findings and providing recommendations for follow-up activities.

Urgency and Potential Benefits

Over the last decade, pedestrian and bicyclist fatalities are increasing as a proportion of overall traffic fatalities, with pedestrian fatalities reaching to highest levels. Estimating the safety performance of countermeasures and their impacts on bicyclists and pedestrians is critically important to improving safety. The outcomes from this study can inform agencies about the safety performance of various countermeasures and will help them make data-driven decisions regarding treatments to improve bicyclist and pedestrian safety.

This research was ranked priority #9 by the AASHTO Committee on Safety.

Implementation Considerations

This research will have value to traffic safety practitioners in all types of organizations and will support and advance efforts to improve pedestrian and bicyclist safety, quantitatively consider pedestrian and bicyclist safety in project decisions, balance crash-reduction and other project considerations, and advance safe system efforts. Implementation efforts should include outreach to potential users of the research products especially at the state and local levels. This could be accomplished in part through collaboration with national associations such as AASHTO, TRB, the National LTAP Association, and others.

Recommended Research Funding And Research Period

\$600,000 3 years

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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Nick Ferencak, University of New Mexico, ferencak@unm.edu, (505) 277-0698

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

To be determined.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Adnan Qazi, P.E.

Arkansas Department of Transportation

AASHTO Committee on Safety, Research Subcommittee Chair

501-569-2642

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NCHRP Review of G-03

Reviewed By:

Richard A. Retting
rretting@nas.edu

Comments:

This problem statement addresses an important highway safety issue, especially given large increases in pedestrian fatalities during the past 10 years. I am concerned, however, that we currently lack sufficient information to assess the size, scope, and specific needs for future research efforts required to develop HSM guidance on pedestrian and bicyclist countermeasures. The problem statement notes that NCHRP 17-84, *Pedestrian and Bicycle Safety Performance Functions for the HSM* (currently underway) is not comprehensive, and the safety benefits of many (especially newer) pedestrian and bicycle countermeasures will still be unknown after the project is completed. But until 17-84 is complete, we will not know what recommendations for future research will be developed by 17-84. The problem statement further notes “the HSM’s CMFs for roadway lighting generally require updating”, but does not recognize a new NCHRP project anticipated to begin in 2022, NCHRP 05-25 (*Safety Performance of LED and Variable Lighting Systems*). I think we need to complete (and digest findings from) NCHRP 17-84, as well as NCHRP 17-71A (*Proposed AASHTO Highway Safety Manual, Second Edition*) and NCHRP 22-45 (*Understanding and Analyzing the Crash-Contributing Factors*) to fund additional research related to the development of HSM guidance on pedestrian and bicyclist countermeasures.

Review Date:

12/11/2021

FHWA Evaluation of G-03

Reviewed By:

Do/HRSO; Redmon/HSA

Comments:

There is a significant need for additional CMFs and SPFs for pedestrian and bicyclist countermeasures in the Highway Safety Manual, as there is very little contained in there now. The problem described is significant. The potential payoff from research is estimated to be high. The target of this proposal is desirable, and it is necessary for development of the HSM Guidance on Pedestrian and Bicyclist Countermeasures. This tool will help states, regional planning organizations, and local jurisdictions to properly design bicycle lanes with safety concerns. The funding level of \$600,000 is appropriate for the study, and the timeframe can be 2.5 years.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for G-03**Submitted By:**

Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A

Comments:

The Council on Active Transportation strongly supports this research proposal. This research is imperative to improving bicyclist and pedestrian safety. Recommend addressing CMFs in the context of network connectivity. Filling a gap in a trail system allows vulnerable road users to complete a longer trip away from vehicular traffic, adding safety value. How many total miles of safer connections does a given project enable? Crossing guidance is crucial. Resource: FHWA Measuring Multimodal Network Connectivity Pilot Grant Program Final Report (FHWA-HEP-21-024) includes a report on development and application of a route directness index to support decision-making for crossing placement.

https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/measuring_multimodal/index.cfm

Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: 9

Comments:

The Committee on Safety ranked this #9 (of 9 submitted).

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-G-04

Problem Title

Incorporating Safe System Approach into the NCHRP 500 Series

Background Information and Need For Research

The NCHRP 500 Series identifies proven, tried and experimental safety strategies for each of the emphasis areas in AASHTO's original 1998 Strategic Highway Safety Plan. FHWA and the States partnered through a pooled fund study to develop reliable estimates of the effectiveness of the safety improvements identified as strategies in the NCHRP Report 500 Guidebooks. Through this research, 38 studies for various countermeasures have been completed or are currently in progress with the results presented in the FHWA Crash Modification Factor Clearinghouse and used to support State's safety investment decisions.

While the information presented in the NCHRP 500 series guides is still useful and referenced in many national reports, a lot has changed over the last 20+ years. In 2010, AASHTO published the Highway Safety Manual. In 2014, AASHTO adopted Towards Zero Deaths: A National Strategy on Highway Safety and in 2018 the National Safety Council published a Road to Zero: A Vision to Achieve Zero Deaths by 2050. Technology is advancing at rapid pace and has the potential to change traffic safety as we know it. Many agencies are beginning to implement a Safe System Approach. There is an opportunity to update these guides and provide guidance to agencies on safety strategies and countermeasures of the future.

The proposed research supports several key strategies for improving safety management in AASHTO's Toward Zero Deaths National Strategy. Specifically, the proposed research will "Develop data analysis methods and tools for use at state, regional, and local levels across all stakeholders, including cost-benefit analysis for behavioral programs" and "Implement analysis tools that support data-driven decision making". In addition, the Toward Zero Deaths Roadmap identifies Focused Safety Priorities and Strategies as an essential element for success, and includes specific mention of the NCHRP 500 series.

Literature Search Summary

The NCHRP Report 500 series is the subject literature and other efforts have not replicated the proposed research. There are, however, several relevant efforts that could support this research project. The following are just a few guides and resources that have focused on components of one or more of the emphasis areas from the NCHRP 500 series and would serve as content to update the guides:

- FHWA Proven Safety Countermeasures

- FHWA Crash Modification Factors Clearinghouse
- NHTSA Countermeasures that Work
- Evaluation of Low Cost Safety Improvements Pooled Fund Study
- Unsignalized Intersection Improvement Toolkit
- NCHRP Report 600: Human Factors Guidelines for Road Systems
- Intersection Safety: A Manual for Local Rural Road Owners
- NCHRP Report 988: Rural Transportation Issues: Research Roadmap
- Roadway Departure Safety: A Manual for Local Rural Road Owners
- Speed Management: A Manual for Local Rural Road Owners
- Non-Motorized User Safety: A Manual for Local Rural Road Owners
- Improving Pedestrian Safety at Unsignalized Crossings
- Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations
- A Guide for Maintaining Pedestrian Facilities for Enhanced Safety
- Pedestrian Countermeasure Policy Best Practice Report
- Risk Factors Associated with High Potential for Serious Crashes
- Wrong Way Driving Road Safety Audit Prompt List
- Agricultural Equipment on Public Roads

There has also been much research internationally and in the U.S. on the Safe System Approach, which include the following:

- Safe System Assessment Framework
- Safe Systems Framework
- A Safe System-Based Framework and Analytical Methodology for Assessing Intersections
- Primer on Safe System Approach for Pedestrians and Bicyclists
- Implementing Safe Systems in the United States: Guiding Principles and Lessons from International Practice

The following could serve as examples to guide the development of an online toolbox related to the NCHRP Report 500 series:

- FHWA Crash Modification Factors Clearinghouse
- Unsignalized Intersection Improvement Toolkit
- FHWA Roadway Safety Data Program Toolbox

Research Objective

The objective of this research is to update the guides to align with AASHTO's current priorities and Safe System principles, as well as reflect the most recent research and identify new innovations to help achieve our goal of zero deaths on our nation's roads. The research should focus on what would be most useful to Federal, State and local transportation professionals. The output should include an online version that is searchable by crash type, contributing factor, facility type and other variables to support countermeasure selection.

The objective can be accomplished using a phased approach with suggested major tasks as follows:

Phase I: Define scope

- Convene focus group(s) of federal, state and local transportation professionals to gather input on priority crash types and desired toolkit content and capabilities. Priority crash types shall address Safe System (e.g. pedestrian, bicyclist and speeding) and consider rural priority crash types (e.g. run off road, head on, unsignalized intersections).
- Conduct literature review to identify new and innovative countermeasures, current research on safety effectiveness and other relevant information as identified by the focus group.
- Provide information for each countermeasure, including considerations on implementing the strategy (e.g. engineering, human factors, behavioral, cost).
- Propose how the toolkit will coordinate with other tools (e.g. CMF Clearinghouse)
- Identify options for long-term maintenance of the toolkit.
- Develop recommended content of priority crash types for review by subject matter experts and panel.
- Develop recommended technical requirements of the toolkit for panel review.
- Finalize content and technical requirements for the toolkit based on subject matter expert and panel feedback.

Phase II: Develop toolkit

- Develop toolkit based on final content and technical requirements from Phase I.
- Facilitate user testing of toolkit.
- Update toolkit based on feedback from testing.
- Develop materials to promote and demonstrate use of the toolkit, including but not limited to flyers, tutorial video, and webinar.

Urgency and Potential Benefits

This research has the following benefits:

- Help analysts consider a broader list of countermeasures
- Applicable to majority of crash types
- Improve the efficiency of countermeasure selection
- Link to State analysis tools
- Enhance usability of the NCHRP 500 Guidebooks
- Provide access to the most current information
- Allow for ease of updating information ensuring it is current
- Advance implementation of the Safe System approach in the US
- Increase awareness of a valuable tool for implementing safety projects

Without the update of this project, the usefulness of the past project will continue to be diminished. If these are not updated in a timely manner, a complete redevelopment will be required instead of an update which would drastically increase future costs.

This research tied for top priority for the AASHTO Committee on Safety.

Implementation Considerations

The NCHRP 500 series is a significant research outcome that provides practitioners with useful information and data on countermeasures. The research is very dated at this time, however, as most CMFs used in those guides have been surpassed by newer/better studies. An update/refresh of these guides would bring back much of their relevance to today's federal, state and local transportation practitioners. The research results would inform State Strategic Highway Safety Plan updates and Highway Safety Improvement Program implementation efforts and help state DOTs shift more toward a Safe system philosophy and eliminate fatalities and serious injuries on the nation's roads. Additional products and activities that will help create awareness and facilitate implementation of the research results include, but are not limited to testing with the user community, creating and disseminating a promotional flyer, developing a how-to video tutorial, delivering presentations at safety and design related webinar(s), AASHTO and TRB Committee meetings, conferences and peer exchanges. The new toolkit could be linked to and referenced in other Federal, State and local resources such as Federal safety program guidance, State safety program manuals or policies, FHWA's CMF Clearinghouse, NHTSA Countermeasures that Work and other similar technical resources.

An important implementation consideration is long term maintenance of the toolkit. While this will be an extremely beneficial resource, it should be updated on a regular basis as new safety countermeasures become available for use by federal, state and local transportation practitioners. Part of this research should be to explore options for the appropriate agency/entity to lead long-term maintenance of the toolkit.

Recommended Research Funding and Research Period

\$600,000 30 months

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NCHRP Review of G-04

Reviewed By:
 Richard A. Retting
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Comments:

Updating the NCHRP 500 series is an interesting idea and would provide value. Technical information contained in the 500 series is now dated, with the most recent volume published 13 years ago. Other volumes were published almost 20 years ago. But the suggestion to update this large, 23-volume series to incorporate Safe System principles and reflect the most recent research and identify new innovations is a much larger undertaking than suggested in the problem statement. Updating the 500 series to reflect the enormous amount of research and technical information produced over the past 20 years, in addition to incorporating Safe System principles, would seem to require a level of effort far in excess of \$600,000. Another concern is redundancy with more recent NCHRP reports and other industry publications. For example, updates to Vol. 10 (Guide for Reducing Collisions Involving Pedestrians) and Volume Vol. 18 (Guide for Reducing Collisions Involving Bicycles) would be largely redundant with NCHRP 926, Guidance to Improve Pedestrian and Bicyclist Safety at Intersections. It is also worth noting that state and local road owners have ready-access to Safe System principles through multiple web resources, including PIARC Road Safety Manual: A Manual for Practitioners and Decision Makers on Implementing Safe System Infrastructure: <https://roadsafety.piarc.org/en/road-safety-management/safe-system-approach>; ITE Safe System web resource, which was developed in partnership with the Road to Zero Coalition and members of the RTZ Safe System Working Group: <https://www.ite.org/technical-resources/topics/safe-systems/>; and Recommendations of the Safe System Consortium: <https://www.jhsph.edu/research/centers-and-institutes/johns-hopkins-center-for-injury-research-and-policy/our-impact/documents/recommendations-of-the-safe-system-consortium.pdf>

Review Date:
 12/2/2021

FHWA Evaluation of G-04

Reviewed By:
 Eisert/HRSO; Doctor/RC-SHD; Amjadi/HRSO; Scurry/HSA

Comments:

The NCHRP 500 Series is very outdated, as noted in the problem statement. The proposed research will update a valuable resource for the safety community, improve safety countermeasures selection, and help advance implementation of the Safe System Approach. The proposal is well researched and stated, and it appears to demonstrate the research need, objectives, benefits, and implementation considerations reasonably and clearly. The estimated cost of \$600K is reasonable, but it may need more than 30 months for its period of performance (e.g. 40 months). In 2021 FHWA published the Focus Crash and Facility Types for systemic safety improvements to high interest. The State DOTs are eager for research of this type.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for G-04Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: 1Comments:

The Committee on Safety ranked this #1 (of 9 submitted - two tied for the top priority).

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-05

Problem Title

Integrated Strategies for Managing High Travel Speeds

Background Information and Need For Research

High traffic speeds are arguably the largest contributor to traffic deaths in the United States. High speeds contribute to crash occurrence and their direct influence on impact speeds determine crash severities (Aarts & van Schagen, 2006; Hussain et al, 2018). Moreover, specific populations, i.e., traditionally marginalized, and underserved communities, bear a disproportionate burden of our collective traffic injury problem (Hamann, Peek-Asa, & Butcher, 2020). Despite the existence of isolated interventions to curtail higher speeds—e.g., speed safety cameras, traffic calming road design, concordance between land use and road classifications—few of them have been widely and equitably adopted, and none get at the deeply rooted and interconnected causes of the problem, such as people’s harried lifestyles, thrill-seeking behaviors, the consumption of increasingly more powerful vehicles, prioritizing speed over competing values of concern for self and others, among many other interacting factors.

Literature Search Summary

The reasons people drive at high travel speeds are complex and often situation specific. For example, many drivers strongly believe that most other drivers speed and that therefore, speeding must be a normal, even expected behavior (Yannis, Louca, Vardaki, and Kanellaidis, 2013). And as most drivers consider themselves as better than the average driver, they tend to think that they are immune to being injured when driving at high speeds (Mouter, van Cranenburgh, and van Wee, 2018). Furthermore, as most drivers overestimate how much time they can save by driving at high speeds (Peer, 2010), the driving public tends to rationalize speeding, arguing that sometimes it is necessary to drive fast (Fleiter, Lennon, and Watson, 2010). More recently, the COVID-19 pandemic and associated dampening of commuting and leisure travel has provided us with an “unnatural experiment” into how travel speeds have tended to increase in response to a decrease in traffic volumes (e.g., Lee, Porr, and Miller, 2020).

In short, driving at high speeds is often conceived as normal, expected, not too risky, nearly always time saving, and simply necessary in many circumstances. Therefore, it should not be surprising that often uncoordinated education, enforcement, and engineering interventions fail to incite lasting reductions in people driving at high speeds (Naumann et al, 2020).

To manage traffic speeds proactively and over longer periods of time, professionals need to both recognize the complexity of this public health issue and to broaden their repertoire

of ways to address it. Relevant here are cross-sectoral partnerships and tools to help teams of partners to visualize the complex processes that could be driving an outcome of interest (Arnold and Wade, 2015). To ultimately develop integrated strategies to managing travel speeds in various contexts, teams will need to draw upon traditional data (e.g., crashes, roadway inventory, traffic speed and volume data, freight transport) and less traditional data (e.g., indicators of land use density and mix; perceiving those who speed as “cool”; in-vehicle feedback on drivers’ travel speeds; consumer trends privileging vehicles of increasing size, weight, and horsepower; and workplace and social group “culture” and policies surrounding high travel speeds) to consider the interacting elements of the system that influence high travel speeds. These integrated strategies should also be adaptable enough to contend with disruptions that could impact travel speeds, such as global pandemics, siloed funding of disconnected parts of the system, increased awareness of social injustices and inequities in transportation safety and access, natural disasters, and technological breakthroughs.

Research Objective

As mentioned, there are several efficacious speed-reducing tools (e.g., speed safety cameras, traffic calming road design, concordance between land use and road classifications), yet these are often not widely or equitably applied, and none address the complex array of reasons that people drive at high speeds. For example, traffic calmed streets can reduce operating speeds, however, they fail to make people feel less hurried in their lives. This research would build upon a foundation of work focused on speed limit setting (e.g., NCHRP Research Report 966; NCHRP 17-79), street redesign, traffic signal coordination, and automated speed enforcement toward enhancing pedestrian safety (e.g., NCHRP Synthesis 535) to examine the confluence of factors that influence travel speeds. This research would bring to bear a package of promising practices (e.g., speed limit setting, land use, workplace, congestion pricing), transportation investments (e.g., transit provision, speed-oriented school and workplace practices), communications strategies (e.g., media framing of travel speeds and traffic congestion), and interventions (e.g., intelligent speed adaptation [ISA], speed safety cameras and their equitable placement, operation, and re-investment schemes) that can be incorporated into a unified, adaptable framework for managing high travel speeds. The research should also shed light on strategies that do not work, or that may have unintended consequences to help free agencies from defaulting to costly and ineffectual schemes and to encourage working with partners to improve outcomes.

Research objective-related tasks could unfold over four phases:

- The first phase in this research project would be to synthesize a broad literature on speed reduction strategies, as well as community-based injury reduction interventions to expand the suite of potential strategies to expand upon in subsequent project phases and begin to address the root causes of high travel speeds among various road user demographic (e.g., based upon gender, race/ethnicity, income, age) and modal groups (e.g., drivers of trucks, cars, SUVs, motorcyclists).
- In the second phase, diverse teams of researchers, practitioners, and policymakers would convene and engage in systems thinking exercises to generate

insights on speed-related dynamics (e.g., workplace practices that knowingly or unknowingly incentivize high travel speeds among employees), feedbacks (e.g., sprawling land uses that incite high speeds to cover increasingly distances), and potential leverage points for intervention (e.g., incorporating safe design speeds in traffic impact assessment [TIA] procedures) that will support continued effectiveness. Combined with the literature review in the first phase, this will provide a comprehensive and holistic view of what we know about factors generating high travel speeds, where current interventions attempt to intervene on the problem, weak points in these strategies, and where we might need to consider additional interventions or supports given varying legal, financial, and cultural contexts.

- A third phase in this project would be to incorporate strategies identified in the literature review and second phase into a prototype Integrated Strategies for Speed Management Framework for managing high travel speeds in an integrated manner that DOTs and their partners can use to manage travel speeds across the network and within various community (e.g., schools) and institutional (e.g., DOTs, county public health departments, local hospitals, local news media) environments, as well as overcoming barriers to securing funding and additional resources to help mitigate travel speeds.
- The fourth and final phase would draw from results of the third phase to design prospective demonstration studies with local, regional, and state partners on the implementation of the Integrated Strategies for Speed Management Framework. These prospective studies would be designed to assess real-world applications of the framework, provide tips on carrying out a formative evaluation of the demonstration, and recommendations for refining the framework based upon formative evaluation results. It is anticipated that this prospective demonstration study would seek guidance on best practices for identifying partners, policies, practices, and interventions which, when used in appropriate contexts and in combination, can help manage travel speeds across various spatial and time scales.

Urgency and Potential Benefits

Road user safety is foundational to all state DOTs' missions. As such, developing and implementing ways to curtail high travel speeds—the largest contributor to traffic deaths in the United States through their direct influence on impact speeds, which determine crash severities (Aarts & van Schagen, 2006; Hussain et al, 2018)—is, or should be, a central, organizing goal of most DOTs.

Given that more recent traffic monitoring studies have revealed average travel speeds increasing throughout 2020, and a 7.2 percent year-over-year increase in the number of people (38,680 in 2020) dying in motor vehicle crashes in the US, the largest increase in fatalities since 2007 (National Highway Traffic Safety Administration, 2021), the consequences of failing to meaningfully address the dangers of high travel speeds will result in many more deaths and serious road injuries. Plus, the potential benefits of attenuating high travel speeds are sizable, including reductions in deaths, injuries, and suffering, as well as improved public health via lower ambient noise and air pollution (Distefano, & Leonardi, 2019). To optimize the many benefits for managing travel speeds, state DOTs and their cross-sectoral partners would profit from more than a synthesis of existing speed management practice, and instead engage with an expanded, coordinated

set of strategies to help address root causes and issues in speed management that are virtually impossible to fully tackle by any single agency or strategy (e.g., solely relying on speed safety cameras to address the problem).

The AASHTO Committee on Safety ranked this its #6 priority.

Implementation Considerations

Considering the use of the research results from the proposed effort, staff within state DOTs who conduct safety research, design roadways, approve driveway permits and posted speed limits on state-owned and operated roads, those who develop the departments' street classifications and cross-sectional design guides, those who work on school travel, parking, and circulation, and administrators seeking ways of enhancing their employees' traffic safety culture and safety performance, among others, will find results from this research practical and readily adaptable in their workflows.

An increasing number of state DOTs are committing to "Towards Zero Deaths" initiatives, which many recognize requires coordinated action among multidisciplinary players who set out to solve complex road safety problems, including the critical issue of speed management (FHWA, 2020). Thus, a few anticipated steps for state DOTs to take to implement the proposed project's research findings within their organizational structures would be to consider agencies' roles in supporting safer speeds on our roadways, and to acquire a deeper understanding of how they can work with partners to effectively reduce travel speeds and do so in a sustainable manner.

Processes to support adoption and implementation of the research could take the shape of demonstration projects coupled with peer exchanges and tailored trainings, wherein the research team partners with several state DOTs to experiment with applying key recommendations of the project and transmitting lessons learned to additional agencies. The project team would likely seek assistance from the NCHRP Implementation Support Program to carry out the following.

To foster awareness and facilitate widespread implementation of the proposed Integrated Strategies for Managing High Travel Speeds framework, research teams could develop brief, two-page summaries of the project's background, methods, results, and practical implications, and then share the summaries via social media and through various email lists; establish an "academy" around coordinated and innovative means of tempering travel speeds, one that requires agencies to apply to participate, connects participants with others to problem-solve, receive coaching, engage in systems thinking, etc.; the demonstration projects referenced above; and accessible multi-media (text and video) "stories" that feature academy and demonstration project participants implementing integrated and holistic speed management strategies, thereby demystifying the project's complexity, and inspiring colleagues through processes of imitation as facilitated through peer exchanges and expert coaching.

Recommended Research Funding and Research Period

\$500,000 over 24 months.

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NCHRP Review of G-05

Reviewed By:

Richard A. Retting

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Comments:

The problem statement focuses on an important highway safety topic. Speeding makes crashes more likely because it takes longer to stop, and makes collisions more deadly because crash energy increases exponentially as speeds increase. It is important to note, however, that speeding is among the most researched and documented highway

safety issues. Furthermore, the literature search summary fails to acknowledge many important resources related to speeding, such as *Speed Management: A Road Safety Manual for Decision-makers and Practitioner* (European Conference of Ministers of Transport); FHWA's *Speed Management: A Manual for Local Rural Road Owners*; NHTSA's *Uniform Guidelines for State Highway Safety Programs*; ITE's *Speed Management for Safety* resource hub (an interactive website on speed management); and TRB Special Report 254, *Managing Speed*. In addition, there is significant research and policy work currently underway in conjunction with FHWA's Speed Management Safety and Safe System Approach programs. The need to develop an Integrated Strategies for Speed Management Framework is questionable and largely redundant given the plethora of available resources related to speed management, including those noted above, which provide solid information for practitioners.

Review Date:

11/30/2021

FHWA Evaluation of G-05

Reviewed By:

Xu/HSA; Mookherjee/HSA

Comments:

The statement of problem is very well thought out and makes a good case for thinking holistically and beyond the silos of the traditional 3-4 E's. The research statement proposes to develop comprehensive speed management strategies that would address issues such as the perceived 'time-saving' by driving at high speeds, challenges and advantages associated with modern vehicle technologies and performances, and many other aspects that influence speed culture in addition to the conventional speed management strategies. It also proposes to evaluate strategies to mitigate/modify the public perceptions around speed and positively influence speed culture. The outcomes of integrated strategies for managing speed as proposed will further contribute to the implementation of the Safe System Approach and Complete Street strategies. The project will also evaluate strategies that do not work, and this could be particularly useful to practitioners. The estimated cost seems somewhat low for the relatively broad scope of the proposed project.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for G-05

Submitted By:

Bud McDonald

AASHTO staff

Council on Active Transportation

Priority #: N/A

Comments:

Consider how G-02, C-11 and G-05 are interconnected and impact one another and could influence the alternatives developed.

Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: 6

Comments:

The Committee on Safety ranked this #6 (of 9 submitted).

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

PROBLEM NUMBER: 2023-G-06

Problem Title

Intersection Crash Prediction Models for Future Editions of the HSM

Background Information And Need For Research

In 2010, AASHTO published the first edition of the Highway Safety Manual (HSM). HSM Part C includes methods to predict the safety performance of new facilities, assess the safety performance of existing facilities, and estimate the expected effectiveness of proposed improvements to existing facilities. In preparing the first edition of the HSM, decisions that determined which facility types would be addressed by the predictive methods chapters were made based on availability of data, funding limitations, and highway agency priorities. Since the preparation and publication of the first edition of the HSM, several NCHRP projects have been funded to expand the safety knowledge and improve the crash prediction methods provided in Part C of the first edition of the HSM.

The HSM Part C provides the capability to analyze the safety performance of approximately thirteen intersection configurations and traffic control types as shown in Table 1.

Table 1. Intersection types addressed by predictive methods in the first edition of the HSM

Intersection Type	HSM Chapter			
	10	11	12	19
Three-leg intersections with stop control on minor approach	X	X	X	
Four-leg intersections with stop control on minor approaches	X	X	X	
Three-leg intersections with signal control			X	
Four-leg intersections with signal control	X	X	X	
Diamond ramp terminals at crossroad				X
Parclo ramp terminals at crossroad				X
Free-flow ramp terminals at crossroad				X

Recently, research was conducted to develop crash prediction methods for intersection configurations and traffic control types not covered in the first edition of the HSM. In NCHRP Project 17-68, crash prediction methods were developed for the following general intersection configurations and traffic control types for consideration in the second edition of the HSM (currently being produced under NCHRP Project 17-71A):

- Rural and urban all-way stop-controlled intersections
- Rural three-leg intersections with signal control
- Intersections on high-speed urban and suburban arterials (i.e., roadways with speed limits greater than or equal to 50 mph)
- Urban five-leg intersections with signal control
- Three-leg intersections where the through movements make turning maneuvers at the intersections
- Crossroad ramp terminals at single-point diamond interchanges
- Crossroad ramp terminals at tight diamond interchanges

To further expand the intersection types addressed in future editions of the HSM (i.e., HSM3), crash prediction models could be developed for additional intersection configurations and traffic control types that are not addressed in the first edition of the HSM and were not developed for HSM2 as part of NCHRP Project 17-68. For example, several additional intersection configurations and traffic control types for which crash prediction models could be developed for future editions of the HSM include:

- Intersections with frontage roads
- Restricted crossing U-turn intersections (RCUTs)
- Median U-turn intersections (MCUTs)
- Jughandle intersections
- Displaced left-turn intersections
- Continuous green tee intersections
- Intersections with yield or no control
- Rural five-leg intersections
- Urban and suburban five-leg intersections with minor-road stop control
- Six-or-more-leg intersections
- Diverging-diamond ramp terminals

The need for this research is based on the results of NCHRP Project 17-68 and a clear understanding of what is planned for incorporation in the second edition of the AASHTO Highway Safety Manual. Thus, the recommended scope for this research, as stated above, is appropriate for further research beyond the second edition of the HSM.

Literature Search Summary

A review of previous studies that addressed the safety performance of intersections was conducted. The final report from NCHRP Project 17-68 provides a detailed summary of the intersection safety performance functions (SPFs) and crash prediction models (CPMs) included in the first edition of the HSM and planned for incorporation in HSM2. Several other studies have documented the safety performance of intersection types that will not be addressed in the HSM2; but these studies address the general safety performance of these intersections and/or provide estimated crash modification factors (CMFs) for these intersections. For these other intersection types not addressed in the HSM, CPMs need to be developed in a consistent manner with procedures in the HSM so that comparisons can be made about the relative safety performance of different intersection configurations and traffic control types.

Research Objective

The objective of this research is to develop new intersection crash prediction models (CPMs), as discussed above, for potential inclusion in a future edition of the HSM that are consistent with existing methods in HSM Part C and comprehensive in their ability to address a wide range of intersection configurations and traffic control types in rural and urban areas. The new CPMs should be developed so that comparisons can be made between the safety performance of intersection types included in the HSM and the intersection types that will be addressed in this research.

Urgency and Potential Benefits

Intersections create conflict points where crashes can occur. Annually, approximately 28 percent of traffic fatalities in the United States occur at intersections. State and local transportation agencies across the United States are looking for ways to reduce the frequency of crashes, particularly fatal and serious injury crashes, at intersections. This research will help agencies assess the safety performance of intersections under their jurisdiction and help to evaluate the safety performance of design alternatives that may be considered either to improve the safety performance of existing intersections or when designing new intersections.

The research was ranked priority #8 by the AASHTO Committee on Safety.

Implementation Considerations

State and local transportation agencies and safety practitioners are looking for guidance and tools to evaluate the safety performance of a range of intersection configurations and traffic control types to help them make more educated decisions. This research is intended to expand the range of intersection configurations and traffic control types for which quantitative safety performance estimates can be made to aid with the decision-making process.

Recommended Research Funding and Research Period

The funds and time period necessary to accomplish the research objectives are estimated to be \$750,000 over a 30-month period of performance.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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NCHRP Review of G-06

Reviewed By:

Richard A. Retting
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Comments:

The problem statement provides solid background information, explains the need for research, and offers a clear research objective. The types of intersection configurations and traffic control types for which crash prediction models could be developed under the proposed research are far less prevalent, and thus less of a priority, than intersection configurations and traffic control types for which crash prediction methods have been a research focus. Thus the suggested funding of \$750,000 might not be justified on a priority basis. In addition, the timing of the proposed research may not be a priority given extensive ongoing research to update the 1st edition of the HSM, the uncertain publication date for the 2nd edition, and rapid advancement of automated driving systems, which could significantly influence all future crash prediction methodologies.

Review Date:

11/27/2021

FHWA Evaluation of G-06

Reviewed By:

Intersections Team/HSA/HRDS

Comments:

This would be a timely and useful project that would provide significant value to the Intersection Safety program. As the problem statement indicates, there are several very common intersection scenarios that lack SPFs, and result in limitations to predictive analysis when it comes to intersection projects. The timing for this is very good given the completion of project 17-68 and preparation of the HSM-2.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for G-06

Submitted By:
Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A

Comments:

Consider adding specific discussion of pedestrian and bicyclist movements in the intersection types examined.

Submitted By:
Kelly Hardy
AASHTO staff
Safety

Priority #: 8

Comments:

The Committee on Safety ranked this #8 (of 9 submitted).

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-07

Problem Title

Method for Evaluation of a Mixed-Project Safety Program

Background Information and Need For Research

The general purpose of the Highway Safety Improvement Program (HSIP) is to accomplish a substantial reduction in traffic fatalities and serious injuries on all public roads (including non-State-owned public roads and roads on tribal land) through the implementation of infrastructure highway safety improvements (1). The HSIP requires follow-up on the strategic highway safety plans to identify the targeted safety emphasis areas and key actions to reduce severe injury crashes. The HSIP (Section 148 of Title 23, United States Code (23 U.S.C. §148)) is one of the core federal-aid programs in the federal surface transportation act, Fixing America's Surface Transportation Act (FAST)(2). The HSIP is supported and funded at the federal level and is administered on the state level.

The HSIP process includes three primary stages:

1. Planning stage: focuses on studying, analyzing, and selecting projects that potentially require safety improvements.
2. Implementation stage: includes installing the optimal countermeasures that are expected to improve safety performance.
3. Evaluation stage: focuses on project effectiveness and monitoring the HSIP process from start to finish.

The evaluation stage provides an opportunity to continuously improve planning, implementation, and project documentation processes and decisions. Implementing a reliable evaluation method is key to supporting the HSIP project process by increasing the effectiveness of future projects and maximizing the return of investment for safety funding. State transportation agencies continue to enhance and expand their HSIP evaluation practices (1). Currently, most state transportation agencies track basic project information, evaluate individual projects in some manner, and disseminate results to stakeholders (3). While agencies are making progress in enhancing HSIP evaluation practices, a variety of approaches are being used across agencies. Specific guidance on tracking and evaluating the effectiveness of projects, countermeasures, and programs can benefit agencies and help them enhance their own processes.

The focus of the evaluation stage of the HSIP, as well as the concept of evaluation to many agencies, refers to the post implementation safety performance of a single project. While the individual project may have multiple countermeasures implemented

the majority of the currently used evaluation techniques do not focus on the evaluation of a program of diverse safety projects. The American Association for State Highway Transportation Officials' (AASHTO) Highway Safety Manual (HSM) outlines a multipart method for the evaluation of multiple projects using an Empirical Bayes (EB) methodology, however, this process is directed towards the analysis of similar site types implementing the same countermeasure (or same combination of countermeasures). The methodology is best suited for development of crash modification factors (CMFs) rather than the evaluation of a diverse portfolio of safety projects, which is typical for State HSIPs.

While simpler statistical methods, such as naïve before-after or before-after with traffic volume correction, don't have the methodological limitations of the EB methodology from the HSM, the results can be influenced by a few larger projects or dominant site types when individual projects are aggregated for the program level effectiveness. Given the push for involving local agencies and off-state system roads within the HSIP, it's more important now than ever before to be able to effectively evaluate a full portfolio of HSIP projects with an even comparison. This will help state agencies improve funding allocations and project types across all roadway and site types and drive down fatal and serious injury crashes across complete roadway networks. Furthermore, simpler statistical evaluation methods being used at a program level, cannot account for the biases that EB methods do.

Literature Search Summary

Chapter 6 of the Highway Safety Improvement Program Manual (HSIP Manual) focuses on project level evaluation detailing the benefits and drawbacks of various project level evaluation methods. The HSIP manual specifically notes that the evaluation procedures are intended for individual projects, groups of similar projects/ treatments, or development of CMFs (1).

The Highway Safety Improvement Program Evaluation Guide (2017) covers program evaluation from crash data-based and activity-based measures of performance. The methods discussed in the guide serve as high level indicators of program effectiveness offering several methods that use aggregate program level data (such as total crash numbers and total HSIP funds implemented) to capture a big picture evaluation of state programs. The guide does not offer a quantitative approach to program level effectiveness that builds off EB based before/ after analyses (4).

The Highway Safety Manual Part B Chapter 9 provides guidance on how to calculate safety effectiveness of a treatment using predictive analyses with the EB before-after safety evaluation method. The method provided offers a starting point for evaluation from the HSM Part C Predictive Method and EB based before/ after project evaluations. However, this method is recommended for similar projects or treatments and is best used for CMF development (5).

The Texas Transportation Institute, on behalf of the Texas Department of Transportation conducted an analysis of more than 387 segment and 70 intersection

projects in Texas. The research applied the HSM Part B Chapter 9 method to the segment and intersection projects as complete groups, developing safety effectiveness indices for each. The research indicates that the methodology can be applied to an entire program of projects, but there is no discussion of how different predictive method site types were accounted for when using the EB before/after methodology. Furthermore, the researchers chose to only evaluate the groups of projects for development of CMFs (essential program level effectiveness) using naïve before/ after and naïve before/after with traffic volume correction (6).

References

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- (2) Fixing America's Surface Transportation Act. (2015). Washington, D.C.: U.S. Government Publishing Office.
- (3) HSIP Evaluation Study – Final Report. Ohio Department of Transportation. Columbus, Ohio. 2020.
- (4) Gross, F. (2017). Highway Safety Improvement Program (HSIP) Evaluation Guide (Rep. No. FHWA-SA-17-039). Washington, DC: US Department of Transportation, Federal Highway Administration.
- (5) Highway Safety Manual. (2010). Washington, DC: American Association of State Highway and Transportation Officials.
- (6) Tsapakis, I., Sharma, S., Dadashova, B., Geedipally, S., Sanchez, A., Le, M., . . . Dixon, K. (2019, October). EVALUATION OF HIGHWAY SAFETY IMPROVEMENT PROJECTS AND COUNTERMEASURES: TECHNICAL REPORT (Rep. No. FHWA/TX-19/0-6961-R1). Retrieved February, 2020, from Texas Department of Transportation website: <https://static.tti.tamu.edu/tti.tamu.edu/documents/0-6961-R1.pdf>

Research Objective

To develop a methodology capable of producing quantitate estimates of how a broad group of projects has affected crash frequencies or severities. The broad group of projects will represent the breadth of treatments and project site types that may comprise a state's HSIP yearly body of projects (in so much as the sites are represented by Predictive Method site types either included in or planned for inclusion in the Highway Safety Manual). At a minimum the methodology will:

- allow for an aggregation of EB analysis across and diverse site types, accounting for the different relative contributions of various site types in the Safety Effectiveness Calculation (Odds Ratio or equivalent performance metric) result for the entire program of projects,
- account for outliers or otherwise weight projects to prevent high leverage sites from obscuring true effectiveness evaluation of program level results,
- include robust examples for support in methodology implementation, and
- include recommendations for potential inclusion of the methodology into the HSM and HSIP Program Evaluation process.

Urgency And Potential Benefits

Implementation of the AASHTO HSM Predictive Method has had a dramatic effect on the project development and implementation processes across the country. While these improvements have undoubtedly improved traffic safety, there needs to be an analogous statistical method for the critical evaluation component at the program level to help direct funding efforts and focus improvements to the most effective project types. The proposed methodology addresses an immediate need for improvement of the HSIP evaluation process. The research resulting from this needs statement has the potential to be adopted for yearly evaluation by state departments of transportation as a part of their HSIP, allowing States to measure the impact of the HSIP on reducing fatalities and serious injuries and make continuous process improvements, resulting in a national shift in the priority and implementation of HSIP funding. The evaluation results could also be aggregated at the national level to demonstrate the value of the HSIP. Additionally, the evaluation results could guide a state's project portfolio to ensure progress towards the federal safety performance measures.

The AASHTO Committee on Safety ranked this its #5 priority.

Implementation Considerations

Deliverables of the research project should include an implementation approach that involves outreach to users of the proposed methodology. Guidance on applying the methodology should be provided to enable agency staff to assess the level of effort, skills, and knowledge needed. Implementation efforts could include a pilot use of the research results, with plans for disseminating any reports, case studies, noteworthy practices, and lessons learned to additional potential users.

Recommended Research Funding and Research Period

Estimate for Funding: \$400,000

Research Period: 24 Months

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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 To be determined.

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NCHRP Review of G-07

Reviewed By:
 Richard A. Retting
 rretting@nas.edu

Comments:

The problem statement provides solid background information and documents the need for research; a good literature search summary; and clear research objectives. The recommended funding seems reasonable for the stated research objectives. It is noteworthy that one of the authors of this HSIP-related research problem statement, Karen Scurry, serves as FHWA program contact for the HSIP program.

Review Date:
 11/26/2021

FHWA Evaluation of G-07

Reviewed By:
 Scurry/HSA

Comments:

The expected outcome of this proposal can provide a timely need to enhance program level safety evaluations. It would serve as a useful tool for HSIP which can further

strengthen agency capability to prioritize their project development cycle and support national HSIP evaluation efforts. It may also offer a valuable addition to be considered in a future edition of AASHTO's Highway Safety Manual.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for G-07

Submitted By:

Bud McDonald

AASHTO staff

Council on Active Transportation

Priority #: N/A

Comments:

Consider evaluation methodologies enabling analysis of active transportation projects. Consider incorporating Safe System Approach in evaluation structure. This will set DOTs up for application of requirements under IIJA. Recommend evaluating active transportation projects in context of network connectivity. Filling a gap in a trail system allows vulnerable road users to complete a longer trip away from vehicular traffic, adding safety value. How many total miles of safer connections does a given project enable? How do safety improvements support mode shift?

Submitted By:

Kelly Hardy

AASHTO staff

Safety

Priority #: 5

Comments:

The Committee on Safety ranked this #5 (of 9 submitted).

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-08

Problem Title

Pedestrian Crosswalk Spacing and Placement Guidance to Improve Safety

Background Information And Need For Research

An estimated 6,205 pedestrians were killed in traffic collisions in the U.S. in 2019 – a 44% increase in pedestrian fatalities since 2010, representing 17% of total traffic fatalities. Over 80% of those pedestrian fatalities occurred at unmarked midblock locations. Roadway safety is a shared responsibility and while some fatalities are due to pedestrian negligence, many cases result from a system that prioritizes automobile mobility at the expense of pedestrian safety. Research has found that locations where pedestrians are most likely to cross outside crosswalks are highly influenced by the surrounding roadway environment and characteristics, such as pedestrian volume, number of bus stops, vehicular volume, distance between crosswalks, and crossing distance. For most pedestrians to walk far out of their way to cross a street at a marked crosswalk would contradict basic human behavior. Therefore, to prevent needless fatalities and injuries, we must provide safely designed crosswalks that are properly spaced so that pedestrians can practically utilize them. While prior research has established the safety and effectiveness of countermeasures such as refuge islands, pedestrian hybrid beacons (PHBs), and rectangular rapid flashing beacons (RRFBs) and provides guidance (e.g. STEP guide) for selecting countermeasures at uncontrolled crossing locations, current guidance and research regarding midblock crosswalk spacing is limited. The ongoing study NCHRP 03-141 - Guidance on Midblock Pedestrian Signals (MPS) will assess the safety effects of MPS and develop language suitable for inclusion in the MUTCD, but more work is needed to understand suitable spacing of these treatments. The AASHTO Council on Active Transportation's Research Roadmap (July 2021) identifies "Determining context-driven optimal spacing between marked crosswalks" as one of their six highest-priority needs. This research aims to reduce pedestrian fatalities and severe injuries through a better understanding of appropriate midblock crosswalk spacing.

Literature Search Summary

National crosswalk spacing guidance is ambiguous, with Section 3B.18 of the MUTCD stating: "Crosswalk lines should not be used indiscriminately. An engineering study should be performed before a marked crosswalk is installed at a location away from a traffic control signal or an approach controlled by a STOP or YIELD sign." Although it is recommended that the engineering study consider the distance from adjacent signalized intersections and the possible consolidation of multiple crossing points, there are no specific criteria offered in terms of spacing and no specific criteria that take varying infrastructure and land use conditions into account.

Several state guidelines for crosswalks refer to the American Association of State Highway and Transportation Officials (AASHTO) Stopping Sight Distance formula. This formula combines a driver's reaction time, braking distance, travel speed, and roadway grade to calculate the distance necessary for a vehicle to make a complete stop. AASHTO recommends that midblock marked crosswalks not be installed where sight distance and sight lines are limited. However, while this guidance identifies where marked crosswalks should not be installed, it does not directly inform where they should be installed and their appropriate spacing.

To ensure efficient traffic operations, many agencies have also adopted requirements that preclude marking a crosswalk within a close distance of another crossing. These requirements generally specify a minimum distance of 200-600 feet between a midblock crosswalk and the next nearest marked crosswalk (see e.g., Arizona Department of Transportation; City of Boulder; City of Sacramento; Florida Department of Transportation; Georgia Department of Transportation; San Francisco Municipal Transportation Agency; Utah Department of Transportation; Vermont Agency of Transportation; Virginia Department of Transportation).

While these minimum distances are important to ensure safety and efficient traffic operations, the maximum suitable distance between crosswalks is more critical for ensuring that there are adequate crossing opportunities that are designed appropriately to reduce the risk of pedestrian crashes. After a thorough review of crosswalk guidance, the Portland (OR) Bureau of Transportation appears to be the only agency with a recommended maximum distance between pedestrian crossings (530 feet within pedestrian districts and 800 feet outside pedestrian districts). Note, however, that these guidelines have not been rigorously studied.

The only relevant research that we could find (from the 1995 Nationwide Personal Transportation Survey) reported that about 25 percent of pedestrians stated they would walk 550 feet to a controlled crosswalk and 50 percent would walk 200 feet. Such findings may help define the relationship between crosswalk spacing and pedestrian compliance.

In this vein, research could examine not just the maximum distance that pedestrians will walk to a marked crosswalk, but also their preferred distance. It would also be warranted to explore these criteria in different geographic locations including urban versus suburban, varying land uses, and different regions of the country. This would be useful for regions with relatively fewer pedestrian collisions that do not have a clear pattern. A vitally important aspect will also be to account for roadway classification and characteristics including vehicle speed and volumes as recommendations will need to balance safety and operations.

More research is needed to provide states and cities with guidance on the important criteria of maximum crosswalk spacing. Providing appropriately spaced crosswalks that are properly designed for the specific roadway conditions may improve the safety and security of pedestrians.

Research Objective

The research aims to determine the maximum distance pedestrians will travel to use a crosswalk and develop crosswalk spacing recommendations in various contexts, based on pedestrian behavior and willingness-to-deviate. A better understanding of this spacing will help to inform when to add marked crosswalks at uncontrolled midblock locations to discourage pedestrians from crossing at higher-risk locations between crosswalks. In addition to crosswalk spacing, the research will explore factors that influence pedestrians' choice to divert from an unmarked direct crossing path toward a marked crossing in terms of origin/destination proximity, land use context, and crossing need. Considerations may include: pedestrians' vehicle gap acceptance, the number of conflict points at crossings, the impact of vehicle volumes, vehicle speeds, number of travel or turn lanes, pedestrian travel distance, crossing distance, and different levels of midblock crosswalks (e.g. signage, flashing beacons, curb extensions, road diet, HAWK signals, etc.).

Research tasks may include:

1. Literature review of existing strategies and research regarding crosswalk spacing compliance and safety outcomes with a focus on human factors.
2. Data collection (crosswalk location and land use and transportation context, pedestrian compliance and safety outcomes, roadway environment such as lighting, geometry, facilities, vehicle speeds and volumes, operational details, users, vehicles, etc.).
3. Survey pedestrians to explore willingness to deviate to cross at a marked crosswalk across a variety of land-use contexts.
4. Identify compliance and safety outcomes related to crosswalk spacing and context.
5. Propose solutions and guidance for agencies on maximum crosswalk spacing.

Urgency And Potential Benefits

This research will inform design guidance and work to counteract the trend of increasing pedestrian fatalities and severe injuries at midblock crossing locations. The trend is found throughout the country and will be of interest to a majority of state DOTs as well as regional and local agencies. Findings will also serve to greatly improve overall pedestrian safety, with benefits being directly borne by some of the most vulnerable users of our roads.

This research was ranked #4 by the AASHTO Committee on Safety.

Implementation Considerations

Traffic and geometric design professionals responsible for facility design and planning will be most likely to use the research results.

AASHTO committees that might be interested in the research results and could help with implementation include the AASHTO Technical Committee on Nonmotorized Transportation (Rodger Gutierrez, P.E.; 503-986-3554; rodger.c.gutierrez@odot.state.or.us) and the AASHTO Safety Committee (Kelly Hardy, P.E.; 202-624-5868; khardy@ashto.org).

Recommended Research Funding and Research Period

Funding to accomplish research objectives and communication activities is estimated at the level of \$400,000-\$500,000. A research period of 24-36 months is expected.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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Person Submitting The Problem Statement: Name, affiliation, email address and phone.

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NCHRP Review of G-08

Reviewed By:

Camille Crichton-Sumners

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Comments:

The findings of this study will help the state transportation agency geometric design and planning staff, responsible for designing crosswalk facilities, to better accommodate pedestrians and increase their compliance and safety. Should this study advance, IRB approval may be needed depending on the methodology. Given the need for extensive field work and the potential risk to the project schedule from the involvement of volunteers, the budget should be increased to \$700,000 and the duration increased to 36 months.

Review Date:

12/17/2021

FHWA Evaluation of G-08**Reviewed By:**

Mero/HRSO; Redmon/HSA; Calawa/HOTO

Comments:

There has been a lot of interest and discussion about this topic over the last few decades. Placing crosswalks far apart does not encourage safe crossing behavior and often forces pedestrians to cross somewhere in the middle, where it may be unsafe. The vast majority of pedestrian fatalities occur at midblock, and some standard guidelines for state and local agencies to follow would be helpful and would aid in increasing safety and consistency. Accordingly, this is a very important project. This will build on study NCHRP 03-141 - Guidance on Midblock Pedestrian Signals (MPS) and lead to a natural progression. The research objective seems very comprehensive. There is an opportunity for the authors to provide more information on what type of data collection (e.g., field study, simulator, both, other) and method for survey of pedestrians would respond to the objective. It is hard to determine if the proposed cost or project duration is appropriate given the information in the proposal. FHWA encourages the research team to choose a number of variables they can thoroughly and reasonably examine within the time and cost.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for G-08**Submitted By:**

Bud McDonald

AASHTO staff

Council on Active Transportation

Priority #: N/A**Comments:**

Recommend combining with C-01: Determining Context-Driven Optimal Spacing between Marked Crosswalks.

Submitted By:

Kelly Hardy

AASHTO staff

Safety

Priority #: 4

Comments:

The Committee on Safety ranked this #4 (of 9 submitted).

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-09

Problem Title

Practical Approaches to Quantifying Safe System Concepts

Background Information And Need For Research

For 2020, according to the National Highway Traffic Safety Administration (NHTSA), estimates show that 38,680 people died in motor vehicle traffic crashes. This represents the largest projected number of fatalities since 2007. This figure represents an increase of about 7.2 percent as compared to the 36,096 fatalities reported in 2019. These figures demonstrate that traffic-related deaths continue to be a serious public health issue.

Worldwide, the use of Safe System principles for roadway design and operations is showing significant success in driving down fatal and serious crashes for all road users, including those who walk and bike. The Safe System approach recognizes that all road users should be treated equitably, in a manner that considers safety tradeoffs for all, and that death and serious injury are preventable when consideration is given to the tolerance of the human body to crash forces. In addition, the Safe System approach applies to all roadways: urban or rural, and under state, local or tribal jurisdiction. The Safe System approach recognizes that human errors occur and that by designing and operating road infrastructure to account for these errors crash likelihood is reduced.

This research directly supports the AASHTO Committee on Safety's Strategic Plan goal to "partner in the implementation of a national highway safety strategy and performance measures to reduce fatalities and serious injuries on all public roads and locations where roads intersect with other modes of transportation." In addition, the strategic goals to "institutionalize analytical tools to advance the science of safety" and "provide data-driven safety technical and policy advice" are supported by this research.

Literature Search Summary

This research will provide specific applications to advance the Federal Highway Administration (FHWA) published "Integrating the Safe System Approach with the Highway Safety Improvement Program: An Informational Guide". The FHWA publication "A Safe System-Based Framework and Analytical Methodology for Assessing Intersections" outlines a set of future research steps that are in line with the objectives of this research. In addition, this research will complement the NCHRP 17-101 project "Safe System in the U.S.: Developing a Roadmap for Transportation Road Designers, Planners, and Engineers" as a first step in Safe System implementation in the United States. This research will provide applications that build upon the practices highlighted in The Institute of Transportation Engineers (ITE) document "Case Studies on Implementing the Safe System Approach in the U.S."

Research Objective

The objective of this research is to investigate the correlation between a Safe System for Intersections (SSI) score and observed fatal and serious injury crash frequency at an intersection so that a benefit/cost ratio or cost effectiveness associated with the SSI score can be determined. This methodology can then be applied to corresponding roadway segments. The research will also recommend how the SSI can be adopted to design and operational criteria for future implementation. Pilot testing of the research results will be used to validate and strengthen the methodology and will provide additional knowledge to those transportation agencies implementing the new model.

The Safe System approach applies to all roadways, urban and rural, and relies on analysis and evaluating/quantifying the safety benefits of differing design and operational alternatives. Importantly, the FHWA SSI report (FHWA-SA-21-008) provides a method for developing a SSI score and other Safe System related metrics that quantify exposure, complexity, and severity in the event of different crash types. This method also provides for an assessment of a wide selection of intersections, including but not limited to signalized urban intersections and rural uncontrolled intersections. This SSI method can be applied at a project level and be incorporated into an Intersection Control Evaluation (ICE) alternatives screening process to provide another metric for safety. While a compilation of states' existing activities may be beneficial, new research is needed to assess the significance of the correlation of the Safe System approach and the SSI method currently underway in several states. For example, Florida DOT is in the process of adding SSI into the Safety Performance for Intersection Control Evaluation (SPICE) spreadsheet and will be effective January 2022. The SSI analysis will be for all intersection forms included in the FDOT SPICE. The FDOT ICE Manual is also being revised to discuss the SSI analysis compared to the SPF crash prediction. Massachusetts used the SSI approach to compare design alternatives for intersection types that do not have Safety Performance Functions.

This SSI process still requires several high-level assumptions to be included in the analysis that impact the outcome and states are reluctant to adopt these assumptions without some level of validation. The method is a combination of quantitative concepts (such as exposure and fatal and serious injury probability) and qualitative concepts (such as user complexity and comfort).

Major activities:

- a. Further test the SSI approach so that efforts can be made to validate and calibrate the SSI method with crash data at differing crash severity level, differing urban and rural locations, and develop a means to compare the output of the SSI models with actual safety performance at existing locations to better integrate these methods into the Safety Management Process. This will support the use of the SSI approach for alternative analysis, prioritization of projects and with implementing effective projects as part of a successful Highway Safety Improvement Program (HSIP).

- b. Develop refined input SSI criteria, including pedestrians and bicyclist paths through intersections, to improve upon the high-level assumptions and enhance the selection of intersection crash types (ex: rear end crashes) and intersection geometric inputs such as turn lanes. This will provide more realistic and usable results for transportation agencies at all levels.
- c. Use the initial research findings to conduct pilot testing of the SSI model in volunteer states and assess the research findings.
- d. Expand the quantification of the Safe Systems approach to cover segments and to use existing crash data to estimate the kinetic energy models for those segments.
- e. Development of dissemination materials for use by transportation agencies in the use and implementation of the SSI, including items such as worksheets, analysis tools and presentations.

Research results should be presented in a final report and guidance that gives clear and actionable strategies to state DOTs and other agencies to effectively implement safe system principles.

Urgency And Potential Benefits

Searching For Opportunities To Reverse the upward trend in traffic fatalities, many States are interested in moving towards a Safe System approach and have been looking at practical ways to reduce crash forces at intersections and roadways. In some cases, this has resulted in the development of policy changes in speed management and design directives.

According to FHWA guidance, there are six principles that form the basis of the Safe System approach: deaths and injuries are unacceptable, humans make mistakes, humans are vulnerable, responsibility is shared, safety is proactive, and redundancy is crucial. Road design and operation seeks to reduce complexity and to manage speeds and crash angles so that all road crashes and severity of those crashes are lowered. Without this research, advancement in a practical data-driven application of the Safe System approach could be limited.

This research will help safety professionals more fully understand the relationships between economic, regulatory, vehicle, and infrastructure factors and traffic fatalities and the mechanisms by which they operate to provide states with insights that can be used to target fatality reduction programs and projects. Moreover, strategies that combine domains will be important for using state resources efficiently to maximize fatality reductions.

This research tied for top priority for the AASHTO Committee on Safety.

Implementation Considerations

There are several potential users of this research, namely state DOT traffic and safety engineers as well as State Governor's offices of Highway Safety and local agencies. The states of Florida, Massachusetts and Virginia have already used the SSI approach to enhance their respective safety performance initiatives. The research could have direct application to state implementation of the HSIP, enhanced safety performance target development, and future safety funding requests. The results of the research could be disseminated through technical presentations and peer exchanges. Pilot testing of the SSI model would strengthen the overall research and benefit future implementation. The AASHTO Committee on Safety is interested in this research and will assist the member states with implementation. Also, the FHWA Office of Safety is interested in this research.

Recommended Research Funding And Research Period

Research Funding: A proposed budget of \$450,000 would be necessary to complete the research tasks, the pilot testing, and training via a webinar or through a peer exchange

Research Period: The expected time-period to complete the research is 24 months including the pilot testing and the webinar/peer exchange.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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NCHRP Review of G-09

Reviewed By:
Richard A. Retting
rretting@nas.edu

Comments:

The topic of Safe System Approach is timely and a significant research focus for the FHWA Office of Safety. The problem statement provides strong background information and documents the potential benefits of conducting additional research; a good literature search summary; and clear research objectives. The recommended funding seems reasonable for the stated research objectives, although perhaps a bit high. Given the significant FHWA attention and resources currently focused on Safe System Approach it is important to identify any related research projects that are planned, underway, or recently completed to avoid duplication.

Review Date:
11/24/2021

FHWA Evaluation of G-09

Reviewed By:
Eisert/HRSO; Doctor/RC-SHD

Comments:

This would be an excellent project that builds upon the completed FHWA work that developed the safe system for Intersections Framework. This research could help validate and refine the FHWA framework and expand application by practitioners. Expanding utilization of the Safe system for Intersections (SSI) framework could improve Intersection Control Evaluation policies and practices and contribute to data-driven decisions for intersection improvements. The budget and proposed duration are reasonable, while the tasks and pilot testing of the SSI model could help further the cause of the Safe System approach. This is a highly valuable project.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for G-09Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: 1Comments:

The Committee on Safety ranked this #1 (of 9 submitted - two tied for the top priority).

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-10

Problem Title

Safety Performance Functions for Horizontal Curves

Background Information and Need For Research

Statistics from the Fatality Analysis Reporting System (FARS) indicate that more than 25 percent of fatal crashes occur at horizontal curves, with most of these crashes being roadway departures. In the U.S., the average crash rate for horizontal curves is about three times higher when compared to crash rates of other types of roadway segments. Although researchers and practitioners agree that curvature plays a role in crash frequency, crash rate, and crash severity, Safety Performance Functions (SPFs) for horizontal curves have not been thoroughly investigated or widely implemented. The Highway Safety Manual (HSM) provides SPFs of various facility types for segments and intersections, but no specific SPFs for curved segments are presented. Rather, curves are handled by applying an Adjustment Factor (AF) to estimate the predicted crash frequency of a curved segment. Unfortunately, not all the SPF models within the HSM have AFs for horizontal curves. Recent studies have been implemented to develop AFs for curved segments of certain facility types to begin filling this gap. However, applying a horizontal curve AF to an existing segment SPF assumes that the underlying prediction model of a tangent segment only needs to be adjusted to appropriately estimate a horizontal curve's influence on the segment's safety performance. This method may not be the best way to assess the safety performance of horizontal curves. A more thorough investigation may reveal that common geometric attributes used to estimate the safety performance of tangent segments have a different degree of influence on the safety performance of horizontal curves. For example, length has been shown to be an important attribute for predicting crashes on a tangent segment; however, for predicting crashes at a horizontal curve, the length of curve may have less influence and attributes such as curve radius and deflection angle may have stronger influence. Taking this possibility further, the attributes most important for predicting the safety performance of a horizontal curve may differ due to setting (rural vs. urban), facility type (2-lane vs. freeway), or other factors such as lane width, shoulder with, and roadside elements. Therefore, extensive additional research is needed to better understand the attributes that most influence the safety performance of horizontal curves. Ultimately, this research will lead to the development of SPFs for horizontal curves along a variety of facility types so that the safety performance of most facility types can be predicted much more comprehensively by utilization of three categories of SPFs: one for tangent segments, one for horizontal curves, and one for intersections.

Literature Search Summary

In the HSM (AASHTO, 2010), horizontal curves were mentioned for some facility types and addressed with a Crash Modification Factor (CMF), which is now referred to as an AF, but no specific SPFs were proposed for curved segments. Recent studies demonstrate that the application of curve CMFs/AFs within the HSM could not properly reflect this roadway element in the safety prediction for some locations and the development of additional CMFs/AFs and SPFs could be beneficial in safety studies (Banihashemi 2015, 2016; Harwood and Bauer 2015; Wu, Lord, and Geedipally 2017, Silva 2017). Moreover, some initiatives have shown that horizontal curves are an important roadway element and need to be addressed separately using a SPF (Anarkooli et al. 2019; Aram 2010; Bauer and Harwood 2014; Findley et al. 2012; Gooch, Gayah, and Donnell 2016; Khan et al. 2013; Miaou and Lum 1993; Montella 2009; Saito et al. 2015; Saleem and Persaud 2017; Vogt and Bared 1998; Xin et al. 2019). A common limitation in previous studies is the lack of a comprehensive sample of horizontal curves. The horizontal curve features were not always available in a roadway database, causing some researchers to collect data by identifying horizontal curves manually, resulting in the use of a small set of horizontal curves for SPF development. However, there is now an opportunity to use horizontal curve features from automated data collection methods to address this gap in knowledge and practice through this proposed research.

Research Objective

- Investigate a wide variety of roadway and traffic attributes to better understand which attributes, or combination of attributes, have strong correlation with the safety performance of horizontal curves for various facility types.
- Explore the impact new data sources might have on the predictive results of horizontal curve SPFs. Potential data sources could include, but are not limited to: measured operation speed (e.g. INRIX data), continuous pavement friction measurement (e.g. SCRIM), and curve advisory speed and other curve data (e.g. CARS).
- Evaluate various SPF model forms to determine which have the best fit for various facility types. Consideration should be given to the SPF models described in the SPF Development Guide (Srinivasan and Bauer, 2013).
- Develop horizontal curve SPFs for a variety of facility types:
 - o Rural & Urban Freeways
 - o Rural & Urban Multilane Divided Roadways
 - o Rural & Urban Multilane Undivided Roadways
 - o Rural & Urban 2-Lane Undivided Roadways

Urgency and Potential Benefits

Over the last few years, fatal and serious injury crash trends have been flat or increasing for many transportation agencies in the U.S. after several years of downward trends. There are many possible reasons for the change in trend, but the application of new methods for evaluating safety performance will always be of interest to transportation agencies as they screen their roadway networks in search of their safety challenges. Furthermore, many agencies across the U.S. are beginning to implement the systemic safety approach. Not surprisingly, many agencies are discovering horizontal curves are one of the roadway elements most at risk for severe crashes. While the systemic method does provide a way to identify groups of similar horizontal curves that would likely benefit

from the application of low-cost safety countermeasures, horizontal curve SPFs would allow for a much more thorough and sophisticated analysis of the safety performance of a wider variety of potential horizontal curve improvement projects. In short, horizontal curve SPFs will benefit transportation agencies by improving their network screening and safety performance prediction and evaluation of their proposed roadway projects. As such, this proposed research has the potential for considerable benefit at a time when finding ways to greatly improve safety is as urgent as ever.

The AASHTO Committee on Safety ranked this research its #3 priority.

Implementation Considerations

When exploring the impact that new data sources (e.g. measured operational speed, continuous pavement friction measurement, curve advisory speed, etc.) might have on the predictive results of horizontal curve SPFs, it will be important to consider how many transportation agencies currently have access to such data and/or the average cost for a transportation agency to acquire such data. Further, different agencies have different challenges when investing in new data sources; therefore, to have wider implementation, consideration should be given to developing a set of horizontal curve SPFs based on the common curve data most states currently have and developing a different set of horizontal curve SPFs that incorporates any new data that improves the predictive results of the horizontal curve SPFs.

Also, for the horizontal curve SPFs developed through this proposed research, it will be important to consider how best to coordinate with current software providers so that horizontal curve SPFs can be integrated into existing safety predictive software.

Recommended Research Funding and Research Period

\$350,000 – 2 years

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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NCHRP Review of G-10

Reviewed By:
 Richard A. Retting
 rretting@nas.edu

Comments:

The topic of horizontal curves is central to highway safety, especially for rural roads. The problem statement provides strong background information and documents the need for research; a good literature search summary; and clear research objectives. The recommended funding seems reasonable for the stated research objectives. It is important to identify any related research projects that are planned, underway, or recently completed to avoid duplication.

Review Date:
 11/24/2021

FHWA Evaluation of G-10

Reviewed By:
 Roadway Departure

Comments:

This is a very worthwhile project - curves are over-represented in severe crashes, but they can often be overlooked when performing network screening on a segment basis such as HSM Part B methods. This research looking specifically at the safety performance of horizontal curves would also be directly applicable in Part C predictive

methods at the project level. It will increase the reliability of prediction models and be helpful finding accurate contributing factors. Potential improvements: develop separate SPF for different horizontal curve types such as 1. Simple Curve, 2. Compound Curve, 3. Reverse Curve, and 4. Broken-back Curve.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for G-10

Submitted By:

Kelly Hardy
AASHTO staff
Design-Technical Committee on Roadside Safety

Priority #: N/A

Comments:

Having a better understanding of what happens on curves is a continuing concern for all parties involved in highway safety, and is a major concern for the roadside safety community since so many run-off-road crashes occur on curves.

Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: 3

Comments:

The Committee on Safety ranked this #3 (of 9 submitted).

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-11

Problem Title

Understanding the Impacts of Operational Changes on Safety Performance

Background Information and Need For Research

Mobility and safety are often identified in mission statements as core values for transportation agencies around the country. Traffic operations management has many metrics including level of service, volume to capacity ratio, and travel time reliability measures. Safety performance is often measured in the number of crashes and the injury outcome of crashes.

Operational improvements aim to keep vehicles moving freely, often resulting in higher vehicle speed. As agencies consider the Safe System approach, which has a focus on reducing vehicle speed to reduce crashes and the impact energy when crashes do occur, competing interests between safety and operations could arise. These seemingly opposed goals of safety and mobility need to be balanced.

As an example of these competing goals, data from 2020 show that during the pandemic traffic volumes decreased while traffic fatalities increased. According to the National Highway Traffic Safety Administration (NHTSA), early estimates show a 7.2 percent increase in fatalities from 2019, while preliminary data from the Federal Highway Administration (FHWA) show a 13.2 percent decrease in vehicle miles traveled (VMT). The reduction of volumes during peak hours also reduced the frequency and duration of congestion. Therefore, vehicles were traveling at a higher level of service and often at free flow speeds during most of the day. A fundamental principle of traffic safety and in the Safe System approach is that as vehicle speeds increase, the likelihood of a fatal or serious injury also increases. Therefore, the lower volumes allowed vehicles to travel at free flow speeds, and this may have contributed to the increase in fatalities.

The safety performance functions (SPF) included in the AASHTO Highway Safety Manual (HSM) indicate that as capacity increases, crashes will typically be reduced in frequency and severity on freeway and arterial segments. Vehicle speed is another metric that can be used to understand both operational improvements and changes in crashes. In addition, systemwide changes in factors related to use of the roadway network, such as traffic volume, peak hours, mode choice, and road user risk factors, can impact the safety performance of the system and of individual facilities.

Literature Search Summary

This research will provide specific applications to advance existing tools and guidance found in the FHWA Surrogate Safety Assessment Model and Validation: Final Report and

the FHWA A Primer on Work Zone Safety and Mobility Performance Measurement. Report FHWA-HOP-11-033.

In addition, this research will build upon the knowledge gained from multiple studies and projects including

Measuring Congestion and Reliability Impacts of Safety Projects, Transportation Research Record: Journal of the Transportation Research Board; Incorporating Traffic Operation Measures in Safety Analysis at Signalized Intersections, Transportation Research Record: Journal of the Transportation Research Board; National Cooperative Highway Research Program (NCHRP) Report 618: Cost-Effective Performance Measures for Travel Time Delay, Variation, and Reliability; and Crashes vs. Congestion—What's the Cost to Society?, American Automobile Association (AAA) 2011.

This research would complement the currently active NCHRP 17-95 project, Crash Modification Factors (CMFs) for Intelligent Transportation System (ITS) Applications.

Research Objective

This objective of this research is to produce a tool to assess how implementation of operational measures impact crash outcomes and to develop associated guidance and procedures that will improve the understanding of the complex relationship among existing operational and safety performance measures.

This research has the unique opportunity to use data from the pandemic period to assess how unintended changes in operational performance led to negative impacts to safety performance. This assessment could provide insight into how operational improvements—that lead to reduced congestion, improved travel times, and changes in peak period traffic—impact crashes in a real-world environment. Examples of states tracking the impacts of the pandemic on transportation facilities include Washington state DOT and Virginia DOT.

Specifically, the research activities should:

- Compile existing research findings regarding the relationship and correlation between operational measures and safety performance measures.
- Investigate how crash frequency and severity changed due to various types of projects that improved operations—such as projects to alleviate congestion and bottlenecks to improve travel time reliability—and produce an outcome model exhibiting the findings.
- Develop a quantitative analysis procedure to understand the tradeoffs between capacity improvements (or societal changes that impact traffic volumes) and resulting change in crash frequency or severity.
- Complete an analysis of the level of service during peak hours and off-peak hours and change in crash typology and severity to produce a quantitative or graphical representation of this relationship.
- Produce an operational and safety performance measure correlation model to be used as decision-making and countermeasure prioritization tool.

- Develop outreach materials to support transportation agencies' use of the research results, including items such as models, worksheets, analysis tools and presentations.

Research results should be presented in a final report and guidance that gives clear and actionable strategies to state DOTs and other agencies to effectively consider the safety impacts of operational changes.

Urgency and Potential Benefits

Transportation agencies need tools to support decisions concerning the impacts of mobility, capacity, and crashes and to help understand the systemwide impacts of changes in external factors that affect use of the system. Corridor operational improvements have led to many research studies which show mixed results with respect to reducing crash frequency and severity. This research will provide clarity to this topic.

This research is needed to analyze the performance of the roadway system more thoroughly from the perspective of various safety and operational performance measures, and to develop a tool to assist transportation agencies in performing this type of analysis for decision-making. This research will help transportation safety professionals more fully understand the relationships between operational performance measures and traffic fatalities and to provide agencies with insights on the competing or complementary nature of the performance measures. This knowledge can be used to combine performance measures and will be important for using state resources efficiently to maximize fatality reductions while still prioritizing mobility for all road users.

This research directly supports the American Association of State Highway and Transportation Officials (AASHTO) Committee on Safety's Strategic Plan goal to "partner in the implementation of a national highway safety strategy and performance measures to reduce fatalities and serious injuries on all public roads and locations where roads intersect with other modes of transportation." In addition, the strategic goals to "institutionalize analytical tools to advance the science of safety" and "provide data-driven safety technical and policy advice" are supported by this research.

The Committee on Safety ranked this research its #7 priority.

Implementation Considerations

Results of this research will be of interest to numerous transportation stakeholders, specifically state and local transportation agencies. Potential outreach activities should include AASHTO and TRB committees on traffic safety, traffic engineering, and operations, as well as non-technical stakeholders that provide input to conversations about potential mobility or safety projects.

The AASHTO Committee on Safety is interested in this research and will assist the member states and other AASHTO committees with implementation.

Recommended Research Funding and Research Period

Research Funding: A proposed budget of \$450,000 would be necessary to complete the research tasks and training via presentations, a webinar, or through a peer exchange.

Research Period: The expected time-period to complete the research is 30 months including the outreach activities.

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NCHRP Review of G-11

Reviewed By:

Richard A. Retting

rretting@nas.edu

Comments:

The proposed research seeks to produce a tool to assess how implementation of operational measures impact crash outcomes. Yet the discussion in the problem

statement revolves almost entirely around the COVID-19 pandemic, which is not an “operational measure”. Furthermore, the problem statement indicates the proposed research has the unique opportunity to use data from the pandemic to assess how unintended changes in operational performance led to negative impacts to safety performance. Yet it is unclear that pandemic travel impacts are representative of broader, systemic impacts of operational changes on safety. It is also important to note the literature search summary does not identify a large and growing body of literature that examines impacts of operational measures on safety performance, such as: Conceptual Framework for Integrated Traffic Safety and Operational Analysis (FHWA – 2018 (unpublished)); Safety Performance Analysis of TSMO: A Practical Approach for Assessing Safety Service Patrol Effects on Secondary Crashes (FHWA Office of Safety – 2019); Real-Time Crash Risk Visualization Tool for Traffic Safety Management (University of Central Florida Smart & Safe Transportation Lab); Safety Performance Analysis of TSMO: A Practical Approach for Assessing Traffic Signal Coordination Effects on Crash Probability and Severity (FHWA – 2019); Developing Florida-Specific Mobility Enhancement Factors and Crash Modification Factors for TSMO Strategies (Florida DOT – 2020).

Review Date:
11/23/2021

FHWA Evaluation of G-11

Reviewed By:
Banihashemi/HRSO

Comments:

This is a very timely project. We need to look for solutions to our highway problems that consider more than one discipline (e.g., safety and operations combined). A more general approach is to have many disciplines involved. Trying to combine safety and operations is a very good start. One way of doing this is to try to optimize the total cost of crashes (safety) and delays (operations) in a project or even in a network.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for G-11

Submitted By:
Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A

Comments:

As part of the mentioned Safe Systems Approach, recommend considering safety performance for all modes.

Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: 7

Comments:

The Committee on Safety ranked this #7 (of 9 submitted).

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-12

Problem Title

National Traffic Sensor System Evaluation Program

Background Information And Need For Research

Traffic sensors are essential components of all highway traffic monitoring and traffic management systems. Traffic monitoring depends upon reliable vehicle detection and accurate measurement of traffic volume, speed, classification, and weight. Active traffic management systems and other intelligent transportation systems applications require these parameters and more, for varied uses like wrong-way driving detection, near-miss crash analysis, commercial vehicle screening, predictive analysis, and others.

Sensor systems based on new and emerging technologies—such as optics, electronics, communications, and artificial intelligence—are rapidly supplanting traditional traffic sensor systems, but they typically lack independent evaluation of their accuracy and performance. State and local agencies must often rely on informal, inconclusive evaluations and pilot deployments to assess sensor systems' suitability for highway applications. The burden to test every sensor type and revision that comes to market creates massive duplication of effort and wastes time, effort, and funding.

Although millions of traffic sensors are in use, manufacturers and distributors can rarely provide independent third-party test results demonstrating their real-world performance. Sensor errors can seriously affect safety and mobility, particularly in critical traffic contexts. For example, the lack of quantified error rates and types introduces significant risk into use cases involving high traffic volumes and speeds. In addition, the lack of information regarding system performance and reliability in different operational domains can lead to misapplication of sensor systems, unacceptable performance, or short service life.

An authoritative method is needed to characterize the performance and identify the operational domains of current and emerging traffic sensor systems. AASHTO's National Transportation Product Evaluation Program (NTPEP) has expressed interest in expanding into this type of evaluation. The research should develop test procedures that can be applied within the NTPEP or a similar program.

Literature Search Summary

Because a review of the TRID database revealed no innately similar traffic sensor evaluation programs, outreach was undertaken with industry leaders. Most cited ad hoc sensor validation by their own organizations or reliance on peer agency experiences.

Recent research seems to be focused upon vehicle detection for freeway or signalized intersection applications.

The two-volume Federal Highway Administration's Traffic Detector Handbook , was a comprehensive description of traffic sensor technology as of its 2006 publication date, but it does not address more recent technologies and did not propose a standard test methodology for traffic sensors. A 1997 study tested in-ground and overhead traffic sensor technologies, but it is now almost 25 years old. The Indiana Department of Transportation has adopted a basic test method for certain sensors. ASTM has established standards for traffic monitoring devices and weigh-in-motion systems , but they emphasize traffic monitoring rather than traffic management applications. The Federal Highway Administration is in the early phase of research to establish model systems engineering documents for traffic sensor detection systems (TSDS), which may be useful to the proposed work.

What appears to be lacking within the proposed topic is research on:

- (1) sensors focused upon other modes of travel (e.g. pedestrians, bicycles, scooters, wheelchairs)
- (2) use cases beyond traffic monitoring or basic count, occupancy, and signal call/extend functionality
- (3) ways to consistently present test results that can be easily understood and compared
- (4) a way to scale & extend the evaluation methodology to a repeatable, authoritative testing process that can be replicated by a geographically diverse network of laboratories.

A comprehensive literature review will be conducted as part of this research.

Research Objective

This research will examine current practice and needs, and then define a comprehensive traffic methodology applicable to traffic management and traffic monitoring sensor systems in each mode being detected (e.g. vehicle, pedestrian, bicycle, etc.). The test protocols will incorporate factors such as weather conditions, lighting and background, and traffic and roadway characteristics to characterize sensors' operational domains. The methodology will allow testing laboratories to evaluate sensor systems with confidence that the methods and protocols are replicable, transferable, and ultimately useful to transportation agencies.

The research will also examine the feasibility of establishing a national testing program through either existing or newly created institutions and evaluate potential business models in consideration the needs and receptivity of transportation agencies and industry.

Urgency And Potential Benefits

Agencies lack a cost- and resource-effective way to assess real-world performance of traffic sensor systems over a spectrum of operational and environmental conditions prior to investing time, effort, and funding in demonstration pilots or fully operational deployments of traffic sensor systems. Too often sensor systems are overpromised and underdelivered for agencies' multi-modal, multi-purpose applications. Cycles of revisions to address discovered deficiencies consume even more agency resources before sensors are deemed good enough.

Without this research, public agencies will be forced to rely on informal, resource-intensive, and often inconclusive evaluations to assess the performance of sensor systems for critical traffic control applications. The industry will continue to operate traffic sensors in environments and for applications for which they are not suited, resulting in unintended operational and safety problems.

Implementation Considerations

Traffic operations, safety, Intelligent Transportation Systems, and traffic monitoring staff at state and local agencies will be the biggest beneficiaries of this research and creation of an established testing program. Staff of the Georgia DOT, Utah DOT, Oregon DOT, City of Portland, Indiana DOT, Washington County, Oregon, and others have expressed their strong support for the proposed research. DOTs will be able to use the testing methodology and the testing program to more intelligently and confidently select sensor systems for specified applications, reducing cost while increasing effectiveness. The proposed methodology could be incorporated into AASHTO test methods.

To create awareness and facilitate implementation of the research results, the research team is expected to apply proven practices from similar test programs. The research should include workshops with a cross-section of agencies, vendors, regulators, and manufacturers involved in the production, evaluation, and use of ITS traffic sensor systems across a variety of safety and mobility-related use cases. AASHTO/TRB/FHWA outreach mechanisms can be used to broadly disseminate and market findings to support implementation.

As the sponsoring AASHTO Committee for this research proposal, the AASHTO Committee on Transportation System Operations will lead efforts to implement this research. The AASHTO Traffic Engineering committee, the Institute of Transportation Engineers (ITE), Federal Highway Administration, and several state and local transportation agencies have expressed support for this research and its implementation.

Recommended Research Funding And Research Period

Research Funding: Required research funding is expected to be \$600,000.

Research Period: 30 months. The research time estimates for this problem statement are:

- 21 months to perform the research

- 9 months to engage in communication and outreach efforts.

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NCHRP Review of G-12

Reviewed By:

Zuxuan Deng

zdeng@nas.edu

Comments:

Establishment of a standard procedure to assess the performance and identify the operational domains of current and emerging traffic sensor systems, especially for multi-modal, multi-purpose applications, is critically needed. NCHRP can develop testing methods but cannot evaluate and report on the performance of proprietary products or systems. Examining the feasibility of establishing a national testing program through either existing or newly created institutions and evaluate potential business models in consideration the needs and receptivity of transportation agencies and industry is an important aspect of this research. The budget is appropriate, but additional time will be needed to complete this work.

Review Date:
12/15/2021

FHWA Evaluation of G-12

Reviewed By:
Huang/HRSO

Comments:

There are many types of sensors which have been used in practice, and the HW/SW of the sensors have been updated with new versions in the past decades. With the available budget, it may not be feasible for field tests and data collection/analysis of all types. However, it is feasible and useful to develop a thorough literature review and document the performance and feedback from state DOTs. And the document could be a useful reference for the agencies in practice.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for G-12

Submitted By:
Bud McDonald
AASHTO staff
Agency Administration Managing Committee

Priority #: N/A

Comments:

Support with comment: recommend addressing algorithmic bias, including skin tone and bicyclist recognition issues, in sensors and associated software.

Submitted By:
Bud McDonald
AASHTO staff
Committee on Civil Rights

Priority #: N/A

Comments:

Support with comment: recommend addressing algorithmic bias, including skin tone and bicyclist recognition issues, in sensors and associated software.

Submitted By:

Patrick Zelinski
AASHTO staff
Committee on Transportation System Operations

Priority #: 1

Comments:

CTSO's #1 priority.

Submitted By:

Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A

Comments:

Recommend addressing algorithmic bias, including skin tone and bicyclist recognition issues.

Submitter Response for 2023-G-12From:

[email: galen.e.mcgill@odot.state.or.us; pzelinski@ashto.org;]

Comments:

The FHWA review comments are appreciated. As the reviewer notes, many sensors have been used in practice. We agree that an NCHRP project cannot possibly evaluate every sensor and every update of hardware, firmware, and software. It is precisely for that reason that the most important aspect of the proposed work will be to examine the feasibility of establishing an independent national testing program for ongoing evaluation as new sensors and versions become available.

We agree completely with the NCHRP reviewer that establishing a standard procedure to assess the performance and identify the operational domains of current and emerging traffic sensor systems is critically needed. Testing to ensure reliable sensor performance is essential to efficient deployment of intelligent transportation systems and to the safety of travelers who use them.

Contact Info:

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Review Date:
12/28/2021

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-13

Problem Title

Transportation Operations Manual Best Practices Guide

Background Information And Need For Research

The Transportation Operations Manual (NCHRP 03-126) is nearing completion and should be published in 2022.

To support the implementation of the Transportation Operations Manual, this project would identify best practices for each of the Transportation Operations Manual topics by organizing and identifying best practices found in existing case studies gathered by the National Operations Center of Excellence (NOCoe), from the CTSO best practices webinar series, and other industry resources.

The project will identify gaps between the existing body of knowledge already gathered by the NOCoe and the Transportation Operations Manual chapters and fill those gaps through gathering of additional case studies and best practices.

The resulting product would be a digital best practices guide that would support the Transportation Operations Manual chapters with practical real-world examples and best practices.

Once the framework for the best practices guide is established, it will continue to be updated through the NOCoe's ongoing work in gathering case studies and best practices.

Literature Search Summary

The Transportation Operations Manual Best Practices Guide will build directly upon the Transportation Operations Manual (NCHRP 03-126) by identifying and organizing existing best practices that will aid in the implementation of the manual itself.

Additionally, existing research around TSMO Workforce practices, TSMO training, and TSMO strategies will be evaluated for best practices and, where appropriate, be organized around the Transportation Operations Manual topic areas to also assist in implementation.

Research Objective

The objective of this research is to have a digital best practices guide that would support the Transportation Operations Manual chapters with practical real-world examples and best practices.

To build the guide, the project will likely involve:

1. Identifying and categorizing best practices found in the NOCoE Case Study Library.
2. Identifying and categorizing best practices found in additional resources, including the CTSO Best Practices Webinar Series, resources in the NOCoE Knowledge Center, existing NCHRP research, and FHWA peer exchange and state-of-the-practice materials.
3. Identifying gaps between the existing body of knowledge already gathered by the NOCoE and the Transportation Operations Manual chapters and filling those gaps through gathering of additional case studies and best practices.
4. Establishing a framework for the best practices guide, including both how best practices are categorized to support the implementation of the guide as well as how users will most effectively access the information.

Urgency and Potential Benefits

Increasingly, transportation agencies are working to leverage their existing infrastructure and to deploy TSMO strategies to preserve capacity and to improve the security, safety, and reliability of the transportation system.

The forthcoming Transportation Operations Manual will provide staff at state, regional, and local transportation agencies with a seminal resource in advancing transportation systems management and operations.

The proposed Best Practices Manual will be the key resource in implementing and deploying the strategies identified in the Transportation Operations Manual and contribute to uniformly and efficiently achieving the goals of preserving capacity and improving the security, safety, and reliability of the transportation system.

Implementation Considerations

The manual will be utilized directly by TSMO practitioners looking to implement specific TSMO practices. State DOT practitioners will have the Transportation Operations Manual to build internal knowledge on potential TSMO strategies and then be able to utilize the Best Practices Manual to assist in implementing those strategies based on existing and proven practices.

To implement the use of the Best Practices Manual, marketing and outreach will need to be conducted by NOCoE, CTSO, and other knowledge sharing organizations that can assist state DOTs in the access and use of both the Best Practices Manual as well as the Transportation Operations Manual.

Once completed, maintenance and updates to the Best Practices Manual will be accomplished through the ongoing work of the NOCoE in gathering and promoting TSMO best practices.

Recommended Research Funding and Research Period

\$350,000 for 18 months.

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- Galen McGill, Oregon DOT (Co-Chair)
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- Benjamin Acimovic, Colorado DOT
- Susan Klasen, New Hampshire DOT
- Sal Cowan, New Jersey DOT
- Brad Freeze, Tennessee DOT
- Jianming Ma, Texas DOT
- Dwayne Cook, Virginia DOT
- Pamela Vasudeva, Washington DOT
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NCHRP Review of G-13

Reviewed By:
Zuxuan Deng
zdeng@nas.edu

Comments:

This is a timely and necessary research to help implement the forthcoming new version of Transportation Operations Manual. I would like to recommend program this study into FY23 NCHRP.

Review Date:
12/15/2021

FHWA Evaluation of G-13

Reviewed By:
Hunt/HOTM

Comments:

The proposed Best Practices Guide would appear to be a valuable companion to the Operations Manual and promote its reach and application across the country. A couple of comments and suggestions: (1) use of the term "Best" Practices may be too strong. TSMO can advance effectively under different circumstances and organizational models. Suggest using the term "Effective" Practices, (2) has NOCoE commitment to ensuring the Guide is maintained? (3) there are many more FHWA resources that highlight effective TMO practices, including all the examples provided in the TSMO program area capability frameworks.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for G-13

Submitted By:
Patrick Zelinski
AASHTO staff
Committee on Transportation System Operations

Priority #: 2

Comments:

CTSO's #2 priority.

Submitted By:

Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/AComments:

Recommend that examples and practices address active transportation and implications for active transportation users in TSMO practices that focus on driver LOS.

Submitter Response for 2023-G-13
From:

[email: galen.e.mcgill@odot.oregon.gov; pzelinski@ashto.org]

Comments:

I appreciate the comments on this research problem statement. We have had some recent discussions with the AASHTO CTSO Best Practices Task Force about potentially changing the best practices term to something more along the lines of the effective practices term suggested in the review. There will be additional discussions about this prior to this project starting. See the response below from the NOCoE regarding their commitment to maintain the guide:

“The National Operations Center of Excellence is supportive of the effort to synthesize and catalogue best or successful practices within the transportation systems management and operations community. Whether the source material comes from NOCoE case studies, FHWA case studies, the AASHTO CTSO effort to collect successful practices, or other similar efforts, NOCoE will be prepared to collect and manage the results of this project.

In recent years, NOCoE has provided support for comparable website and knowledge management projects deriving from NCHRP projects, TRB committee activities, stakeholder initiatives. Example include:

- TSMO Workforce Guidebook (originally an NCHRP project)
- Research in Operations Database (in collaboration with AASHTO CTSO)
- ATM Project Map (in collaboration with the TRB Freeway Operations Committee)
- TMS and TMC Portal (in collaboration with FHWA)
- Traffic Incident Management Portal (in collaboration with FHWA)

NOCoE regular maintains and updates these important resources as part of its normal technical service delivery program. A similar approach would be taken with a best or successful TSMO practices project, with the additional features of linking to original

source materials, tracking site usage statistics, conducting outreach around the projects results, and presenting the resource via regular communications.”

Finally, we concur with the suggestion to look at FHWA resources as part of this effort.

Contact Info:

Galen McGill

AASHTO CTSO Research Co-chair

Galen.e.mcgill@odot.oregon.gov

503-508-1881

Review Date:

February 2, 2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-14

Problem Title

Evaluate the Benefits of Increasing Clear Zone at Higher Speed/Traffic Volume/Crash Locations

Background Information and Need For Research

The current edition of the AASHTO Roadside Design Guide (RDG) provides guidance to assist transportation agencies develop standards and policies for determining the widths of clear zones along roadways based on design speed, traffic volume, roadside slope, and curvature. By providing clear zones, transportation agencies can increase the likelihood that a roadway departure results in a safe recovery and mitigate the severity of crashes that do occur. The development and use of the clear zone concept has dramatically reduced the number of crashes, injuries, and fatalities on urban and rural highways.

Although the RDG provided a more realistic approach than the application of a single lateral distance, it provides only a general approximation of the needed clear zone distance. Clear zone recommendations can be extrapolated for design speeds greater than the maximum ranges shown in the 4th Edition of the RDG, corresponding to 65 to 70 mph (100 to 110 km/h) and for Average Daily Traffic (ADT) greater than 6,000 vehicles/day or more. However, it is unclear if extrapolated values are optimized for posted speed limits (PSLs) greater than 70 mph (110 km/h) or for roads with ADTs significantly higher than 6,000 vehicle/day. Two of the key factors in assessing risk are design speed and traffic volumes. In some locations in the U.S., posted speed limits (PSLs) have been increased to 80 mph (129 km/h) or more, and there are many segments of highway in which the ADT is greater than 50,000 vehicles/day. Limited data has been collected to evaluate the effectiveness of clear zone recommendations which are not consistent with the existing ranges shown in the RDG. The width of the clear zone should be based on actual risks. Therefore, there is a need to analyze crash data to determine if revisions to the RDG clear zones are warranted to accommodate increased design speeds, locations with higher crash frequencies, and increased traffic volumes.

The results of this research could increase the safety of the traveling public and aid roadside safety design practitioners and transportation agencies in determining safer and cost-effective clear zone. The guidance developed through this research directly correlates with TCRS' Strategic Plan and the number one goal in the TCRS mission statement which is, "develop, implement, and maintain guidance which will reduce fatal and incapacitating-injury roadway departure crashes." Results of this research will help

guide futures editions of MASH, the Roadside Design Guide, and other AASHTO documents.

Literature Search Summary

NCHRP Project 17-11, Determination of Safe/Cost Effective Roadside Slopes and Associated Clear Distance, developed relationships between recovery-area distance roadside features, vehicle factors, encroachment parameters, and traffic conditions for a range of highway functional classes and design speeds. The project developed baseline relationships for different functional classes of highways. These relationships are then adjusted for shoulder width, horizontal curvature, and ditch configuration. In NCHRP Project 17-11(03), Development of Clear Recovery Area Guidelines, the objective is to develop guidelines for roadside clear zones that can be incorporated into the AASHTO Roadside Design Guide. This is the final stage of work begun in 17-11 and continued in 17-11(02).

In the study, Benchmark Compliance Evaluation of the Roadside Design in an Urban, High-Density Area, a roadside design compliance evaluation was performed in an urban, high-density area. Visits were made to over 100 single vehicle run-off-road (SVROR) injury-crash locations. Almost all locations were found to be non-compliant. A lack of the minimum recommended clear zone provision was the main cause of non-compliance, while 80% of all locations suffered from barrier misplacement. The study concluded that roadside design guidelines have been poorly implemented in the area studied, and findings indicate that more focus on proper, on-site design implementation is warranted. The authors are not aware of previous studies that have investigated roadside design compliance in other parts of the world. Hence, the authors encourage researchers to replicate this study in their respective geographical areas of interest.

The clear zone concept, related to lateral distances measured from the roadway edge, is also strongly correlated with roadside barrier runout length and length-of-need (LON), which are longitudinal measurements measured from a shielded hazard and based on a vehicle's trajectory from the point of departure. Vehicle trajectories were documented and reported by Hutchinson and Kennedy in 1966 and Cooper in 1980 corresponding to vehicle tracks in the median in Michigan and tracks on snow-covered roads in Canada, respectively. Sicking and Wolford revisited guardrail runout lengths in 1996 and observed that the Cooper data for vehicle trajectories was associated with a higher benefit-cost and reduced number of unnecessary crashes with roadside barriers, which was subsequently confirmed by Coon, Sicking, and Mak in Guardrail Run-Out Length Design Procedures Revisited. Although the evaluation of roadside barrier lengths-of-need are not part of this research effort, responding agencies are encouraged to collect data which subsequently could be used to evaluate barrier runout lengths on these roadways as well.

This proposed research will build upon the above research, with an emphasis on roads with posted speed limits, traffic volumes, and crash frequencies which greater than the RDG ranges. The project will attempt to determine how best to accommodate road conditions beyond what the RDG currently recommends for clear zones.

Research Objective

The research objective is to recommend guidelines for clear zone values corresponding to conditions with design speeds, traffic volumes, and crash frequencies which are in excess of thresholds recommended in the RDG. The results of this research study would be used to inform updates to future publications of the RDG and identify safe and cost-effective guidance for roads at extremes of typical operational conditions. Specific objectives include:

- Perform a literature review and summarize published findings of encroachment rates based on ADT, including roadway geometrical effects, with attention to divided vs undivided roads;
- Determine encroachment rates for high-ADT and high-design speed roads, and compare with published historical values;
- Identify the distribution of lateral encroachment distances for high-ADT and high-design speed roads during ROR crashes;
- Determine criteria, including thresholds, which can be used to identify regions with increased rates of roadside departure which may require special treatment or considerations; and
- Recommend updates for the RDG to accommodate higher ranges of traffic volumes and speed limits than are shown in Table 3-1, and warrants for special consideration for roads with departure rates in excess of a standardized threshold of departure rates.

Urgency and Potential Benefits

Providing an appropriate clear zone is critical for reducing severe crashes on the nation's highway. There is a need to develop clear zone guidance based on actual crash data at higher speeds, higher traffic volumes and high-crash locations. This research will provide a measure of assurance in the clear zone application and an increase level of safety for the traveling public. State Transportation Agencies may utilize the results of this research for policy development for the clear zone. It is anticipated that the results of this research will be incorporated into the AASHTO Roadside Design Guide.

Because there is no clear recommendation in the RDG to address clear zones for extreme conditions, guidance between states and for different road conditions may vary widely. It is unclear if recommendations provided for lower-speed and lower-traffic volume roads remain applicable at higher speeds and traffic volumes. It is possible that as state DOTs consider increases in posted speed limits, higher frequencies of SVROR crashes occur and result in catastrophic injuries without refined guidance for these conditions. In the absence of this research, needless severe injury and fatal crashes will likely continue to occur due to the hazard posed by obstructions within the clear zone.

This research is ranked as the top priority out of 5 topics by the AASHTO Technical Committee on Roadside Safety. This research is endorsed by the AASHTO Committee on Design

Implementation Considerations

The results of this research will assist state and local standards engineers to update the design manuals to provide guidance on clear zone. With proper review, the AASHTO TCRS could assist implementation through adopting the research results into the future update of AASHTO Roadside Design Guide. Implementation could also be supported through a discussion of the findings at a TRB AKD20 meeting and the conduct of the TRB webinar.

Recommended Research Funding and Research Period

Research Funding:

Funding for this research study is recommended at \$450,000.

Research Period:

The research period for this project should be 36 months, completed in two consecutive phases. The 36-month evaluation should include 1 month following the execution of the contract resulting in a kickoff meeting with the panel, 1 month to review the interim report at the completion of Phase 1 and to evaluate and approve the revised research plan to address Phase 2, and a 90-day review period at the end of the contract to review the final report and recommendations, discuss conclusions with the panel, and recommend revisions to the contractor. As a result, the effective research period will span 31 months.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Hung Tang, P.E., New Jersey Department of Transportation, AASHTO Technical Committee on Roadside Safety, (609) 963-1839, hung.tang@dot.nj.gov

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Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Hung Tang, P.E., New Jersey Department of Transportation, AASHTO Technical Committee on Roadside Safety, (609) 963-1839, hung.tang@dot.nj.gov

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Kristin Schuster, P.E.
Michigan Department of Transportation
Chair, AASHTO Technical Committee on Roadside Safety
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NCHRP Review of G-14

Reviewed By:

Zuxuan Deng
zdeng@nas.edu

Comments:

Higher running speeds usually correlate with severe crashes. Imposing higher design speed limit is not a common practice at most States. The proposed research topic may have limited applications and the potential design recommendations could be cost prohibitive or infeasible due to ROW constraints. Furthermore, it is unclear how the research will be conducted. If it is meant to be an empirical study, it may be challenging to identify adequate number of representative sites to collect field data.

Review Date:

12/15/2021

FHWA Evaluation of G-14

Reviewed By:

Roadway Department

Comments:

There is a need to reevaluate clear zone, although there is concern somewhat with the practicality of increasing it.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for G-14

Submitted By:

Patricia Bush
AASHTO staff
Committee on Design

Priority #: N/A

Comments:

Endorsed by the Committee on Design.

Submitted By:

Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A

Comments:

Recommend including that the clear zone also serves bicyclists who may be traveling on a high-speed roadway. Consider addressing design implications to reduce fatal crashes for VRUs on shoulder.

Submitted By:

Kelly Hardy
AASHTO staff
Design-Technical Committee on Roadside Safety

Priority #: 1

Comments:

TCRS ranked this research its #1 priority (of 5 submitted).

Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: N/A

Comments:

Can this research be coordinated with 17-104 and the Highway Safety Manual? Is there a way to align the methodologies for the HSM and RDG to maximize the usefulness of the research?

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2022 NCHRP PROBLEM STATEMENT OUTLINE

Problem Number: 2023-G-15

Problem Title

Conflict-Based Crash Prediction Method for Intersections

Background

As the number and prevalence of intersection forms and configurations increase, it has become more challenging for practitioners to quantify the safety effects of constructing these designs. Currently the Highway Safety Manual (HSM) provides safety performance functions (SPFs) for a few conventional intersections based on empirical research, but any deviation from the basic assumptions in the HSM requires the application of one or more crash modification factors (CMFs). Although there are a high number of CMFs from various sources, some apply to alternative intersection forms and fewer apply to complex traditional intersection that vary from the basic intersections in the HSM. Intersection control evaluation (ICE) policies and efforts typically promote the consideration of alternative intersections not covered in the HSM, which has limited the ability of practitioners to compare these alternative intersections with conventional designs.

One measure of safety that is common to all at-grade intersections is the conflict point, or the point where two or more vehicle paths may cross. Conflicts may be classified as crossing, merging, or diverging based on the angle between vehicle paths. Previous research has demonstrated the relationship between the number of conflict points at an intersection and the number of resulting crashes over a given time-period. Similarly, crash severity can be roughly correlated to conflict type/angle/speed differential. Alternative intersections have been touted as an improvement in safety over conventional forms due to a reduction in total conflict points, conversion of angle conflicts to merge/diverge conflict points and/or reducing speeds at conflict points.

The product of the research will be a series of crash prediction models with not only the typical rural, urban/suburban setting types, but conflict point frequency, type (merge, diverge, crossing), and speed differential as independent variables, applicable to all intersection forms, and implementable within the HSM Part C methodology. This is relevant to the AASHTO HSM Committee as it will contribute to future updates to the HSM.

Literature Search Summary

- Kittelson & Associates, Inc. NCHRP Report 948: Guide for Pedestrian and Bicycle Safety at Alternatives Intersections and Interchanges (A.I.I.). 2021.
- Hummer, J. Developing, Using, and Improving Tables: Showing the Safest Feasible Intersection Design. 2020.

- Porter, R.J., Michael Dunn, Jonathan Soika, Ivy Huang, Dylan Coley, Annette Gross, Wes Kumfer, and Stephen Heiny, FHWA-SA-21-008: A Safe System-Based Framework and Analytical Methodology for Assessing Intersections
- Corben, B., van Nes, N., Candappa, N., Logan, D. & Archer, J., Monash University Accident Research Centre Report #316c: Intersection Study Task 3 Report: Development of the kinetic energy management model and safe intersection design principles
- Candappa, N., Logan, D., Van Nes, N. and Corben, B., 2015. An exploration of alternative intersection designs in the context of Safe System. Accident Analysis & Prevention
- Jurewicz, Chris, Amir Sobhani, Phuong Chau, Jeremy Woolley, and Colin Brodie: Understanding and Improving Safe System Intersection Performance. No. AP-R556-17. 2017

Research Objective

The objective of the research is to identify and quantify the relationships between each basic conflict point and/or type of conflict within an intersection to the overall crash frequency of the intersection. The research will result in a methodology to develop new safety performance functions (SPFs) to supplement those in the HSM Part C models.

Urgency and Potential Benefits

The HSM predictive methodology covers a few basic conventional intersection types but is not yet expandable to complex or alternative intersection forms. As new intersection forms become more prevalent and more crash data is available, future research efforts may develop new predictive models for new designs but will be limited to a specific geometry. Beyond the traditional conflict point diagram, agencies currently have little-to-no guidance on how to quantitatively assess the safety effects of these new designs or evaluate hybrid intersection types. If the research remains unfunded, practitioners will continue to use intersection type-specific guidebooks and research results to assess relative differences in intersection types, but this practice is inefficient and discourages the use of new designs. This research will also benefit practitioners by giving them research-based safety analysis to present to local governments and residence when seeking local buy in to a proposed alternative intersection configuration. Additionally, when equipped with a more comprehensive crash prediction methodology, agencies will have the ability to develop more complete cost-benefit analyses for intersection improvements, which supports increasingly more prevalent intersection control evaluation (ICE) policies and safety performance of intersection control evaluation (SPICE) practices.

Implementation Considerations and Supporters

At a minimum, State DOTs and other practitioners will utilize the results of the research within the mechanics of the HSM, including calibration if needed. Depending upon the complexity of the resulting models, practitioners may require a spreadsheet or software-based tool to quantify the results, in addition to written guidance.

Training and technology transfer may be needed to enhance the applicability and general knowledge of the research results. A comprehensive model validation effort, if included either within the research period or as supplemental research, may help inform practitioners of the research by gathering crash data from different intersection types in several areas and comparing them to model results.

Organizations potentially interested in research findings and who could support implementation:

- AASHTO Council on Highways and Streets (CHS)
- AASHTO Committee on Design (COD)

Recommended Research Funding and Research Period

Recommended Funding:

- \$400,000 for initial research period
- Up to \$150,000 for model validation effort

Research Period:

- 24 months for initial research period
- Up to 18 months for model validation effort

The amplified research plan will likely include a substantial period (6 to 9 months) devoted to developing a new predictive/analytical method, including a detailed literature review and team work sessions. The remainder of the research period would include crash data collection and model development. Crash data would be collected from a wide variety of intersection types to identify trends common to each.

If funded, an optional model validation effort would be initiated as a follow-up project and compare the models with other sites, potentially updating the models if necessary. This would also serve as a method to familiarize agencies and practitioners with the predictive method and encourage widespread use.

If funded, an optional tool development effort would be initiated as a follow-up project and would include training workshops with agencies to test the methodology and tool and gather feedback on the tool user interface and applicability of the methodology. This would also serve as a method to familiarize agencies and practitioners with the predictive method and encourage widespread use.

Problem Statement Author(s)

Zachary Bugg, Senior Engineer, Kittelson & Associates, Inc., (910) 399-5699,
zbugg@kittelson.com

Brian Frazer, Senior Transportation Engineer, Caltrans, (916) 862-4571,
brian.frazer@dot.ca.gov

Others Supporting the Problem Statement

The AASHTO Committee on Design has endorsed the submittal of this statement.

Potential Panel Members

Robert Wunderlich, Texas A&M Transportation Institute
 Mark Orton, Indiana Department of Transportation
 Ryan Laub, Port Authority of New York and New Jersey

Person Submitting the Problem Statement

AASHTO Technical Committee on Geometric Design, supported by the TRB Standing Committee on Performance Effects of Geometric Design (AKD10)

Contact: Marshall Elizer, Chair, AASHTO Technical Committee on Geometric Design
 Assistant Secretary for Multimodal Development & Delivery, Washington State
 Department of Transportation
 310 Maple Park Avenue SE, PO Box 47351, Olympia WA 98504-7351
 e-mail: ElizerM@wsdot.wa.gov

NCHRP Review of G-15

Reviewed By:

Zuxuan Deng
 zdeng@nas.edu

Comments:

The proposed research approach appears to be tangible and potentially could fill the knowledge gap between number/type of intersection conflict points and quantifiable crash reduction effects.

Review Date:

12/15/2021

FHWA Evaluation of G-15

Reviewed By:

Intersections Team/HSA/HRDS

Comments:

This would be significantly valuable to the implementation of alternative/innovative intersections and the Safe System Approach. It would build upon established HSM-based methods and make connections to the 2020 Safe System Intersections methodology developed by FHWA. It would also allow for more informed intersection design decisions for future innovative ideas or different combinations of innovative intersection designs. Additionally, this project could explore upstream and downstream

conflicts, as well as recurring stop/go crashes like rear-end and sideswipe. This project has very high impact potential.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for G-15

Submitted By:

Patricia Bush
AASHTO staff
Committee on Design

Priority #: N/A

Comments:

Endorsed by the Committee on Design.

Submitted By:

Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A

Comments:

Consider including the movements of people using all modes in the intersection control evaluation.

Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: N/A

Comments:

Will this tie into Highway Safety Manual methodologies? The focus should be on crash severity, and should coordinate with HSM methods. Also, this seems similar to the safe system approach for intersections and hopefully will further that work. This should be coordinated with earlier research.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2022 NCHRP PROBLEM STATEMENT OUTLINE

Problem Number: 2023-G-16

Problem Title

Safety Performance of Complex Interchanges

Background

Many service interchanges include custom designs that do not fit into the traditional interchange definitions contained within the AASHTO Green Book, which makes it challenging to predict and compare the relative predicted crash frequency of different interchange forms. Complex interchanges involving isolated ramps, direct HOV connections, direct connections to frontage roads, or frontage road intersection with the crossroad close so close the intersection operate as one, ramps connecting to one-way frontage roads nearby developments, and/or other customizations are becoming more common within suburban and urban areas. The HSM provides crash prediction for interchange elements such as simple ramps and basic ramp termini configurations, but none provide a comprehensive crash prediction methodology that can be applied to the large number of interchanges that are not of a “typical” basic design.

Currently freeways are partitioned into basic, weaving, and merge/diverge segments in order to quantify safety and operations. This research would similarly partition interchanges into elements which all have in common—one example may be partitioning an interchange into directional ramps, loop ramps, merge/diverge segments, and weaving segments—and utilize a conflict- or exposure-based method (or some other method) to predict crash frequency for each element, allowing the results to be aggregated to the entire interchange form.

The product of the research will be a series of crash prediction models for the various interchange elements, implementable within the mechanics of the Highway Safety Manual (HSM). This is relevant to the AASHTO HSM Committee as it will contribute to future updates to the HSM.

Literature Search Summary

- Xin, G., et al. Analyzing Crash Risk at Interchange Merging Areas Using Aerial Data. 2019.
- Song, Z., and H. Lloyd. A Comprehensive Safety Assessment Methodology for Innovative Geometric Designs. 2018.
- Wang, J. Geometric Elements and Wrong-Way Crashes at Partial Cloverleaf Interchange Terminals. 2018.
- Islam, M, et al. Freeway Safety Evaluation: A Quantitative Approach Using Highway Safety Manual to Informed Decisions. 2018.

- Abatan, A., and P. Savolainen. Safety Analysis of Interchange Functional Areas. 2018.
- Caleffi, F., et al. A Multivariate-based Conflict Prediction Model for a Brazilian Freeway. 2017.
- Shea, M., et al. Combined Crash Frequency-Crash Severity Evaluation of Geometric Design Decisions: Entrance-Exit Ramp Spacing and Auxiliary Lane Presence. 2015.
- Venkataraman, N., et al. A Heterogeneity-in-means Count Model for Evaluating the Effects of Interchange Type on Heterogeneous Influences of Interstate Geometrics on Crash Frequencies. 2014.
- Sadia, R., and A. Polus. Modeling Interchange Complexity and Its Effect on Safety. 2012.
- Yang, H., and K. Ozbay. Estimation of Traffic Conflict Risk for Merging Vehicles on Highway Merge Section. 2011.
- Torbic, D., et al. Safety Analysis of Interchanges. 2009.

Research Objective

Identify and quantify the relationship between each conflict point type at service interchange on the overall crash frequency of the interchange. The research will result in a methodology consistent with HSM to develop customized safety performance functions (SPFs) for complex interchange designs, including those not identified in the AASHTO Green Book or HSM.

Urgency and Potential Benefits

Many gaps remain within the HSM predictive methodology regarding possible interchanges configurations being used. As interchange forms are continuously being expanded and modified to address safety concerns, local growth and need, multi-modal concerns, and/or traffic congestion on freeways; agencies currently have little-to-no guidance on how to quantitatively assess the safety effects of different interchange configurations and major changes such as converting a adding ramps to a median high occupancy/ tole (HOT) access to an existing interchange crossroad or ramps connecting multiple roads. If the research remains unfunded, State DOTs will continue to use existing methods to assess relative differences in interchange forms regarding design speed, weaving, merging, and diverging, but these methods are purely qualitative and based on experiences with traditional interchange forms, not complex, customized, designs. Additionally, when equipped with a more comprehensive crash prediction methodology, agencies will have the ability to develop more complete cost-benefit analyses for interchange improvements to ensure that their limited funds are spent efficiently.

Implementation Considerations and Supporters

At a minimum, State DOTs and other practitioners will utilize the results of the research within the mechanics of the HSM, including calibration if needed. Depending upon the complexity of the resulting models, practitioners may require a spreadsheet or software-based tool to quantify the results, in addition to written guidance.

Training and technology transfer may be needed to enhance the applicability and general knowledge of the research results. A comprehensive model validation effort, if included either within the research period or as supplemental research, may help inform practitioners of the research by gathering crash data from interchanges in several areas and comparing them to model results.

Organizations potentially interested in research findings and who could support implementation:

- AASHTO Council on Highways and Streets (CHS)
- AASHTO Committee on Design (COD)

Recommended Research Funding and Research Period

Recommended Funding:

- \$400,000 for initial research period
- Up to \$200,000 for model validation effort

Research Period:

- 24 months for initial research period
- Up to 18 months for model validation effort

The amplified research plan will likely include a substantial period (6 to 9 months) devoted to developing a new predictive/analytical method, including a detailed literature review and team work sessions. The remainder of the research period would include crash data collection and model development. Crash data would be collected from a wide variety of interchange types to identify trends common to each.

If funded, an optional model validation effort would be initiated as a follow-up project and compare the models with other sites, potentially updating the models if necessary. This would also serve as a method to familiarize agencies and practitioners with the predictive method and encourage widespread use.

If funded, an optional tool development effort would be initiated as a follow-up project and would include training workshops with agencies to test the methodology and tool and gather feedback on the tool user interface and applicability of the methodology. This would also serve as a method to familiarize agencies and practitioners with the predictive method and encourage widespread use.

Problem Statement Author(s)

Zachary Bugg, Senior Engineer, Kittelson & Associates, Inc., (910) 399-5699,
zbugg@kittelson.com

Brian Frazer, Senior Transportation Engineer, Caltrans, (916) 862-4571,
brian.frazer@dot.ca.gov

Others Supporting the Problem Statement

AASHTO Committee on Design

Potential Panel Members

Eric Marabello, Maryland Department of Transportation

David Smith, Louisiana Department of Transportation & Development

Person Submitting the Problem Statement

AASHTO Technical Committee on Geometric Design, supported by the TRB Standing Committee on Performance Effects of Geometric Design (AKD10)

Contact: Marshall Elizer, Chair, AASHTO Technical Committee on Geometric Design
Assistant Secretary for Multimodal Development & Delivery, Washington State
Department of Transportation
310 Maple Park Avenue SE, PO Box 47351, Olympia WA 98504-7351
e-mail: ElizerM@wsdot.wa.gov

NCHRP Review of G-16

Reviewed By:

Zuxuan Deng

zdeng@nas.edu

Comments:

Complex interchanges tend to have unique features. Therefore it could be challenging to gather adequate sample size to estimate statistically significant SPF. Intercorrelations among potential explanatory variables are difficult to control, too.

Review Date:

12/15/2021

FHWA Evaluation of G-16

Reviewed By:

Intersections Team/HSA/HRDS

Comments:

The research completed by FHWA on complex interchanges (published in 2013 and 2014) suggests that this would be a very difficult undertaking, but the interest and need for this remains steady, and the suggestion per the proposal to "partition" the research could offer a way forward. However, it should be acknowledged that this would be a very large undertaking with an uncertain outcome and impact. In spite of the magnitude of these projects, the priority for this would be low without a more thoughtful long term and comprehensive research plan.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for G-16

Submitted By:
Patricia Bush
AASHTO staff
Committee on Design

Priority #: N/A

Comments:

Endorsed by the Committee on Design.

Submitted By:
Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A

Comments:

Recommend consideration of pedestrian and bicyclist movements.

Submitted By:
Kelly Hardy
AASHTO staff
Safety

Priority #: N/A

Comments:

Given that the Freeways models in the HSM are going to be revisited for directional models, building out the components of the complex interchanges should factor in all changes yet look for a way to tie into the HSM models. Also, there should be a component added to develop calibrations for a few states and test the models against the calibrations.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-17

Problem Title

Exit Speed Warning Sign Placement

Background Information and Need For Research

The National Safety Council estimates that in 2018 there were 40,000 motor vehicle related fatalities. NCHRP Report 500: Volume 7, A Guide for Reducing Collisions on Horizontal Curve estimated that approximately 25% of these USA crashes occurred on horizontal curves (s). Traffic control devices (TCDs) such as signs and delineation treatments are intended to inform and warn motorists of horizontal curves and the Manual on Uniform Traffic Control Devices (MUTCD) is the national standard for all TCDs on roads open to public travel. Research has consistently demonstrated that TCDs on curves are inconsistently applied across the United States (NCHRP Report 559: Communicating Changes in Horizontal Alignment). The 2009 MUTCD promotes sign uniformity across the country and, thereby, improve safety on horizontal curves.

Recent research has found the effectiveness of TCDs within curves increases as traffic volume increases, rather than with changes in curve severity. There are several instances of probable crash reductions due to advance warning signs, and the models suggest that the effect increases with increased severity. In the work additional signs were outlined as speed differential due to reduced speed for curves increased (above 10 to 15 mph differential). This research covered the type of devices (signs and markings) but does not delve into application. The National Committee on Uniform Traffic Control Devices (NCUTCD) working with research has advanced recommendations to FHWA related to horizontal curve advisory traffic control devices. The research focused on two lane roadways. Freeway exits, for example, are locations with significantly higher speed differentials and where crash potential due to exit speed can be severe (noted above). This is an area that has had limited research into driver expectations, needs, messaging and uniformity of traffic control device application.

The MUTCD section 2C.14 outlines how advisory exit and ramp speed signs are to be applied (see below). State traffic engineers and designers apply this section in various ways. The note that the example provides in Figure 2C-3 is a unique example of sign layout and does not reflect either common interchanges or a range of exit/ramp applications. The result is a wide variance in the application of MUTCD Section 2C.14 in the field across the United States. While there is uniformity in the sign displays themselves, the layout and placement of signs varies within jurisdictions and across the county. The recent NCHRP 03-106 made recommendations to Section 2C.14, but those (see below) focus when signs might be considered or required but not the location

and application of the signs. The need for the sign (criteria) is established. At issues is a lack of uniformity in terms of application.

The questions that lead to lack of uniformity that should be addressed include:

- Use of the terminology of EXIT v. RAMP. Currently guide signs uniformly display the word EXIT and include options for speed advisory. The warning signs provide options (which leads to lack of uniformity) that include both the words EXIT and RAMP. Designers will argue that all exits are ramps but not all ramps are exits. If uniformity leads to greater safety, which message should be recommended?
- Placement of the exit speed advisory signs can vary in position prior to the gore, at the gore and beyond the gore. When is the ramp advisory speed utilized on an exit v. horizontal curve warning? When is excessive speed differential determined and supplementary guide sign warnings (supplementary speed advisory to E13-2 or E5-1a)?
- What is the basis for advisory speed designation (first curve, slowest curve)?
- What is order, sequence and location/placement of horizontal exit speed advisory signs to have the greatest positive influence on reduction in excessive speed exiting a freeway or highway.

This gap in research creates a significant and immediate need to address application to complement the research already completed. Because of the higher speeds at these facilities, addressing the most appropriate traffic control application to avoid run off the road issues/barrier strikes/risky behavior is needed for public safety.

Literature Search Summary

NCHRP 03-106 provides research on sign placements for horizontal curves but little to no research on exit speed advisory conditions. Freeway to ramp transitions are one of the most commonly speed transition where horizontal alignment change can play a role in run off the road and tipping (truck) crashes.

Research Objective

There are two elements to the research approach – synthesis and human factors testing. The synthesis might have two phases: a) a map-based review of state's advisory speed sign practice at ramps or exits; and b) a survey of DOTs that inquires about their practices and design approach. The map-based review would consist of having the contractor identify sample several exit types utilizing Google Earth/traffic view. They could identify approximately 10 samples in every state from the following categories:

1. Urban Interchanges in top MSA
2. Urban Interchanges in smaller city
3. Rural Interchanges
4. System Interchanges

They would identify example of modern geometry and separate samples of unique/tight/old/ constrained geometry. Use of guide signs with supplemental warning would be included. They would document sign applications (MUTCD sign type) and identify their type/order/sequence and general placement.

The contractor would then determine for each of the categories if in these states that the signing is:

- a. consistent among applications in that state
- b. is generally consistent with what the MUTCD would consider standard (they could outreach to the NCUTCD to help outline the "general" checklist of items that would define conformance to standard).
- c. use of the terminology EXIT v. RAMP
- d. first curve, slowest curve applications
- e. how guide signs are used to supplement warning signs

Once the contractor has completed this Phase 1 work, outreach would be conducted to a select group of state traffic engineers/traffic control leads to answer a short survey about circumstances and issues they face at their agency with conformance and uniformity. A survey (SurveyMonkey) of 5-10 questions would be developed regarding their state of the practice. Outreach to the NCUTCD could be utilized to develop the proper question list.

With Phases 1 and 2 complete a report summarizing findings would be prepared and submitted to the NCUTCD for their work to address standards and guidance in this area of the MUTCD. A key deliverable would be a sketched up version of revisions to Figure 2C. This should reflect the condition most widely utilized identified from Phase 1 and (if appropriate) supplemental sketches of key changes that may occur given the speed differential magnitude (related to NCHRP 03-106 as different levels).

The second element of research would be to undertake human factors research on the applications developed in Phase 2 (above). This testing could be a combination of "image comparisons" and/or driving simulations to determine the best applications among alternatives/options. Following this research element, the contractor would work with the NCUTCD to develop recommended language and graphics for the MUTCD that could be forwarded to the NCUTCD council for approval and advanced to FHWA for their consideration.

NOTE: the follow pages provide background materials reference from the MUTCD and NCHRP 03-106>

Urgency and Potential Benefits

The FHWA released the NPA for the MUTCD in December 2020. It is likely within 20 months that the final rule making will occur. Should this research be completed in 2022 it would be possible to effect an interim approval aligned within one year of the final rule making. Having the input from this research would allow the NCUTCD to immediately

recommend proposals to change the MUTCD that could be provided to FHWA for consideration in interim approval to forthcoming 11th edition of the MUTCD.

Run off the road crashes in the transition from freeway to ramp curves can be fatal due to high speeds when the speed differentials are great. They can be difficult for motor carriers to negotiate without proper warning to avoid overturning. By providing uniform guidance for warning of the speed changes, the crash reduction potential is The benefits of this research is sign update programs for all 50 states will be undertaken with final rulemaking of the MUTCD and the timeliness of implementation will represent significant cost savings.

Implementation Considerations

The target audience is State DOTs and their freeway signing divisions. Through changes to the MUTCD, each state can uniformly apply the recommendations to improve safety in a timely manner with other sign replacement and upgrade efforts, associated with the MUTCD update.

Recommended Research Funding and Research Period

The recommended funding for this effort is based upon $\frac{1}{4}$ to $\frac{1}{2}$ person years of labor. This is estimated to be \$75,000 to complete the synthesis to complete phase 1 and phase 2, as outlined above.

The research period would be six months to complete phase 1 and 2 research, three months for review and revisions to the draft report and two months for final revisions based upon panel input.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Randy McCourt, PE, PTOE, member
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Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

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Bill Lambert, New Hampshire DOT
Mike Kimlinger, ODOT

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Regulatory and Warning Signs Technical Committee, NCUTCD. Tom Heydel, WisDOT

Reviewed By:

Leslie C. Harwood
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Comments:

There are unreasonable expectations for this project. The target date for the research to be completed is 2022 in order to align with interim approval for the 11th edition of the MUTCD. If selected, this research will not begin until 2023. The duration for the research is very short and may not be reasonable in light of the need for survey responses. The proposed budget is too low and should be increased to \$150,000 in order to allow for the contracting team to quickly perform the work on a short timeline. The objective for this needs to be clarified, for example: to provide guidance for exit and ramp speed signage to be incorporated into the MUTCD.

Review Date:

12/17/2021

AASHTO Committee Evaluation for G-17Submitted By:

Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A

Comments:

Recommend incorporating the effects on pedestrians crossing ramp junctions, effectiveness of sign placement in reducing serious/fatal crashes involving driver hitting pedestrian. Structure data discussion to enable understanding of implications for vulnerable road users.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-18

Problem Title

LED Applications on Traffic Control Devices

Background Information and Need For Research

The use of LED's has been expanded into the traffic control area with units used to enhance attention/conspicuity of signs, create dynamic sign legends, and provide basic traffic control. The Manual on Uniform Traffic Control Devices (MUTCD) administered by the FHWA has contained limited LED provisions to guide the LED applications. This has created some indecision among public agencies relative to the appropriate application of LED's in their traffic control applications. The NCUTCD has submitted LED recommendations to FHWA that maintain basic traffic control concepts, recognize the adaptability of LED technology and provide guidance for LED use. The development of those MUTCD recommendations identified a number of issues where research was not available to support the recommendations. There continues to be growing use of LED signs without clear understanding of possible safety advantages and/or impacts to automated vehicles, road users and adjacent residents. This research is needed to provide industry clarification on the LED applications and guide roadway agencies on basic traffic control concepts that ensure life cycle of significant investments and safety to road users.

Literature Search Summary

A literature search on the TRID database identified limited research that have addressed the LED design issues identified below. Most of the prior work focuses on design rather than consequence of LED applications. The following studies partially reviewed the application of LED's but provided little to no information on emerging issues noted in this problem statement.

A. Texas Transportation Institute (TTI)

TTI has conducted a number of research studies that utilized LED's beginning with Report FHWA/TX-04/4271-1, October 2003, Traffic Operational Impacts of Higher Conspicuity Sign Materials, on LED Stop signs and red border Speed Limit signs. A 2004 report, Project No. 404940, Legibility Distances of Smaller Character Light-Emitting Diode (LED) Dynamic Message Signs for Arterial Roadways, recommended that the City of Dallas should not reduce the legend size. Report FHWA/TX-12/0-6462-1, December 2011, Modern Traffic Control Devices to Improve Safety at Rural Intersections, provided some guidance on usage of embedded LED's on STOP signs. Project FHWA/TX-12/0-6407-1, January 2012, Studies to Determine the Effectiveness of Automated Flagger Assistance Devices and School Crossing Devices, addressed various configurations and LED applications for STOP/SLOW paddles.

B. Transportation Association of Canada

The Transportation Association has sponsored two research studies. TOMSC No. 293, Appropriate Use of Blinking Border Lights, April 2010, provided some recommendations on border LED applications and the Final Report, September 2010, provides some recommendations on usage, flash rate, pattern, color, number and placement, and intensity.

Research Objective

The objective of this research is to evaluate various LED sign applications and provide research data that supports the best LED application on regulatory and warning signs for the road user. The issues to be researched are identified below in priority order with the scope of the research subject to change because of limited funding. A research plan for each issue should be developed and approved.

The issues to be considered in the research are as follows:

1. Refresh Rate: LEDs refresh at a rate that is not observable by human eyes (typically above 60 Hz). However, at these rates detection systems for automated vehicles see blank images due to the “slow” refresh rates. This applies to CMS as well as traffic signal and beacon displays (in addition to street lighting and vehicle lighting which may affect automated vehicle perception devices – sensors, cameras, software). A 200 Hz minimum rate has been proposed without research into secondary impacts to radio frequency standards set by FCC Part 15 due to power loads. Future misinterpretations of traffic control or vehicle lighting/turn displays would pose a public safety risk. Because of the significant cost of CMS, signs could become obsolete without clear understanding of refresh rates, machine detection and radio frequencies. What is the optimal refresh rate for LEDs in traffic control applications and how can this be shared across street lighting and vehicle lighting use?
2. Flash Rate: The recommended MUTCD (Section 2A.07) flash rate varies from 50 to 120 times per minute. Rectangular Rapid Flashing Beacons (RRFB's) have interim FHWA approval for a unique flash rate at pedestrian crosswalks. Would different specified flash rates for beacons based upon groups of signs such as stop, warning, or pedestrian to identify the sign application be beneficial for the road user?
3. Flash Pattern: In addition to flash rate, flash patterns are utilized for various traffic control devices. Basic flashing is where illuminated elements are simultaneously on and then off repeatedly at fixed intervals (flash rate). Coordinated flashing can occur in four different ways: a) sequential flashing where flashing elements of the sign progressively display a message either within a sign or from sign to sign (for example W1-8 Chevrons in a curve); b) alternating or dancing flashing where the same symbol or beacon is displayed in different horizontal position (for example alternating diamonds); c) rapid flashing where the flash rate differs from simultaneous (for example a rectangular rapid flash beacon); and d) streaming flashing where a symbol is displayed progressively across a CMS multiple times (different from a single change which would be alternating, for example portable temporary traffic control using sequential chevrons). When should the various flash rates be applied to produce the best outcomes for safety? Should

these flash rates be unique to single traffic control devices or applications to have maximum effect? Given the range of enhanced conspicuity, which flashing rates align with various traffic control devices?

4. LED pitch (spacing): LED's are placed within a sign legend to depict the letter stroke width and size of letter. What LED pitch or spacing should be used to display sign legend and provide maximum sign legibility consistent with MUTCD legends, text and symbols? Can standard CMS font forms matching the standard highway fonts be created to improve uniformity?
5. Sign Shape: The shape of a regulatory and warning sign have been a basic sign design principle since the 1930's. The shape provide the road user advance identification of the sign application prior to legibility of the sign legend. LED's are used in the border of signs to enhance their conspicuity. Placing excessive LEDs on the border can "glare out" driver perspective of sign shape and legend. What spacing of LED's in the border are needed to identify the sign shape for the various regulatory and warning signs and provide enhance conspicuity?
6. LED Size: The LED size recommended for sign enhancement and legend has been limited at ¼ inch. Larger LED's are available in a variety of types, sizes, colors, illumination intensity and side fire LED's. What are the recommended LED size for regulatory and warning sign applications that provide the best sign conspicuity while preserving sign legibility? Does the size of LED, dimming or the intensity of display impact glare and road user/automated vehicle recognition of traffic control device function?
7. LED Sign Size: The LED applications for sign legends increases the sign legibility beyond static retro-reflective sign legends. Does the use of LED's in sign legends permit smaller sign sizes for the some roadway applications?

The research is proposed in two phases. Phase I will review and update the information on LED usage for regulatory and warning sign applications. Phase I will also assess the LED technology available for sign applications and develop appropriate research studies to address the above seven issues plus any additional identified research. Phase II will conduct the research with a final report that will document the research studies and recommend LED applications for regulatory and warning signs.

Accomplishment of the project objectives will require at least the following tasks.

TASKS

Phase I

Task 1 – Conduct a literature search for any documents pertaining to the above issues.

Task 2 – Investigate current state of the practice related to DOT/transportation agency equipment acquisition involving LEDs. Review manufacturers products to assess the current technology and sign applications. Survey specifications related to each of the research issues.

Task 3 – Create research work plans that provide data-driven resolution to each of the seven issues/questions. Develop research plan for the issues and budgets for each issue.

Task 4 – Submit an Interim Report for Tasks 1 through 3.

Task 5 – Meet with Research Panel to review the Interim Report and obtain approval of the research plan.

Phase II

Task 6 – Conduct research studies which provide data and support to determine optimal LED specifications which address road user comprehension, uniformity and automated vehicle detection.

Task 7 – Develop recommendations based on the research to address the issues identified. Recommendations would include guidelines which would be considered for incorporation in the MUTCD. Identify potential solutions which may include physical, electronic, or operational changes to traffic control devices, vehicle image capture and image processing systems, or both that meet the needs of both human drivers and automated driving systems.

Task 8 – Submit a Final Report documenting the entire research.

Urgency And Potential Benefits

Automated vehicles are increasingly becoming a part of the vehicle fleet. Electronic traffic control devices are expensive and have long service lives (over 20 years). Once a CMS or signal is built with LED specifications that ignore the consequences of uniformity and detection, it results in greater potential for negative safety consequences and undue expensive legacy equipment replacement costs. Any delay in the research will result in the use of non-uniform traffic control devices at great cost to the public that have the potential for significant safety implications (ie. dark signals to automated vehicles) and do not have the best interests of the road user before the convenience and discretion of manufacturers.

Implementation Considerations

The prompt completion of this research will provide the answers that can be incorporated in the Manual on Uniform Traffic Control Devices (MUTCD) allowing for rapid incorporation by State DOTs and transportation agencies across the United States to improve long term safety to road users. This research should include panel members from the National Committee on Uniform Traffic Control Devices who develop recommended MUTCD provisions for consideration by the Federal Highway Administration.

Due to the nature of the topic and because this research will benefit not only state DOTs but also the traffic control device and automotive industries, a significant number of organizations will be interested in the research results and could help support implementation

- AASHTO Committee on Traffic Engineering (CTE)
- AASHTO Committee on Transportation System Operations (CTSO)
- American Traffic Safety Services Association (ATSSA)
- Illuminating Engineering Society of North America (IESNA)
- International Commission on Illumination (CIE)
- International Municipal Signal Association (IMSA)

- Institute of Transportation Engineers (ITE)
- National Committee on Uniform Traffic Control Devices
- National Electrical Manufacturers Association (NEMA)
- Society of Automotive Engineers (SAE)
- USDOT, Federal Highway Administration
- USDOT, National Highway Traffic Safety Administration
- American Society for Testing and Materials (ASTM)

Recommended Research Funding and Research Period

Recommended Funding: \$500,000

Research Period: 30 Months

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

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Bill Lambert, New Hampshire DOT

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Regulatory and Warning Signs Technical Committee & Research Committee of NCUTCD.

NCHRP Review of G-18

Reviewed By:

Camille Crichton-Sumners

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Comments:

The problem statement includes several potential research topics for consideration and prioritization by the AASHTO Traffic Engineering Committee. The specified tasks are to be applied to each of the 7 research areas listed and the budget and schedule seem reasonable once the scope is defined with a selected topic given the need to acquire

LEDs for evaluation. Note that NCHRP cannot compare the performance of and recommend proprietary products..

Review Date:
12/17/2021

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-19

Problem Title

Improved Method to Link Crash, Emergency Medical Service, and Trauma Registry Data to Expand Safety Data Analyses and Safety Program Development

Background Information and Need For Research

NCHRP 17-57, Development of a Comprehensive Approach for Serious Traffic Crash Injury Measurement and Reporting Systems, developed a roadmap for states to develop comprehensive crash-related data linkage systems (NCHRP web-only report 302). A particular focus of the research was related to defining and measuring serious injuries in crashes. Since the completion of the research in 2017, newer versions of related systems have been released, additional research has been performed, and technological developments have advanced capabilities in this area. For example, it is now possible to use a Universally Unique Identifier (UUID) to perform deterministic linkage between two records in emergency medical service and trauma registry databases. Applying this method to crash records to link them to Emergency Medical Service (EMS), trauma registries and other types of data will greatly increase the availability of these linkages, allowing for advancements in traffic safety data analysis, which in turn will lead to development of more effective and comprehensive traffic safety programs. In addition, this research would support more sophisticated safety target-setting, as well as safety performance monitoring and management.

Literature Search Summary

National Academies of Sciences, Engineering, and Medicine 2021. Development of a Comprehensive Approach for Serious Traffic Crash Injury Measurement and Reporting Systems. Washington, DC: The National Academies Press.
<https://doi.org/10.17226/26305>.

A Novel Approach to Data Linkage: EMS and Trauma Registry Data. National Association of State EMS Officials and American College of Surgeons. 2021.

Research Objective

The objective of this research is to further refine an approach, proposed by the joint National Association of State EMS Officials (NASEMSO) – American College of Surgeons (ACS) policy statement, “A Novel Approach to Data Linkage: EMS and Trauma Registry Data” to use a Universally Unique Identifier to link traffic crash report data with other data systems. This will allow state agencies to measure serious injuries by linking crash data at the state level with the EMS and hospital trauma registry data, providing more detailed quantification of crash outcomes in terms of injury severity scoring, hospitalization costs, length of stay, permanent disability - powerful insights

never before available to highway safety stakeholders. This research will be especially important for vulnerable road users such as pedestrians and bicyclists – who typically experience especially low reporting rates in police collision datasets – since EMS and trauma registry records are not limited to the incident types for which police records are filed. Tasks may include:

- Analysis of changes in traffic-safety related data and advancements in traffic safety data analyses since research performed during NCHRP Project 17-57. This should include the recommendations provided in NCHRP Web-Only Report 302, which were developed in 2017.
- Further development of the method of deterministic linkage of EMS and trauma registry data using a Universally Unique Identifier to perform similar linkages with crash report databases.
- The technical specification of the “landing spot” for the UUID in various existing data standards (e.g., MMUCC)
- Assessment and application of previously-developed relevant methodology or related research.
- Development of an implementation plan that provides both a potential path for nationwide outreach and implementation and guidance for agencies collaborating in individual states to implement the research results depending on their current readiness to adopt proposed data linking methodology.

Urgency and Potential Benefits

This research would support informed, data-driven decisions that impact safety, and would further enable state departments of transportation to collaborate with traffic safety stakeholders. Reducing the complexity of database linkage practices will allow states to more fully assess the total crash event and the continuum of care offered to patients after the crash.

Current data linkage practices are complex and dependent on the availability and quality of “like” elements within disparate datasets. Specifying and promoting use of a UUID to deterministically link records, (with no use of protected health information or personally identifying information) will greatly enhance the reliability and precision of records linkage and will facilitate record linkage among states and governmental entities that heretofore have had neither resources nor expertise to support complex probabilistic linkage platforms and processes.

This research would support the AASHTO Committee on Safety strategic plan goals of working toward zero traffic fatalities and serious injuries and improving states’ capabilities to perform data-driven safety analyses to quantitatively factor safety into agency decisions regarding multidisciplinary safety program development, target setting, and performance management. The Committee on Safety supports this research, as do the Transportation Research Board Standing Committee on Pedestrians and the Standing Committee on Transportation and Public Health.

Implementation Considerations

Because stakeholders likely to be interested in the results of this research would be employed by multiple agencies within each state, dissemination of the research results would need to use multiple channels that would reach this broad audience.

Implementation will necessitate leadership by and coordination among organizations with a role in data, clinical care and traffic safety, including national associations and federal agencies already working in this field. The focus of this research will be to demonstrate proven methods of overcoming implementation challenges due to HIPAA so that engineers and other non-health professionals will have access to the data.

Opportunities for demonstrating or piloting the implementation guidance developed by the project should be coordinated among relevant partners as well, to both promote agencies' interest in and commitment to being initial adopters of the methodology, and to help ensure distribution of results, success stories, case studies, and lessons learned to other agencies.

Recommended Research Funding and Research Period

Research Period: 24 months

Research Funding: \$400,000

PROBLEM STATEMENT AUTHOR(S): For each author, provide their name, affiliation, email address and phone.

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This statement is also supported by:

TRB Standing Committee on Pedestrians (ACH10)

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To be determined.

N/A

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

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NCHRP Review of G-19

Reviewed By:

Richard A. Retting

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Comments:

Linking crash, EMS, and trauma registry data is a valid traffic safety and public health objective. Given the history of state and federally-funded efforts to improve such data linkages it would be helpful for the authors of this problem statement to provide more thorough literature search summary; only one study is cited. It is important to identify any related research projects that are planned, underway, or recently completed to avoid duplication. The recommended funding seems a bit high relative to the stated research objectives.

Review Date:

11/23/2021

FHWA Evaluation of G-19

Reviewed By:

Pascual/HSA; Eigen/HRSO

Comments:

The proposed research builds upon sound conclusions drawn in NCHRP 17-57 and reported in the final report. While moving away from KABCO is a challenge given the NHTSA/FHWA requirement for all States to include KABCO "A" in their data and reporting, this ties in nicely to the efforts NHTSA is working on with SMEs to develop a prioritization of data sources. Specifically, integrated injury data would be used in crash report sets over injury data collected by LEOs, with trauma data more reliant than EMS,

etc. Any integration methodology that could increase the frequency and ease of data integration would simply slide into that prioritization scheme.

Review Date:
December 17, 2021

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-20

Problem Title

Best Practices for Roundabout and Alternative Intersection/Interchange Lighting

Background Information and Need For Research

Alternative (aka "innovative") intersections and interchanges are junctions of two or more roads that do not use traditional intersection/interchange layouts. Several research projects have demonstrated the numerous safety and operational benefits of Alternative intersections/interchanges over traditional intersection/interchange configurations, as summarized in the FHWA Alternatives Intersections/Interchanges Informational Report (AIIR) and the Roundabouts: An informational Guide (NCHRP Report 672) publications.

Most alternative intersections/interchanges installed in the US to date have roadway lighting, in part because lighting is strongly recommended by both the AIIR and NCHRP 672 publications. However, lighting adds significantly to both the upfront construction cost and ongoing maintenance costs, which can be a barrier to successful implementation to such projects. Lighting can also be a barrier to implementing projects where local communities are concerned about light pollution/trespass. Some agencies have a formal or informal policy that alternative intersections/interchanges must be lit, but do not necessarily light traditional signalized intersections – a policy that may be backwards given that traditional signalized intersections typically have much greater number of conflict points for both pedestrians and vehicles than alternative intersections/interchanges.

This research would support of the following items in the AASHTO Committee on Design Strategic Plan:

- 2.1. Promote Flexibility in Design Practices
- 2.5. Play an active role in the development of guidance on climate change and energy efficiency efforts in the design of projects.
- 4.1. Develop and promote timely research into highway and transportation facility designs that improve safety for all modes.

This research would also support the following items in the AASHTO Committee on Traffic Engineering Strategic Plan:

Goal 2: Improve access and safety of non-motorized user groups to member department roadways.

Goal 5: Prepare and update traffic engineering technical products (which includes the AASHTO Roadway Lighting Design Guide)

Literature Search Summary

Limited research is available to support the recommendations of the FHWA Alternatives Intersections/Interchanges Informational Report (AIIR) and the Roundabouts: An informational Guide (NCHRP Report 672) publications.

The proposed research would build onto 2012 NYSDOT research “Demonstration of Roundabout Lighting using the Ecoluminance Approach”, which investigated a technique involving landscaping in the central island and then landscaping-style low-to-the-ground lighting that illuminates the landscaping.

<https://www.dot.ny.gov/divisions/engineering/technical-services/trans-r-and-d-repository/C-08-03FinalReport-Project18233-C0803.pdf>

Research Objective

The intended research is intended to result in answers to the following questions:

- What are the safety benefits of lighting for motorists and for pedestrians at various alternative intersection/interchange types?
- Can criteria be established that prioritizes what characteristics of alternative intersections/interchanges most strongly warrant lighting? Example criteria might include number of lanes (e.g., multilane vs. single-lane roundabouts), presence of pedestrian or bicycle facilities, etc.
- What are best practices for lighting design of alternative intersections/interchanges?
- For some junction types, lighting has long been recommended as a way to reduce risk of wrong-way entry, for example going clockwise in a roundabout or entering wrong-way on a DDI. Does lighting provide measurable benefit in reducing risk of such maneuvers? Note that for alternative interchanges, wrong-way entry risk may be lower than it is at traditional diamond interchanges.

Anticipated major activities:

- Literature review.
- Survey of current state practices, and practices in other countries where roundabouts are more common than in the US.
- Review crash data for existing alternative intersections/interchanges with and without lighting. Note that this may be challenging given that there are likely few examples nationwide of unlit alternative intersections/interchanges.
- Driver simulation analyses of various alternative intersection/interchange types with and without lighting, and with different lighting strategies.
- Develop conceptual layouts showing recommended pole/luminaire placement for common alternative intersection/interchange types.

The primary final product would be recommended revisions to the AASHTO Roadway Lighting Design Guide. The final product would also be provided to FHWA for their consideration in future revisions to their alternative intersection/interchange and roundabout design guidance.

Urgency and Potential Benefits

Most state DOTs are strongly encouraging use of alternative intersections and interchanges due to their significant safety and operational benefits as compared to traditional designs. However, the current recommendations out there generally strongly encourage or require lighting for all such junctions. This adds significantly to both their initial construction cost and future maintenance costs. Additionally, some communities are opposed to lighting in general, out of a mistaken belief that traditional intersection/interchange designs don't need lighting.

Additionally, some intersection/interchange designs have different vehicle paths and different vehicle speeds than traditional intersections, for example a vehicle exiting a roundabout and approaching the crosswalk at a splitter island or designs like RCUTs that heavily rely on U-turning traffic. Lighting design requirements for traditional junctions may not apply to lighting designs at alternative intersections/interchanges.

This research would benefit all road users by potentially making it easier (more quickly, less expensive) for agencies to implement alternative intersection designs.

Implementation Considerations

This research would primarily be used by those within state DOTs responsible for lighting policy and lighting design. The research should be integrated into other existing national-level design publications such as the AASHTO Roadway Lighting Design Guide and Illumination Engineering Society's (IES) RP-8 Recommended Practice and be used to update the recommendations of the FHWA AIIR report and the NCHRP Roundabout Design Guide.

Training workshops and outreach to state and local road agencies would be necessary during implementation of this research and ensuring awareness of the findings.

This research would primarily be of interest to the AASHTO Joint Technical Committee on Lighting, which reports to both CTE and COD. This research would also be of interest to the Roadway Lighting Committee of IES.

Recommended Research Funding And Research Period

\$500,000, 24 months.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Marc Lipschultz, Virginia DOT, 804-371-6022, Marc.Lipschultz@vdot.virginia.gov

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Members of the AASHTO Joint Technical Committee on Roadway Lighting

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Mark Luszcz
Chair, AASHTO Joint Technical Committee on Roadway Lighting
302-760-2356
Mark.luszcz@delaware.gov

NOTE: This problem statement was Ranked #1 (tied) by the AASHTO Committee on Traffic Engineering, and Ranked #4 by the AASHTO Committee on Design.

NCHRP Review of G-20

Reviewed By:
David M. Jared
djared@nas.edu

Comments:

Timely research with broad support from the AASHTO community from both the traffic engineering and geometric design angles. The research needs to anticipate and address potential implementation hurdles by state and local agencies. Perhaps part of the budget could be dedicated to outreach beyond e-surveys, interviews, etc.

Review Date:
12/8/2021

FHWA Evaluation of G-20

Reviewed By:
Intersections Team/HSA/HRDS

Comments:

This would be very useful research but would need to stay focused on what the recently updated AASHTO Roadway Lighting Guide does not cover with respect to roundabouts and alternative intersections/interchanges. Also, there has been other research completed on lighting for roundabouts and isolated rural intersections that may reduce the scope of this project. Perhaps a synthesis that identifies what other work has been completed along with an assessment of the gaps remaining in the new AASHTO guide would be a beneficial first step.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for G-20

Submitted By:

Patricia Bush
AASHTO staff
Committee on Design

Priority #: 4

Comments:

Committee on Design ranked #4 of 4.

Submitted By:

Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A

Comments:

Needs of active transportation users are an important part of this study. Recommend inclusion of pedestrian-scale lighting. New report from FHWA
https://safety.fhwa.dot.gov/roadway_dept/night_visib/docs/StreetLightingPedestrianSafety.pdf

Submitter Response for 2023-G-20From:

[email: Mark.luszcz@delaware.gov]

Comments:

Thank you for your comments. Based on this comments we did another search for relevant roundabout lighting research, and would like to add reference the 2014 Georgia Tech research "The Impacts of Illumination Levels on Nighttime Safety at Roundabouts" ((1) (PDF) THE IMPACTS OF ILLUMINATION LEVELS ON NIGHTTIME SAFETY AT ROUNDABOUTS | Franklin Gbologah - Academia.edu). We are not aware of other research that attempts to quantify safety benefits of lighting at roundabouts; to our knowledge the first FHWA Roundabout Design Guide (from 2000) called for lighting at all roundabouts to be conservative at a time when roundabouts were still very new to the US and public unfamiliarity/opposition to roundabouts was much stronger than it is today. Note that the "Roundabouts: An Informational Guide (Second Edition" (NCHRP Report 672) does not reference any particular studies or detailed criteria to be used when determining whether to illuminate roundabouts, and if so whether to illuminate them partially or fully.

We are aware of the MnDOT research which found good reduction in crash risk associated with lighting of isolated rural T- and crossroads intersections, however it appears that research did not consider roundabouts or other alternative intersections.

While a Synthesis effort could be beneficial, we feel that there are significant known gaps in the body of knowledge, and a Synthesis effort would serve primarily just to affirm that such a gap exists, so therefore the best course of action is to proceed with a research effort that would include the tasks normally associated with a Synthesis, such as a survey of state DOTs.

Contact Info:

Mark Luszczyk

302-760-2356

Mark.luszczyk@delaware.gov

Review Date:

1/7/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-21

Problem Title

Effective flash patterns using LED-Enhanced Chevron Sign Systems

Background Information and Need For Research

Run-off-the-road fatalities continue to be one of the most significant factors in highway safety. From 2014 to 2018 18,000 to 19,000 fatalities annually resulted from road departure. Research has identified enhanced horizontal curve warning signs as an effective countermeasure. LEDs enhance conspicuity of static traffic signs and are currently allowed in of the Manual on Uniform Traffic Control Devices (MUTCD) in section 2A.07. They are increasingly being deployed in systems across the country. The MUTCD states “LED units may be used individually within the legend or symbol of a sign and in the border of a sign...to improve the conspicuity, increase the legibility of sign legends and borders...” Section 2A.07.09 of the Manual states “if flashed, all LED units shall flash simultaneously at a rate of more than 50 and less than 60 times per minute.” The flash rate and pattern may play a significant role in improving the performance of this countermeasure. Research to date has not focused on flash pattern and simply used either simultaneously or sequentially flash patterns. The purpose of this study is to determine the most effective flash patterns and flash durations for LED-enhanced chevrons in varying applications, seeking eventual approval by the Federal Highway Administration (FHWA) and standardization of flash pattern naming conventions for inclusion in the MUTCD.

Sequential chevron systems have been identified as a proven low-cost countermeasure for reducing roadway departure crashes at horizontal curves by the FHWAi. Roadway departure crash rates are three times higher at horizontal curve locations relative to tangent segments of roadwayii. These systems have been implemented as a countermeasure on two-lane rural highway curves as a means of reducing vehicle operating speeds and improve curve delineation. An example of the results of an FHWA study utilizing sequencing chevrons showed that after 24 months:

- The change in % of vehicles exceeding the advisory speed by 20 mph or more decreased by an average of 32 percent.
- The change in % of vehicles exceeding the advisory speed by 15 mph or more decreased by an average of 30 percent.

Sequential chevrons can effectively reduce vehicle speeds in horizontal curves especially in wet conditions and a Caltrans study reported a 44 percent reduction in crashes in the first year and a 39 percent reduction in the second year.iv Speed reduction is vital, due to the fact that, in the US, drivers who exceed the speed limit or advisory speed are

involved in nearly one-third of all fatal crashes and each year more than 13,000 people in the US are killed in speed-related crashes.

To date, flash patterns have been simultaneous (i.e., each sign is flashing at the same time as the other signs); or, sequential (i.e., in a series of chevrons signs where the LED activate moving away from the driver). In the latter case, this is typically accomplished by having each sign flash at least once per second, with each flash lasting 100 milliseconds to 1 second. Each sign begins flashing at a time that is offset relative to the adjacent sign, producing a sequential flashing effect. At least one sign is always on in the system during the flash pattern. This gives the effect of the system guiding or pulling the driver through the curve and highlights the geometry while still meeting the MUTCD guidelines.

Using the length and speed of the curve, the user can set each of the W1-8 chevron signs to flash in a specific sequence or time interval. Each curve design will have different sign placement and geometry for consideration when determining the appropriate flash sequence. Chapter 2C of the Manual on Uniform Traffic Control Devices (MUTCD) and engineering judgment should be applied when determining appropriate sign layouts and locations.

Typically, each LED-enhanced sequencing chevron sign on a horizontal curve will flash at least once per second according to MUTCD guidelines, with a flash "ON" time of 100 milliseconds to 1 second. Again, not all curves are configured the same and some are longer than other. When curves are long and there are numerous chevrons, vehicles can lose visibility of the flash pattern due to length of time between flashes. This has the potential to reduce the effectiveness of the LED-enhanced chevron sign systems. As an alternative, alternating flashing of pairs of chevrons signs provides shorter segments allowing the flash to be visible throughout the traversal of the horizontal curve. This allows the motorist to see the LED-enhanced chevrons flashing no matter where the vehicle is positioned in the curve and where the system is in its flash pattern.

Literature Search Summary

Information Sources:

i Federal Highway Administration Low-Cost Treatments for Horizontal Curve Safety 2016, APPENDIX E: Application of Sequential Dynamic Curve Warning Systems (SDCWS). https://safety.fhwa.dot.gov/roadway_dept/horcurves/fhwasa15084/appe.cfm

ii US Department of Transportation FHWA report Low-Cost Treatments for Horizontal Curve Safety 2016

iii Smadi, O., N. Hawkins, S. Hallmark, and S. Knickerbocker. Evaluation of the Sequential Dynamic Curve Warning System. Report No. FHWA-HIF-13-040, Federal Highway Administration

iv McGee, Hugh W. and Hanscom, Fred R. (2006), US Department of Transportation FHWA report Low-Cost

Treatments for Horizontal Curve Safety.

v USDOT Report: FHWA-HRT-12-020. (2015) Evaluation of Dynamic Speed Feedback Signs on Curves

Other Research:

Indoor Simulator Study and Field Study Evaluation of Sequential Flashing Chevron Signs on Two-lane Rural

Highways, FHWA-SA-18-075, FHWA, by Penn State, November 2017

Evaluation of the Sequential Dynamic Curve Warning System, FHWA-15-CAI-012-A, by Iowa State, November 2015

Factors Related to Fatal Single-Vehicle Run-off-road Crashes, DOT HS 811 232, NHTSA, by URC Enterprises, Inc., November 2009.

Run-off-road Crashes: An On-Scene Perspective, DOT HS 811 500, NHTSA, July 2011.

Practices for Preventing Roadway Departures – Synthesis, NCHRP 515, TRB, by Hugh McGee, 2018.

Research Objective

To improve the safety countermeasure characteristics of LED-enhanced chevron (W1-8) signs determining the best results from allowable flash rate and patterns such as constant on, simultaneous, sequential, and alternating would be researched. Additionally, wherever practical, study the correlation, if any, between reducing vehicle speeds at different flash durations and actual speeds of the sequence.

Since several enhanced conspicuity chevron sign systems are in the field presently, the first step would be to inventory the applications in the US, assembling a context and performance data base. A synthesis study would be used to obtain this data. A subsequent research effort may be necessary depending upon findings from the synthesis (for example, if flash rate and pattern options show varying performance the need to conduct more thorough research into the best flash rates and patterns). A draft of such follow up research is also provided here.

PHASE 1 SYNTHESIS

- a. Survey of state DOT (AASHTO), county (NACE), local agency (APWA) and transportation (ITE) professionals to identify applications of chevron signs using enhanced conspicuity LEDs.
- b. Follow up with professionals for each application to obtain the following information:

- Location/Route

- Lane configuration, grade, speed limit
- Pictures of application
- LED flash rate(s), flash pattern(s)
- Curve radius and advisory speed
- Chevron sign spacing
- Speed distributions (before/after, as available)
- Crash data (before/after, as available)
- c. Tabulate survey data of current practices and results
- d. Summarize findings in a synthesis report and determine if further research may be necessary to identify the “best” enhanced conspicuity strategy(s) for flash rate and pattern.
- e. Share findings with the National Committee on Uniform Traffic Control Devices, AASHTO, NACE and APWA.

PHASE 2 FLASH RATE/PATTERN RESEARCH (draft work plan to consider, if necessary, based upon synthesis work)

a. Task 1 – Assessment of Existing Research

This would involve literature search into run-of-the-road and LED-enhanced traffic control devices, both those currently available in the industry and concepts in development. Findings would be summarized in an annotated bibliography of prior research, focusing on flash pattern evaluations.

b. Task 2 – Simulator Testing of Flash Patterns

Simulator research will be conducted for various approach speed and flash patterns, analyzing driver-subject behaviors and outcomes. A task report will highlight results of the flash patterns and best performance. The report will recommend open road testing strategies for Task 3.

c. Task 3 – Open Road/Test Course Evaluation of Flash Patterns

A series of signs will be assembled for various curve radius conditions. Test subjects will drive vehicles at various approach speeds and connected vehicle data and driver observation systems will assess performance for the various flash patterns, given curve radii and speeds, to assess the best performance. A task report will outline test conduct, results, and findings.

d. Task 4 – Field Testing

Participating agencies (and vendors noted in 3a Phase 1) will install the best performing flash patterns in the field for high crash locations associated with road departure. After three years, after crash data will be assess and compared with identified other existing locations where LED-enhanced signs were installed (sites to be identified in Phase 1) as control comparisons for crash reduction (this will include the following installations – from existing baselines sites with no chevron signs to static speed advisory and/or chevron signs, to LED-enhanced conspicuity chevron signs (best option). A task report will summarize crash reduction performance of field tests to control comparisons.

e. Task 5 - Final Analysis and Evaluation

The final project report including results from Phases 1-4 will be prepared.

Urgency and Potential Benefits

Run-off-the-road crashes are one of the largest categories of highway fatalities and serious injuries every year. With the changes to the impending MUTCD related to signing for horizontal curves, many agencies will be updating signs in the immediate future. Having research into the best systems for preventing run-off-the-road crashing at horizontal curves would allow agencies to utilize emerging national and local safety funding to significantly reduce run-off-the-road crashes. This synthesis (and if needed, research) will provide practitioners better understanding to the best applications for flash rate and flash pattern for enhancing chevron signs with LEDs. In doing so, limited funding can be for efficiently applied once, immediately, rather than allow non-uniform applications to emerge that will eventually need to be removed, wasting resources

Implementation Considerations

The strategy would be to complete the synthesis study immediately and funding for just this phase would be step 1. With the findings from the synthesis, information would be shared with the NCUTCD for their consideration. In the findings of the synthesis, should it appear that further research would be necessary, a refined problem statement would be prepared to seek further funding for more detailed research (along the lines as preliminarily outlined in this synthesis problem statement (which has been provided to help synthesis analysts to better understand their undertaking. The target audience for the synthesis will be agencies that are designing, installing and operating curve warning systems (likely state DOTs and county engineers). By conducting the synthesis, greater understanding of current knowledge and practice can be obtained. By sharing this with professionals in transportation agencies and national committees, they can advance thinking and applications into how to reduce run-off-the-road crashes.

Recommended Research Funding and Research Period

Level of Effort:

Phase 1 Synthesis: one person month survey outreach and synthesis, one person week summary of findings

Total: 240 hours ~ \$45,000

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

The initial draft of this problem statement was developed by Bob Felt from TrafficCalm Systems, Joanne Conrad and Jay Swinea from TAPCO, Randy McCourt from DKS Associates whom all are members of the NCUTCD RWS Technical Committee Special Research Task Force on sequential flash patterns.

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Tom Heydel

SE Regional Traffic Engineer

Wisconsin DOT

Tom.heydel@dot.sate.wi.us

Chair: Regulatory & Warning Signs Technical Committee of the NCUTCD

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

The initial draft of this problem statement was developed by Bob Felt, Joanne Conrad and Jay Swinea, Randy McCourt whom all are members of the Regulatory & Warning Signs Technical Committee of the NCUTCD Special Research Task Force on sequential flash patterns.

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NCHRP Review of G-21

Reviewed By:

Leslie C. Harwood
LHarwood@nas.edu

Comments:

The objective of this proposed research is to determine the most effective flash patterns and flash durations for LED-enhanced chevrons in varying applications to improve safety countermeasures. A phased approach is appropriate for the research described, however it is unclear just what is being asked for. The funding request of \$45,000 applies to the first phase which is to gather and synthesize information. The budget for Phase 1 activities is low; suggest \$75,000 for this effort. Based on the results of Phase 1, additional work if any can be scoped and a problem statement can be prepared for a second funding request; no budget was suggested for Phase 2 activities. If this project is awarded, it may be appropriate to consider submission for continuation funding of Phase 2 research only if deemed necessary after Phase 1 is complete. The suggested duration of Phase 1 of 12 months may not be enough time; 18 months may be more reasonable.

Review Date:

12/17/2021

FHWA Evaluation of G-21

Reviewed By:

Roadway Departure

Comments:

This is important as it addresses a major crash problem and there isn't consistency in flash patterns of LED enhanced chevron. The synthesis cost seems too small. Suggest adding development of a test plan for Phase 2 and cost estimate. Another way to manage the large scope of Phase 2 is doing the initial work under a pooled fund project. Based on a previous project FHWA completed, many additional sites may be needed for the analysis, and this could become cost prohibitive. Accounting for maintenance and repairs should be considered, as well.

Review Date:

December 17, 2021

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-22

Problem Title

Pedestrian Signing - Determination of the “best” pedestrian regulatory crossing sign at intersections (MUTCD sections 2B.11, B.12, 2B.53 and 2C.50)

Background Information and Need For Research

Background:

The National Highway Traffic Safety Administration (NHTSA) estimates that nearly over 6,700 pedestrians were killed (2020) and another 137,000 injured (2017) in crashes with motor vehicles. Pedestrian fatalities as a share of all roadway deaths has been increasing each of the past five years to over 17 percent. This has occurred while vehicle miles traveled decreased. While numerous efforts and research have been made toward pedestrian safety, the outcomes are not working to reduce these results. Highway designers must often consider a variety of possible safety and operational treatments to mitigate pedestrian crashes at intersections. The lack of uniformity and ability to classify traffic control treatments to applications may be a factor in these crashes.

Issue:

The MUTCD Section 2B.11 provides for a midblock regulatory sign (R1-5 series) for multilane midblock crossings. The R10-15 sign in section 2B.53 covers the right turn application at an intersection application. However, there is no standard regulatory pedestrian sign for application at an intersection where the practitioner desires to provide a regulatory sign in lieu of or in addition to the W11-2 warning sign assembly contained in section 2C.50 for traffic proceeding straight thru the intersection where pedestrians are crossing the roadway. The various options in the MUTCD for pedestrian crossings signs have created numerous interpretations for applications of signs at intersections which tend to be counter to the benefits of uniformity and consistent signing. There is a need for signs that consistently regulate vehicle activity at pedestrian crossings of roads and highways. The current MUTCD language (see attached sections 2B.11, 2B.12, 2B.53 and 2C.50) have limitations for the current signs which aligns with the extent of prior research. The research limitations include:

- Sign application at intersections (signalized or unsignalized – not researched) as compared to the researched multi-lane mid-block crossings (part of prior research)
- Applications of regulatory signs on single lane approaches (not researched) as compared to multi-lane at midblock locations and intersections(part of prior research).

Problem Statement:

The various pedestrian crossing applications create unique interpretations of the current MUTCD signs that lead to inconsistent application. The lack of uniformity is a possible contributing factor to the poor pedestrian safety data historically. There is a need to investigate through human factors testing various sign displays to determine the best application for various unsignalized and signalized regulatory signs for crossing conditions that are not addressed currently in the MUTCD. This work needs to assess what cross cutting opportunities exist to consolidate signing messaging to enhance driver recognition, yielding behavior and pedestrians crossing decisions with the least number of sign types (alternatives) and produce the maximum benefit on safety to meet the vision of the MUTCD.

This request is for the first stage of a multiple stage research undertaking to complete a fact and research-based determination of pedestrian crossing traffic control. The stages involve in order:

- 1) Determine the “best” sign for traffic control at intersections through human factors research (urgently needed as no uniform sign exists today)
- 2) With both the intersection sign and the approved MUTCD mid-block signs determined, assess the methodology for the “best” sign positioning – right side, both sides (gateway), in-road, over road – using the Zeeger approach of context for speed, width and volume
- 3) With 1 + 2 complete, determine the “best” application of lighting/flashing conditions using the Zeeger approach of context for speed, width and volume. In this research, current/emerging research on LEDs at pedestrian crossings to determine the appropriate shape, size, position, color, flash rate, dimming/glare and minimum light levels (if any) will be determined.

Literature Search Summary

Prior human factors work in the 2012 FHWA Pooled Fund Study assessed basic recognition of pedestrian signs without putting the application context into the assessment. Recent Florida DOT/FHWA research into in-roadway signs (R1-6) is in the process of focusing on that sign application and the gateway effect of signs to the left and right of the driver. Recent STEP research provides a menu of options that while helpful, can contribute to lack of consistency in crossing treatments based upon context. Other sign research would be reviewed using the approved NCHRP Synthesis study (covering a vast array of prior research). Vehicle speed, volume and number of lane criteria for pedestrian enhancements was addressed in prior FHWA work for mid-block crossings and will be a foundational element of this research.

Guidance to Improve Pedestrian and Bicycle Safety at Intersection, NCHRP Research Report 926, TRB, 2020

Fitzpatrick, K., S. Turner, M. Brewer, P. Carlson, B. Ullman, N. Trout, E. S. Park, J. Whitacre, N. Lalani, D. Lord. Improving Pedestrian Safety at Unsignalized Crossings. TCRP Report 112/NCHRP Report 562, 2006.

Zegeer, C.V., R. Stewart, H. Huang, and P. Lagerwey. Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations: Executive Summary and Recommended Guidelines. FHWA-RD-01-075, FHWA, US DOT, McLean, VA, 2002.

Research Objective

Use human factors simulation of crossing characteristics to test various pedestrian regulatory sign applications at intersections to determine both the best and highest recognition to aid designers in uniformly applying the pedestrian regulatory signing to pedestrian crossings whether at intersections or mid-block. Supplement simulation with survey research of recognition of signs to their intended use (addressing variation in vehicle code interpretations between states for stop for or yield to pedestrians). An example starting set of signs from the MUTCD and others (below) would be assembled for context sensitive testing. The fundamental questions that will be answered will be:

- 1) The “best” regulatory sign for various intersection pedestrian crossing applications (addressing number of lanes, turn lane conditions) and are consistent with mid-block applications already developed.
- 2) Determine the appropriate role for warning signs when regulatory messaging is not necessary (possible use of W11-2 pedestrian crossing warning sign in advance or elsewhere).

Urgency and Potential Benefits

Enhanced consistency in signing to pedestrian crossing applications will lead to improved recognition of pedestrian crossing yielding behavior, potential speed reduction for pedestrian crossings and reduce the 6,700 annual pedestrian fatalities. By incorporating findings into recommendations for the MUTCD, nearly every designer across the United States would be empowered to implement the recommendations. As significant funding is being directed to pedestrian safety, addressing this now has the potential to be incorporated in project development with great return with little investment. Crossing traffic control design can immediately become part of state and local agencies design guides for pedestrian crossings. The risk without this research is designers continue the non-uniform applications or create new ones to ad hoc address the problem (as has been done in the past) without changing the outcomes for pedestrian safety systemically.

Implementation Considerations

The target audience is all agencies and private roadway owners with pedestrian crossings. Designers benefit from research that resolves the unaddressed issues related to pedestrian traffic control at intersection crossings. All public works departments, transportation divisions and private designers would implement these recommendations upon recommendation to FHWA. Virtually every state DOT has pedestrian coordinators focused on the topic of pedestrian safety and this provides a

low cost, effective means to improve safety through better guidance (rather than major capital investment).

Recommended Research Funding and Research Period

Recommended Funding: Pool Fund Study - \$100,000 to \$200,000

This study could break out the human factors testing of signs as a separate activity for <\$75,000

Task 1: Build upon STEP literature review, focusing upon sign applications and enhanced conspicuity

Task 2: Conduct human factors research of intersection sign(s) including the assessment of regulatory as compared to warning sign applications.

Task 3: Refine criteria for roadside, in-road, above road signing with number of lanes, vehicle speeds, functional class, vehicle & pedestrian volume and sight distance (including advanced stop line placement criteria based upon speed).

Task 4: Undertake field test applications among participating agencies

Task 5: Refine criteria based on Task 4 and review MUTCD sign standards, guidance and options for pedestrians crossing, recommending changes to implement the best practices from research.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Tom Heydel

SE Regional Traffic Engineer

Wisconsin DOT

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Chair: Regulatory and Warning Signs Technical Committee; NCUTCD

Randy McCourt

Retired

ITE Past President

503.randy.mccourt@gmail.com

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Tom Heydel, WisDOT

Bill Lambert, New Hampshire DOT

Trey Tillander, FDOT

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Regulatory and Warning Signs Technical Committee & Research Committee of NCUTCD.

NCHRP Review of G-22

Reviewed By:
Zuxuan Deng
zdeng@nas.edu

Comments:

Uniformly applying the pedestrian regulatory signing to pedestrian crossings at intersections or mid-block provides potentially a low cost, effective means to improve pedestrian safety, which is among one of the top priorities of most transportation agencies. Investigating through human factors testing various sign displays to determine the best application for various unsignalized and signalized regulatory signs for crossing conditions that are not addressed currently in the MUTCD seems to be a good approach to provide better guidance. The budget may be sufficient if only simulation evaluation is involved. However, if field data is expected to be collected and analyzed, it may be necessary to increase the budget. Suggestive study period would be 18 months and the timing should be coordinated with the release of the 11th edition of MUTCD.

Review Date:
12/15/2021

FHWA Evaluation of G-22

Reviewed By:
Mero/HRSO

Comments:

FHWA is working to award a project for the TCD PFS that used the proposal of G-22 for the basis.

Review Date:
December 17, 2021

AASHTO Committee Evaluation for G-22

Submitted By:
Kelly Hardy
AASHTO staff
Safety

Priority #: N/A

Comments:

Will there be a task that defines "the best signage" is it measured by adherence, driver reaction, etc.? Will there be a component that looks at crash severity reduction? Ultimately we will need the measured benefits if states are going to retrofit.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-G-23

Problem Title

Investigate the use of Meteorological Satellite products for Operational Highway Visibility Notification

Background Information and Need For Research

This research will investigate the use of artificial intelligence (AI) and machine learning (ML) to improve safety on our nation's surface transportation system by providing real-time visibility information to State Dept. of Transportation (DOT) agencies and travelers. Low visibility conditions due to adverse weather create unsafe conditions for travelers. There are a variety of weather information available to help inform the use of traveler information systems, including widely spaced surface weather observing stations. Low visibility, especially fog conditions are highly localized phenomenon and it is difficult and cost prohibitive to install surface (ground)-based visibility sensors continuously along the highway system. This research will identify and highlight regions along the nation's Interstate system where the Geostationary Operational Environmental Satellites (GOES) Meteorological Satellite Products (MSP) detect visibility hazards, including fog, blizzards, blowing snow, smoke from wildfires, etc. Special emphasis would be given to segments of highways historically prone to visibility hazards.

Literature Search Summary

Research Problem Statement

This research is to advance the use of AI and ML in analyzing various surface (ground)-based Intelligent Transportation Systems (ITS) visibility sensor data, such as that from Road Weather Information System (RWIS) comprised of Environmental Sensor Stations (ESS), Traffic Management Center (TMC) ITS and/or Machine Learning Cameras, which are capable of detecting visibility, either from the obscuration of landmarks a known distance away, or through digital processing of the image to assess the sharpness of the imagery and the MSP-based data (generated via algorithms/models) from GOES operated by the National Oceanic and Atmospheric Administration (NOAA) & the National Aeronautics and Space Administration (NASA) and ingest these data sets using Artificial Intelligence and Machine Learning to get a probabilistic assessment that can identify hi-confidence visibility hazard regions alongside Interstate highways.

Prepared by TRB Library

Search Parameters: Past 3 years, US Only

Summary: Citations are listed in below in relation to the use of Meteorological Satellite products for Operational Highway Visibility Notification. Citations were manually screened from results to remove reports or articles that were duplicates or did not discuss the topic in the problem statement.

Citations

Projects

- Automated Real-Time Weather Detection System using Artificial Intelligence [Project].
<http://www.dot.state.wy.us/files/live/sites/wydot/files/shared/Planning/Research/Completed%20Projects%20for%202009/RS05220%20Automated%20Weather%20Detection%20using%20AI.pdf>
<https://www.mountain-plains.org/research/downloads/2020-mpc-630-project-update.pdf>
<https://trid.trb.org/view/1688736>
 - Deep Learning for Unmonitored Water Level Prediction and Risk Assessment [Project].
<https://trid.trb.org/view/1846500>
 - Weather-Responsive Management Strategies [Project].
<http://library.ctr.utexas.edu/Presto/project=7007> <https://trid.trb.org/view/1641427>
- TRB Results
- Khan, M. N., & Ahmed, M. M. (2021). Development of a Novel Convolutional Neural Network Architecture Named RoadweatherNet for Trajectory-Level Weather Detection using SHRP2 Naturalistic Driving Data. Transportation Research Record: Journal of the Transportation Research Board. doi:
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<https://doi.org/10.1177/0361198119842105> <https://trid.trb.org/view/1593486>

Research Objective

The objective of this research would be to achieve an AI/ML data fusion application, replicating what humans presently do in a quantitative and automated process. In using AI/ML, surface observations across the country can be used to develop, both, regression models and propagation neural network models that predict visibility conditions. Additionally, the research will also investigate applying a novel fog detection algorithm to generate real-time satellite-based fog products nation-wide. Finally, the collected sensor visibility data would be used during this research to validate both statistical and propagation neural network models and assess the accuracy of numerical weather prediction models, thus producing a mechanism to help evaluate visibility and provide real-time visibility/fog-related weather data for safety applications and traveler information.

Urgency and Potential Benefits

The key benefits from this research will be realized by integrating NOAA's weather satellite-based products, surface-based observations, and other meteorological data into machine learning and artificial intelligence frameworks to produce near-real time forecasts of visibility, so that drivers, safety and transportation operations personnel, and others can be alerted to potentially hazardous situations. The likelihood that this research will be successfully achieved will be in uniting the University of Wisconsin (UW) Space Science and Engineering Center (SSEC) experience in developing satellite-based products for operational stakeholders with State DOTs expertise in traffic management. The merits of that collaboration will be realized by developing and distributing implementation-ready, automatically generated products that fuse satellite and RWIS data to state DOTs and TMCs for dissemination to highway safety and operations personnel nation-wide. The consequences in not advancing this research, will jeopardize the country in advancing toward and realizing the national Vision Zero goal of eliminating injuries and fatalities from traffic crashes, those specifically caused by adverse weather-produced visibility constraints. In addition, a statistical analysis of the accuracy of GOES visibility hazard information as compared to ITS and/or Machine Learning Cameras and RWIS data would be beneficial. The satellite-based product(s) would be assessed for both its skill in a binary hazard / no hazard detection as well as in determining specific visual ranges. A study of the performance of the GOES visibility/fog product(s) during known fog events and crashes. Comparisons to the visibility products from operational numerical models and/or to orbiting satellites will quantify the value added by the real-time satellite product as well as assess how much improvement could be made with the next generation of geostationary satellites. This research will produce the following potential benefits: improved transportation operations, mitigating the impacts of fog and other low visibility environments and will validate both satellite fog detection and numerical model simulations, giving a measure of confidence to both. In addition, the proposed research will focus on and benefit safety and operational improvements for both motorists (road users) and TMC operations. In addition, the proposed research here for current operational satellites will be easily adaptable to future satellite/numerical modelling technologies.

Implementation Considerations

The UW-SSEC has a long history of developing tools to interact with data from many different providers. Their Man-computer Interactive Data Access System (McIDAS) computer system blends numerical model output with satellite and RWIS data. In addition, their SSEC Real Earth Program provides a web-based interface which displays and interacts with meteorological data products/forecasts and is mobile friendly. It is recommended that representative SSEC scientist(s) serve on the panel in implementing the proposed research in the form of a demonstration research project in concert with a State Transportation Agency (such as Wisconsin and/or Florida DOT) that will support the comparison of geostationary satellite visibility/fog products to both that of operational computer models (such as data produced by the National Center for Environmental Prediction (NCEP)) and that of available surface visibility sensors along the Interstate system and in-turn disseminating these forecasts to State Transportation Agencies and other stakeholders. These comparisons are critical for improving forecasts of the

development of visibility hazards and of a visibility notification system that exploits known visibility-detection algorithms of GOES MSP as well. Expected and/or desired outcomes from this collaborative research by the Space Science and Engineering Center (SSEC) in concert with the National Environmental Satellite, Data, and Information Service (NOAA NESDIS) and NOAA's Cooperative Institute for Meteorological Satellite Studies (CIMSS), would potentially include the development and implementation of a now-casting system using Artificial Intelligence and Machine Learning that targets highway visibility hazards, such as adverse weather due to fog or other obstructions. One implementation consideration would be in seeking to exploit and improve the detection and quantification of visibility hazards, such as, but not limited to fog, blizzards, blowing snow, smoke from wildfires, etc. and develop notification capabilities for use by travelers and traffic management agencies using appropriate communications applications; such as via private entities as Google/Waze GPS traffic application and/or an existing application as the SSEC RealEarth that could host these products. In using AI and ML, surface observations across the country will be used to develop, both, regression models and propagation neural network models in an effort to predict visibility conditions. Additionally, efforts would include applying a novel fog detection algorithm to generate real-time satellite-based fog products nation-wide. The data to be collected using visibility sensors will be used to validate both statistical and propagation neural network models and assess the accuracy of numerical weather prediction models thus producing a mechanism to help evaluate visibility and provide real-time fog/visibility related weather data for safety applications and traveler information. Demonstration and verification and validation of the research results will be managed by a State DOT in concert with UW-SSEC in facilitating the implementation of the research results.

Recommended Research Funding and Research Period

The recommended amount of research funding is \$548,000 over a 30-month period.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Ray Murphy, FHWA ray.murphy@dot.gov 224-415-1449

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

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Ray Murphy, FHWA, ray.murphy@dot.gov, 224-415-1449

NCHRP Review of G-23Reviewed By:

Leslie C. Harwood
LHarwood@nas.edu

Comments:

As I understand, there are 3 objectives of this research: 1) create an AI/ML data fusion application to develop models to predict visibility conditions using surface-based visibility sensor data, 2) investigate generating a nationwide fog product based on real-time satellite data, and 3) validate and assess accuracy of weather prediction models for roadway safety and information applications. The timeline and budget are appropriate for this work, but would round up the budget to \$550,000.

Review Date:

12/17/2021

Submitter Response for 2023-G-23From:

[email: ray.murphy@dot.gov]

Comments:

I concur with the NCHRP evaluation below.
NCHRP Review of G-23

As I understand, there are 3 objectives of this research:

- 1) create an AI/ML data fusion application to develop models to predict visibility conditions using surface-based visibility sensor data,
- 2) investigate generating a nationwide fog product based on real-time satellite data, and
- 3) validate and assess accuracy of weather prediction models for roadway safety and information applications.

The timeline and budget are appropriate for this work but would round up the budget to \$550,000.

Contact Info:

Ray Murphy, FHWA, ray.murphy@dot.gov, 224-415-1449

Review Date:

December 23, 2021

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-24

Problem Title

Using Advanced Technologies to Reduce Commercial Motor Vehicle Crashes in Work Zones

Background Information and Need For Research

Commercial motor vehicles (CMVs) have been overrepresented in work zone fatal crashes for many years. While CMVs have typically been involved in approximately 13 percent of overall fatal crashes nationally outside of work zones, they have been involved in about 32 percent of fatal crashes in work zones. The issue is even more significant on rural interstate facilities, where nearly 56 percent of fatal work zone crashes involve a CMV. Work zones can also create significant congestion and advanced technologies can help CMV drivers avoid these congestion locations as well. Several agencies of the USDOT (FHWA, FMCSA, and NHTSA) have joined forces to work with other stakeholders across the country to improve CMV safety in work zones.

Agencies, contractors, and even CMV operators themselves continue to look for ways to reduce CMV-involved work zone crashes. Opportunities exist to apply advanced technologies to better warn and inform CMV drivers in real-time about work zones they are approaching (through electronic driver logging or other in-cab devices) so that they can be better prepared to take appropriate actions. Opportunities also exist to utilize technologies to help drivers of personal vehicles as well as highway workers better anticipate and accommodate CMVs operating in work zones. Research is needed to identify those technology opportunities, develop and/or enhance the functionalities of those opportunities, and implement and test those technologies under real-world condition to evaluate their effectiveness.

Literature Search Summary

Navigational apps (WAZE, HERE, those developed by state DOTs, etc.) are widely available that can provide real-time visual and auditory alerts about road conditions being approached by motorists via smart phones. Meanwhile, developers and providers of CMV in-cab communication technologies are working with state DOTs to develop and implement systems to provide warnings of various types of roadway hazards to drivers. For example, the North Carolina DOT is working with Drivewyze and INRIX to provide real-time in-cab alerts based on current travel time and speed information. Geo-fences around hazard locations will be established and CMVs entering into those geo-fenced areas will automatically receive those alerts. Work zones is one of the hazards they are pursuing to include in the project. See <https://www.ccjdigital.com/technology/article/15065689/north-carolina-testing-incab-traffic-alerts-for-truckers>.

However, the work zone information provided by such apps is often general in nature and not conducive to significantly improving CMV driver abilities to negotiate the work zone. Work is underway to develop and refine methods of digitally defining critical work zone features and elements through ongoing Work Zone Data Exchange specification development (<https://github.com/usdot-jpo-ode/wzdx>). The Georgia DOT is working to develop CMV safety alerts using the Work Zone Data Exchange (WZDx) specification. In addition, the ability to use the data specification to convey information to CMV drivers was recently demonstrated in Arizona (see <https://ops.fhwa.dot.gov/publications/fhwahop20022/fhwahop20022.pdf>). A study in Texas is also examining opportunities and potential pathways for getting interstate work zone as well as current traffic conditions in and around those work zones to freight carriers. Similar research is needed to explore opportunities for providing this type of information to CMVs on other types of facilities, to evaluate the effects of these efforts upon safety and mobility via case studies, and to disseminate the results of those evaluations and lessons learned to practitioners.

Smart work zone (SWZ) technologies are now available that are designed to detect when construction-related CMV (or other vehicles) are exiting the work space and providing warning to motorists upstream of the work zone so that they can change lanes or otherwise prepare for the vehicle entering at a slower speed (see <https://www.jtitraffic.com/our-products/saws-warning-system/> as an example). Similar type systems are possible to warn when CMVs are slowing to enter into a work space. Although implemented on a few projects nationally, such systems have yet to be rigorously evaluated in terms of their ability to improve safety and reduce CMV-involved crashes in work zones.

Research Objective

The objectives of this research are as follows:

- Identify available advanced technologies to mitigate CMV crashes in work zones and prioritize them in terms of their implementation readiness, support systems and stakeholder collaboration required (e.g., data integration processes between traffic management and freight management systems), and expected effectiveness.
- Work with at least two state DOTs to implement one or more of the high-priority technologies in one or more work zones for case study evaluations.
- Conduct studies to evaluate the quality of the deployments and their effectiveness.
- Document the case studies in terms of efforts required, effectiveness of the deployments, lessons learned, and recommendations for future deployments.

Urgency and Potential Benefits

The extent to which CMVs are overrepresented in fatal work zone crashes makes this research a high-priority need. State departments of transportation where CMV work zone crashes occur frequently are highly interested in the potential benefits of providing useful warnings and information in-cab to CMV drivers. In addition to reducing CMV crashes,

improved warning and information can yield significant mobility benefits by allow CMV drivers to adjust their routes and avoid congested work zones completely.

Implementation Considerations

Collaboration with developers and vendors of these type of advanced technologies will be needed to successfully accomplish this project.

Recommended Research Funding and Research Period

\$500,000 – 2 years

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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NCHRP Review of G-24

Reviewed By:

Camille Crichton-Summers
 ccrichton-summers@nas.edu

Comments:

The emergence of advanced technologies aimed to reduce work zone crashes involving commercial vehicles warrants study, however, if this research centers on the performance of various proprietary products and systems NCHRP cannot conduct this research. Additionally consideration must be given to transfer of liability to state DOTs if they participate in or are the focus of the suggested case studies. The timeframe will be insufficient to provide a significant amount of performance data as described in the objectives. Three years is suggested for the period of performance.

Review Date:

12/17/2021

AASHTO Committee Evaluation for G-24

Submitted By:

Kelly Hardy
 AASHTO staff
 Design-Technical Committee on Roadside Safety

Priority #: N/A

Comments:

This may have lesser impact to the roadside safety community, but work zone intrusions may be favorably impacted by this research. Developing early warning technology for work zones could have many applications including warning commercial vehicles of severe traffic slowdowns. It is possible the technology developed here may be applied to non-commercial traffic as well.

Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: N/A

Comments:

These research results might be able to be transferred to other applications.

Submitted By:

Caroline Kieltyka
AASHTO staff
Special Committee on Freight

Priority #: 2

Comments: N/A

Submitter Response for 2023-G-24

From:

[email: martha.kapitanov@dot.gov]

I agree with the problem statement the way it is and have no additional comments.

Thanks,

Martha C. Kapitanov
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**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-G-25

Problem Title

A Study of Spatio-temporal Traffic Patterns in Metropolitan Atlanta Using Google Maps

Background Information And Need For Research

Urbanization and economic growth in the metro Atlanta region have caused heavy traffic congestions on major roads. According to the 2019 Global Traffic Scorecard by INRIX that was published in 2020, Atlanta is one of the top 10 most congested cities in the United States before the pandemic. For intelligent transportation systems and urban/transportation planning, it is necessary to identify temporal and spatial traffic congestion patterns. Temporal traffic patterns may include, but are not limited to, traffic durations and intensities during morning, afternoon, evening, daytime, and nighttime. Spatial traffic patterns will also tell where certain traffic patterns occur. The main drawback of studying temporal and spatial traffic patterns has been the limitation of available data resources, particularly from field sensors. This research proposes using online traffic layers, like Google Traffic, as a major data source. This research is directly related to the Goals 4 and 5 of “Strategic Plan for the Council on Data Management & Analytics”, approved by the AASHTO Strategic Management Committee on September 17, 2019. Particularly, this research will facilitate the development and advancement of tools to support decision making data and analytics needs (Goal 4.3) and support research to advance the development and use of tools and best practices in communicating data, data management and analytics (Goal 5.1)

Literature Search Summary

Analyzing traffic patterns in a metropolitan area has been hampered significantly due to the scarcity of field sensor data. At best, we could identify potential congestion corridors using AADT and road design capacity (e.g., Seong, Kassa, and Choi, 2011, doi: 10.1007/978-3-642-19214-2_30). Recently, crowd-sourced datasets and online traffic maps, however, have opened a new horizon for transportation research. They have been applied to various transportation applications such as transportation policy research (Loop et al., 2019, DOI: 10.13140/RG.2.2.28893.05), congestion forecasting (Pramanik et al., 2020, arXiv:2011.02359 [cs.CY]), traffic flow estimation (Baji, 2020, doi: 10.15201/hungeobull.67.1.5), and level of service calculation (Ali and Abid, 2021, doi:10.1088/1757-899X/1076/1/01201). Our literature search of TRID, RIP, and academic journals, however, does not show any previous research about identifying temporal and spatial traffic patterns in a metro city from geographical perspectives. Our research will pioneer the temporal and spatial aspects of traffic events by incorporating GIS (geographic information systems) and big data analysis techniques.

Research Objective

The objective of this research project is to identify temporal and spatial traffic patterns in the metro Atlanta area. Traffic patterns will be analyzed at two different geographical scales: one at the macro scale along the major roads in the metro Atlanta and the other at the micro-scale along the interstate highways. Major deliverables of this research are traffic patterns with the information of when, where, and severity. A website will also be developed to visualize traffic patterns interactively and to share them with Georgia DOT, metro Atlanta MPO, and the public.

To achieve the objective, we will construct a 3-D spatio-temporal data cube by sampling Google Maps Traffic Layer every 10 minutes via the Google Maps API, and we will identify temporal traffic patterns by clustering the 24-hour traffic trends at sample points on roads. The following diagram (Figure 1) shows eleven temporal traffic patterns that were derived from a one-day pilot dataset, where the x-axis represents time of a day, and the y-axis represents traffic severity. The inset map shows the extent of the metro Atlanta that were used in the pilot study. In the figure the red line, for example, represents a traffic pattern that has a light traffic in the morning and a very heavy traffic in the afternoon from 3:00 pm to 7:30 pm. We will collect traffic data for 20-weeks, at least, to avoid statistical biases. The optimal number of traffic patterns will be identified, and various temporal traffic-vector clustering techniques will be tested.

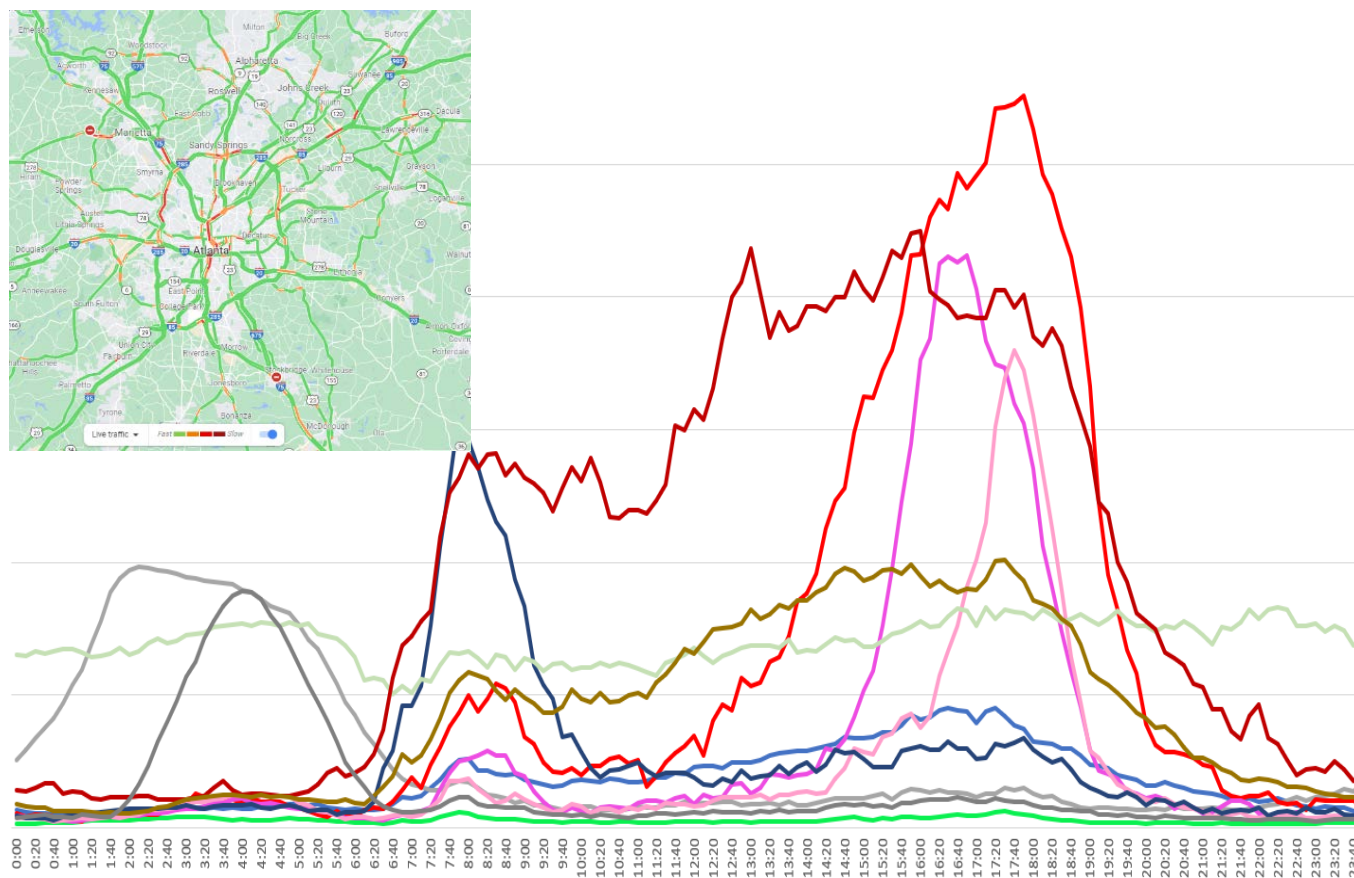


Figure 1. Temporal traffic patterns identified from a one-day sample dataset

We will also analyze the difference between weekdays and weekends. Various geospatial data science techniques will be used such as GIS, Python libraries, R packages, server-side programs like Javascript, and spatio-temporal data visualization techniques. Lastly, we will develop an interactive online mapping application using an online mapping platform such as ArcGIS Online. This research requires extensive resources for 24/7 data acquisition, data post-processing, testing multiple models, validating traffic patterns, visualizing outcomes, and writing reports. Multiple student assistants and research associates will be hired for this project.

Urgency and Potential Benefits

As the population of the metro Atlanta area has increased dramatically, road traffic has also increased significantly. Identifying traffic locations and patterns is an important step for a reliable transportation planning. It, however, has been impossible to analyze them for such a large area mainly because of the limited number of field sensors. Utilizing online traffic layers can supplement field sensors. This research will benefit transportation planners and urban planners by providing them with traffic pattern types and their locations. The methodologies that are developed in this research may benefit other state DOT's and MPO's to analyze their endemic traffic patterns.

Implementation Considerations

The research results of this project will be used by GDOT for implementing the Statewide Transportation Plan (SWTP) and State Transportation Improvement Program (STIP). The Atlanta Regional Commission (ARC), the MPO for metro Atlanta, has recently researched various applications of the Google's floating car data for their long-term metropolitan transportation planning. This research will support ARC's transportation and commuting research with floating car data by providing new perspectives about traffic patterns. Our research may also benefit from ARC's floating car data as a validation source. Research findings will be presented at GDOT and ARC and will be submitted to academic journals for publication.

Recommended Research Funding and Research Period

We propose three years to perform this research. Year 1 will collect data and analyze traffic patterns on major roads of metro Atlanta, Year 2 will focus on interstate highways in detail including their ramps and exits, and Year 3 will implement an online mapping platform that allows interactive queries of traffic patterns. University of West Georgia, Georgia Institute of Technology, Atlanta Regional Commission, and GDOT will collaborate on this research. The annual budget will be \$298,750 that will include PI and co-PI salaries (\$30,000), institutional sub-award (\$120,000), research associates (\$60,000), undergraduate student assistants (\$24,000), supplies (\$8,000), travel (\$8,000), and IDC 37.5% (\$48,000). The three-year total is \$896,250.

Problem Statement Author(s): For each author, provide their name, affiliation, email address and phone.

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Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

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Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Mr. Habte Kassa, GDOT Office of Planning, hkassa@dot.ga.gov, 404-631-1797

NCHRP Review of G-25

Reviewed By:

Camille Crichton-Sumners
ccrichton-sumners@nas.edu

Comments:

The research is Atlanta-centric and not likely to be applicable or of interest to at least 2/3s of the state DOTs. Authors of the problem statement are based in Atlanta, as such have prepared a locality specific problem statement. If the scope was broadened or focused on methods, perhaps other localities may have an interest. This however, may be cost prohibitive given the anticipated research costs for this one location.

Review Date:

12/17/2021

FHWA Evaluation of G-25

Reviewed By:

Rachel James/HRSO

Comments:

The proposed project is interesting and there are no technical concerns with the problem statement. However, it is relatively expensive if only looking at data/traffic patterns in the Atlanta region. The primary deliverables are insights into congestion trends in Atlanta and a website to help GDOT, ARC, and the public visualize traffic patterns. The authors mention that they plan to publish their methodologies through journal papers in hopes that other agencies can use their methodologies on their data. It would be helpful to see a more refined list of what will be shared so that we can more holistically evaluate the broader impacts of the proposed project.

Review Date:

December 17, 2021

Submitter Response for 2023-G-25

From:

hkassa@dot.ga.gov;skamatkar@dot.ga.gov]

Comments:

We sincerely appreciate for the constructive comments by the reviewers from NCHRP and FHWA. We also concur with their evaluations and believe that the following notes will further clarify how our research project will bring broader impacts to state DOTs and transportation research. Upon reviewers' suggestions, we will expand the scope of our research by building spatiotemporal traffic datasets for five more metropolitan areas that are Washington D.C., Chicago, New York, Los Angeles, and Dallas - Fort Worth.

Why we start with the Atlanta area

One of the key aspects of our research project is to develop the automated integration of data collection and accurate identification of traffic patterns. The traffic data from the metropolitan Atlanta area constitutes an attractive and appropriate initial dataset for this study thanks to its heterogeneity and variability. The complexity of such a dataset can offer deeper insights into the task of traffic pattern identification thus having the potential to reveal a more complete view of the problem. Subsequently, the analysis of this dataset can lead to a better understanding of the applicability of unsupervised machine learning from Google Maps Traffic Layer data. The metro Atlanta is also where researchers are located, so that the reliability of source data and results can be checked *in situ*, whenever and wherever.

Broader impacts and dissemination of our implementation...

The task of profiling traffic patterns in terms of temporal, spatial, and severity features requires multiple data cleaning phases and clustering strategies, as well as their adjustment and optimization for traffic data. However, the methodology that will be developed in our research may be general enough so that they may be used by other DOTs or MPOs without significant investment of data collection equipment or proprietary software purchase. The implementation and accompanying documents will be designed to enable smooth installation and deployment by general users. We will

publicly release efficient and well-documented software of all the implemented algorithms of our pipeline through popular hosting sites such as GitHub, BitBucket, Docker images, etc.

Particularly, we will publish technical implementation methods including, but not limited to, the following:

- Capturing Google traffic information
- Creating road reference layers for georeferencing with raster GIS
- Building 3-Dimensional spatiotemporal data cubes
- Preprocessing and handling exceptions
- Clustering and visualization
- Developing interactive online maps

In sum, our research will pioneer the holistic perspectives of metropolitan traffic phenomena by developing innovative datasets and methodologies. Six metropolitan areas may directly benefit from our research, and, we believe, the methodologies that will be developed in this research will also help other metropolitan areas to identify their regional traffic problems.

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**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-26

Problem Title

Capabilities, Requirements, Planning, and Preparing to Virtually Operate Traffic Management Systems (TMS).

Background Information and Need For Research

The ability to virtually manage and operate traffic management system (TMSs) is no longer a luxury, it needs to be a capability of the system, and core capacity of an agency's operations program. It has become a necessity for agencies to work towards developing and sustaining the capabilities and having the resources necessary to remotely manage and operate their own, or another agencies TMS. Agencies continue to explore what organizational policies, procedures, capacity, resources, and capabilities may be needed when they determine it is in their interest to virtually manage and operate their TMSs to support day-to-day traffic management, planned (e.g., concerts, festivals) and unplanned (e.g., during COVID-19 pandemic, weather emergency) special events.

This research will address what issues and analyses may be appropriate for agencies to consider when assessing the current capabilities, needs, requirements, and possible improvements that may be needed to enable current or the next generation of an agency's TMS to be managed and operated virtually or remotely. This research will also identify the policies, procedures, processes, staffing (e.g., human resource issues), tools (e.g., laptops), capabilities (e.g., internet access, electronic access to data, secure access to operating systems), and practices for agencies to consider when planning, developing, preparing, testing, transitioning, and evaluating the ability of existing or the next generation of an agencies TMSs to have the ability to virtually manage and operate TMSs. Considerations for virtual operations may include necessary security measures to be developed and in place; verify needed resources are available and functioning; and the development, testing, implementation and verification of specific system capabilities (e.g., remote access to electronic files and user interface for system), policies, procedures, operational protocols, testing, and training resources are available.

Agencies are looking to develop and adopt policies, operational procedures, review and identify human resource requirements, and identify the resources and changes needed to allow TMSs to be managed and operated virtually and ensure TMSs and their operations centers can be managed and operated remotely. They are also looking for resources to explore what planning, development, and training may be needed to successfully position or prepare TMSs with the capabilities and resources needed to allow an agency to transition the operation of a TMS involving highly technical traffic management centers to a virtual operating environment with minimal service

disruptions. This research seeks to develop two technical resources to assist agencies. The first resource will assist agencies with planning, developing, or improving their TMSs to enable virtual operation, and the second resource will assist agencies with preparing for, training, testing, and transitioning to the remote or virtual TMS operation.

This proposed research project supports the AASHTO Committee on Transportation System Operations goal of developing TSMO best practices and proving support for agencies virtually managing and operating their TMSs. This research was also identified as a high-priority by the members of the TMC Pooled Fund Study.

Literature Search Summary

The TMC Pooled Fund Study (TMC PFS) developed the Virtual TMC technical report summarizing current practices with agencies having and using the capability to remotely manage and operate their TMSs. Technical resources (e.g., training, technical resource documents, outreach material, and case studies) have also been developed to support agencies planning, preparing, and assessing how agencies may manage travel associated with different types of planned special events. However, technical resources have not been developed to support agencies assessing their capabilities (e.g., policies, procedures, human resource issues), operational resources, (e.g., policies, procedures, protocol, tools), and capabilities (e.g., user interface, access to data subsystem, security) to allow agencies TMSs to be virtually or remotely managed and operated. Hence, technical resources are needed to support agencies assessing to assess, plan, enable, prepare, test, and virtually operate their TMS.

Research Objective

Research results and final deliverables: The objective of this research is to develop two technical resources. The first technical report will compile and review available resources, offer insights, and synthesize current practices for agencies to consider in the planning, design and development of projects to improve their TMSs to enable virtual operations. It will also assess and identify key issues to consider, capabilities, needs, requirements, technologies, and other issues to integrate the virtual or remote operation of a TMS into the planning or design of a new or improved legacy system. This information will support agencies in assessing the current capabilities of legacy TMSs, identifying possible improvements needed to enable or meet agencies needs for operating virtually, assessing the capabilities and requirements when planning or designing the next generation of their TMS.

The second technical report will explore the range of issues agencies may consider to ensure they have the authority, policies, procedures, capability (e.g., human resource issues, position descriptions, security clearances), capacity (e.g., IT, security, access to agencies operating system and files), and resources (e.g., access to resources normally available and used in the operations center, laptops for remote access, internet access, software) to ensure remote operation of their TMS. This research will also explore the range of initiatives, planning, projects, testing (e.g., acceptance testing, scenario training), and training agencies may conduct in support of establishing, using, and

demonstrating ability to virtually managing and operate their agencies, or another agencies TMS.

Research Activities: This research would be executed in two phases. Potential tasks in each phase may include:

Phase 1

Task 1: Literature Review

Conduct a comprehensive review (literature review, surveys, interviews, etc.) of agencies with remote TMS operations and how these agencies currently design their TMSs to enable complete virtual or hybrid operation. The synthesis will provide insights on industry best practices as well as what agencies may consider when designing their TMSs to enable virtual or remote operations. It will also assess the issues to consider in planning, preparing, testing, assessing, providing the needed resources (e.g., human resource issues), methods (e.g., remote access to operating system and data), capability and resources to transition into the virtual or remote operation, and then return to the normal operation of the TMS.

Task 2: Technical Report Annotated Outline for Reports 1 and 2

Develop draft annotated outlines for two technical reports to be developed. The annotated outlines will serve as the basis from which the two technical reports will be developed in Phase 2. Each annotated outline is intended to provide the foundation, context, and framework for the subject matter in the technical report. It will include key technical topics and associated issues, major concepts, current trends, current practices, examples highlighting lessons learned, and checklists of issues to consider. The initial annotated outline will be submitted prior to the stakeholder panel meeting. The revised annotated outline will address the comments provided at this meeting and submitted for review and approval prior to beginning to work on these two technical reports.

Task 3: NCHRP Stakeholder Panel Meeting

Organize a meeting to review and obtain feedbacks on the two draft annotated outlines developed in Task 2. The draft annotated outlines will be revised based on written and oral feedback from stakeholder panel meeting. Revised versions of each annotated outline will be submitted for review and approval, prior to beginning the development of each of these technical reports in Task 4.

Phase 2

Task 4: Technical Reports

Develop two draft technical reports that reflect the final versions of the annotated outlines reviewed, and comments provided in Task 2. The two reports shall address all objectives identified for this research effort. The draft reports shall be reviewed and updated based on comments from the stakeholder panel. The draft report is expected to provide all the information and detail that would be included in the final report. The final

reports which address the review comments provided on the initial drafts, will be submitted for final review and approval.

Task 5: Outreach

Develop one power point presentation (30 minutes in length) for each of the two technical reports developed in Task 4. The presentation slides shall specify the research purpose, objectives, key issues that were addressed, research products developed, and the potential benefit or value of those products. The draft presentations will be reviewed, and comments provided to be addressed in the final versions of the presentations submitted. In addition, there would be a participation in a TRB webinar on this topic to be organized by TRB staff.

Urgency and Potential Benefits

This project and the two technical reports to be developed were identified by the Traffic Management Center (TMC) Pooled Fund Study (PFS) in 2021 as high priority research topics to be addressed. Due to the estimated cost to develop these two technical reports, the TMC PFS did not have the resources available to advance this project in 2021 or 2022. Due to the priority and need to develop these resources, this problem statement was advanced for consideration and funding by the NCHRP program.

Implementation Considerations

Findings from this research may be implemented by TMC managers and others having a role in the evaluation, planning, design, management, operation, or allocation of resources to support TMSs being managed and operated remotely or virtually. Presentations on the project and resources to be developed would be appropriate during industry webinars and annual or mid-year meetings of TRB Technical Committees, TMC Pooled Fund Study meetings, and Work Group or Technical Subcommittees of the AASHTO Committee on Transportation System Operations meetings to raise awareness and facilitate implementation of research results.

Recommended Research Funding and Research Period

\$600,000; 36 months

Problem Statement Author(s)

Jon Obenberger, FHWA, (202) 493-3265, jon.obenberger@dot.gov
Sampson Asare, Noblis, (202) 863-2981, Sampson.Asare@noblis.org

Potential Panel Members (The following individuals endorse and support this proposal)

Beverly Kuhn, TRB Freeway Operations Committee Chair, Texas A&M Transportation Institute,
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Greg Krueger, ITS Committee Chair, HNTB, gkrueger@hntb.com.
John Bassett, TMC Pooled Fund Study Chair, New York Department of Transportation,
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John Hibbard, AASHTO Committee on Transportation System Operations, Technology Subcommittee Co-Chair, Georgia Department of Transportation, jhibbard@dot.ga.gov.

Person Submitting The Problem Statement

John Hibbard, AASHTO Committee on Transportation System Operations, Technology Subcommittee Co-Chair, Georgia Department of Transportation, jhibbard@dot.ga.gov. (404) 631-1401.

NCHRP Review of G-26

Reviewed By:

Zuxuan Deng
zdeng@nas.edu

Comments:

The TMC Pooled Fund Study (TMC PFS) developed the Virtual TMC technical report in 2014. It would be a timely and necessary update of the current best practices of Virtual TMC's after ten years.

Review Date:

12/15/2021

FHWA Evaluation of G-26

Reviewed By:

Obenberger/HRSO

Comments:

FHWA recommends this problem statement be included as a part of the FY2023 NCHRP.? This proposal was endorsed by the AASHTO Committee on Transportation System Operations (CTSO), ITS Working Group and Technology Subcommittee, and ITS Work Group, the Traffic Management Center Pooled Fund Study, the TRB Freeway Operations Committee, the TRB ITS Committee, and the TRB Joint Subcommittee on Active Traffic Management. This proposal will develop a technical resource to assist agencies with planning and developing their TMSs to enable virtual operation, and a second technical resource to assist with the planning and preparation for, and

supporting the remote operation of TMSs. Research is needed and technical resources are not currently available to assist agencies with assessing what issues and analyses should be considered when assessing current capabilities, needs, requirements, and possible improvements that may be required to enable legacy or the next generation of TMSs to be managed and operated virtually or remotely. The ability to virtually manage and operate TMSs is no longer a luxury, it needs to be a capability of the system and core capacity of an agency's operations program.

Review Date:

December 17, 2021

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-27

Problem Title

Evaluation of Trespassing Detection and Warning Systems in the Vicinity of Highway-Rail Grade Crossings

Background Information and Need For Research

Highway-rail grade crossings have always presented a significant safety challenge for road authorities and railroads across the United States (US). Historically, the source of most of the railroad-related deaths, implementation of a dedicated federal funding program in the early 1970s has resulted in tremendous reductions in highway-rail grade crossing fatalities, from 888 in 1975 to 197 in 2020, according to the Federal Railroad Administration (FRA). Still a major focus for safety improvements, highway-rail grade crossings now represent the second highest source of railroad-related fatalities behind trespassing.

Trespassing, including suicides, now represents approximately 70% of all railroad-related deaths and is trending upward. The FRA Office of Safety Analysis data demonstrates trespassing fatalities increasing over 31% the past 10 years to 525 fatalities in 2020, a number far exceeding the 197 fatalities at highway-rail grade crossings. According to FRA, the 9,363 reported trespassing accidents during the 2012 and 2016 period were associated with a societal cost of \$43.2 billion in fatalities and injuries and more than \$56.0 million losses in travel time delays in trains.

Additionally, the FRA reports that about 74% of deaths and injuries related to rail trespassing (excluding suicides) and 73% of suicide attempts occur within 1,000 feet (<0.25 mile) of a highway-rail grade crossing. These incidents occurring in the vicinity of highway-rail grade crossings also cause significant delays to motorists, their passengers, and other roadway users at the crossings.

Reasons behind most trespassing behavior include crossing the rail property provides the most direct route to a desired destination and trespassers not being fully aware of the dangers involved in such trespassing behavior. Lack of deterrents, poor community planning, lack of grade crossings in large sections of track all contribute to an increased number of trespassing. Community decisions such as the placement of public buildings, services and bus stops relative to safe crossing paths could affect people's choices of trespassing the rail property.

In addition to enhancing law enforcement, education, community and roadway planning, new technologies can be applied to railroad and highway right-of-way (ROW) to prevent trespassing from happening in the vicinity of highway-rail grade crossings. One of those

is the surveillance systems that can be installed to detect and warn trespassers. At present, there is extensive knowledge concerning how to detect intruders in terms of general security sensitive installations, such as utility plants, banks, etc. However, technologies and systems that are used to detect trespassers in the vicinity of highway-rail grade crossings are limited and the effectiveness and scopes of implementation of new technologies on such tasks have not been thoroughly evaluated. The unclear effectiveness and range of applications of these detection and warning systems will provide limited, if not misleading, information to the decision makers when choosing the appropriate systems to implement. Therefore, systemic evaluations of the trespassing and suicide detection and warning systems along rail ROW particularly in the vicinity of grade crossings has significant impacts on the health of the integrated multimodal transportation system. The Federal Highway Administration (FHWA) Rail-Highway Crossings (Section 130) Program provides funds for “the elimination of hazards at highway-rail grade crossings” and “eligible projects include those involving all public rail crossings: roadways, bike trails, and pedestrian paths”. Half of a state’s apportionment is prescribed for installing protective devices at crossings, while the remaining can be used for other hazard elimination projects, and the installing of detection and warning systems could be an effective solution for preventing trespassing and suicide in the vicinity of grade crossings. Highway authorities should take the lead on improving the grade crossings safety and working together with rail authorities by choosing and implementing effective detection and warning systems and technologies at grade crossings.

Literature Search Summary

There is a limited amount of existing research available examining systems to detect and provide warnings and alerts to people trespassing on rail ROW and/or warnings to the rail/highway staff prior to an imminent strike by on-track equipment.

In 2007, Volpe provided an update on state-of-the-art technologies at that time on intrusion and obstacle detection that can be applied to rail ROW and crossings. Three application methods – infrastructure-based, cooperation between infrastructure and locomotive, and locomotive-based were discussed. The infrastructure-based are often developed for crossings, such as the AWARE system which incorporated an intrusion detection system with wireless communication, and the Nestor’s Rail CrossingGuard which detected gate/signal violations. Though it was a relatively comprehensive study, emerging technologies between now and then, especially in computer vision, LIDAR, UAV and so on, provide great potential for performance improvement and cost reduction.

In 2012, Volpe published a study on the effectiveness of an automated prototype rail infrastructure security system on a railroad bridge in Pittsford, New York. The system was a video-based trespass monitoring and deterrent system. The system detected nearly 4,000 events or 4.6 events per day. A significant drop in the trespassing rate was seen in Year 2 (60% reduction), however, the trend did not continue in to the third year. It was also noted that large animals triggered many alarms, and it would be difficult to mask without compromising the system’s detection capabilities. With great advances in

machine learning in recent years, a more precise detection and significant reductions in false alarms could possibly be achieved.

Volpe recently conducted a research study along with the Brunswick, ME, police department where fixed cameras were installed at several ROW locations to evaluate the effectiveness of trespass detection technology (2020). Live streaming video was captured and transmitted from the sites via wireless broadband services. The trespasser detection relied on video motion detection software. The report had several important findings – video motion detection and passive infrared both had limitations and came with false alarms; the wireless bandwidth communication is critical in providing high-definition stream videos but can be a challenge for some locations; TV white space transceivers had limited transmission range.

Other proprietary systems have been developed to provide surveillance and warning systems to help with platform safety, crossing safety, or on-track rail work safety. Examples include the Platform Track Intrusion Detection System (PTIDS) and the Railway Level Crossing Safety Detection and Warning System developed by Honeywell (2018) which use radar technology for platform safety and level crossing safety, the closed-circuit television (CCTV) cameras (also known as video surveillance) combined with sound warnings, megaphones, flashcams, infrared illuminator, and automatic vehicle location (AVL), etc. Protran/Harsco developed systems to provide warnings to on-track rail workers to avoid employee casualties. Such systems offer many lessons that can be applied to developing effective trespass detection and warning systems.

As can be seen, though there are some existing studies on technologies and systems that can be used for detecting trespassers on rail ROW, the research is either outdated or has only been focusing on a specific technology prototyped/tested in selected locations. Research on more accurate, efficient, and cost-effective infrastructure-based technologies and systems that can be applied to grade crossings is especially lacking. Considering the extensive railroad lengths in the US and the overrepresentation of trespassing and suicide events in the vicinity of highway-rail grade crossings, investigation of such technologies and systems that can be applied to grade crossings has significant importance. With newer technologies being available in image detection, radar, LIDAR, infrared, UAV, and so on, it is necessary and urgent to conduct a systemic evaluation of such technologies to be used in detecting and warning trespassers as well as giving advance warnings to rail staff and train operators.

Meanwhile, evaluating the effectiveness of the different technologies, systems and their scopes of application is imperative to help guiding better decision making in selecting the appropriate systems to implement. The proposed research should accomplish these goals and helps create a safer multimodal transportation system in the vicinity of grade crossings.

Research Objective

The objective is to identify existing commercial off-the-shelf security and warning technology for detecting intruders, evaluate their effectiveness in deploying to the

vicinity of highway-rail grade crossings for detecting and warning trespassers, and develop guidance on selecting appropriate systems based on different needs and conditions. The following tasks should be considered at a minimum.

- (1) Identify potential intruder detection and warning technologies that can be applied to rail ROW in the vicinity of highway-rail grade crossings.
- (2) Provide for each of the technologies: engineering description of the necessary hardware and technologies; indication of types of automated warnings; discussion of software and analysis technologies (e.g., artificial intelligence) necessary to interpret and collate data collected to assist with decision making; discussion of costs of hardware, software, maintenance and staffing.
- (3) Comprehensively evaluate the effectiveness of existing and new rail detection and warning systems in reducing trespass activities and suicide, support with data when applicable.
- (4) Investigate the circumstances under which the varied systems and technologies are applicable, including but not limited to funding considerations, environmental characteristics, infrastructure requirements, etc.
- (5) Provide guidance to decision-makers on choosing the appropriate warning systems and the roles and responsibilities of the roadway authority.

Urgency and Potential Benefits

This research can reduce trespassing-related fatalities and injuries in the vicinity of highway-rail grade crossings by identifying effective technologies that detect and warn people that they are in a dangerous location and in immediate harm, and provide information on the extent, location and nature of trespass to inform decision makers on engineering, education and enforcement actions. To state DOTs, this will help improve safety and reduce delays to highway traffic caused by trespassing and suicide events in the vicinity of grade crossings.

Implementation Considerations

Some of the proposed systems may be ready for immediate trial using off-the-shelf technology. The proposer should show that there would be clear benefits relative to costs. Implementation may also require a joint and cooperative action between state highway agencies, railroads, transit, local municipalities and local police departments. Other systems may be in development stages, and the researchers should map out a process by which highway and rail stakeholders can be involved in the development of these technologies for future uses.

Recommended Research Funding and Research Period

Research Funding: \$450,000 Research Period: 30 months

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Dr. Shanshan Zhao, University of Connecticut, shanshan.h.zhao@uconn.edu, 860-486-1587

Jeff Warner, Texas A&M Transportation Institute

Dr. Ian Savage, Northwestern University
 Steve Laffey, Illinois Commerce Commission
 Greg Orrell, The MITRE Corporation
 Dr. Robert Rescot, Applied Research Associate, Inc.

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Steve Laffey, Illinois Commerce Commission, Rail Safety Specialist, 217-785-9026, Stephen.laffey@illinois.gov

Dr. Pamela Fischhaber, Colorado Public Utilities Commission, Chief Rail/Transit Safety, 303-894-2529, pamela.fischhaber@state.co.us

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Venetta Keefe, (317) 232-1474, vkeefe@indot.in.gov, Indiana Department of Transportation

NCHRP Review of G-27

Reviewed By:

Christopher T. McKenney
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Comments:

NCHRP cannot evaluate the performance of commercial or proprietary products and recommend their use. If that is envisioned here, NCHRP cannot conduct this research. NCHRP can conduct research that generally identifies types of technologies or systems by their characteristics and applications, and can produce recommendations for functionality that state DOTs can consider in their decision-making. Consideration could also be made of life cycle costs to operate and maintain, including theft prevention. Access to railroad-owned right-of-way is another consideration. For a reduced scope, a budget and duration of \$350,00 and 24 months should be sufficient.

Review Date:

11/29/2021

FHWA Evaluation of G-27

Reviewed By:

Davis/HRSO

Comments:

This is a good topic deserving of further investigation. Indeed, most fatalities near rail crossings are pedestrians who are trespassing in the Railroad Right-of-Way (RR ROW). In many cases, these pedestrians are often intoxicated and likely have suicidal thoughts, so quick and timely intervention is of the utmost importance. A technology scan may be helpful to expedite emergency response times, and crucial to saving their lives. A couple of things for the project team to think about would be who should receive the notification that a pedestrian has been detected in the RR ROW? Also, and along the same lines, in order to succeed as an intervention, it will be important to have buy-in from the RR Industry. There may need to be some level of participation on their behalf since the ROW belongs to them, and not the State or local agency. So enforcement of trespassing laws may also be required.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for G-27

Submitted By:

Rebecca Anger

AASHTO staff

Council on Rail Transportation

Priority #: 1

Comments: N/A

Submitted By:

Caroline Kieltyka

AASHTO staff

Special Committee on Freight

Priority #: 4

Comments: N/A

Submitter Response for 2023-G-27

From:

[email: vkeefe@indot.in.gov]

Comments:

Responses to the NCHRP comments:

The description of the research objective in the original problem statement might be a bit misleading. We agree with the reviewer that the research should be focused on

evaluating the technologies or systems by their characteristics and applications, not on evaluating the commercial or proprietary products. We meant to say the existing security and warning technologies that have been used in other areas for intruder detection. Considerations will also be given to the assessment of life cycle costs for device operations, maintenance, and theft prevention. A reduction of the budget and duration to \$350,000 and 24 months as suggested by the reviewer is reasonable. Since a revised statement is not expected at this moment, we concur with the evaluations and would be willing to revise the statement if needed later.

Responses to the FHWA comments:

We agree with the comments that it will be important to have buy-in from the railroad industry. Panel members or an expert group should include experts from the railroad. Review of existing or potential technologies for detecting trespassing should refer to the current best practices by the railroad. Recommendations, if any, should be based on consensus with the railroad. Regarding who should receive the notification that a pedestrian has been detected in the RR ROW, we think that local police department, state highway patrol, rail and transit police, as well as the railroad company should be notified. Local police department, state highway patrol, rail and transit police could respond quickly to trespassing events and maintain safety of highway and railway traffic. Railroad companies could warn the train drivers of the trespassing events to avoid collisions. The traffic operational office of the State Department of Transportation may also be notified to monitor interruptions to the highway traffic.

Contact Info:

Venetta Keefe vkeefe@indot.in.gov

Review Date:

1/26/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-28

Problem Title

Toward AI-Enabled Decision Support Systems for TSMO Applications

Background Information and Need For Research

As our contemporary transportation systems get more and more complicated, it becomes much more challenging for decision makers to consider a large number of intertwined factors to optimize the system-wide processes, including planning, operation, asset management, and maintenance. For example, when an accident occurs, operational strategies need to be put forward to provide timely and effective multi-modal services, such as vehicle routing, ramp metering, variable speed limits, emergency vehicle preemption, hard shoulder running, and adaptive traffic signal control to improve traffic incident management performance. Over the years, decision support systems (DSSs), which are primarily computer-based information systems used to sort, rank, or choose alternatives, have been developed to help infrastructure owners and operators (IOOs) and policy makers to gear transportation systems towards favorable directions. However, conventional DSSs are usually built on a set of expert rules that might not be able to provide customized and optimal solutions. On the other hand, artificial intelligence (AI), especially advanced machine learning (ML) technique, has been revolutionizing every facet of our daily lives, including the arena of transportation. It takes advantage of the availability of a massive amount of real-time data to model system behaviors, predict traffic states and evaluate overall performance, which is well aligned with the key functions of DSSs. Therefore, there is a need to explore AI potential for transportation DSSs.

Literature Search Summary

As an effective tool to support offline planning and online operation, transportation decision support systems (DSSs) have received much attention from practitioners, researchers and policy makers in the past few decades. They are widely used for land use planning, networked traffic assignment, logistics and supply chains, congestion or bottleneck mitigation, traffic incident management, and fleet/asset repair and maintenance. However, most of these DSS tools are rule-based or model-based without taking full advantage of available data from various sources. Recent advances in artificial intelligence, such as deep neural networks, have unlocked a myriad of opportunities to improve our transportation systems, such as the development of connected and automated vehicles. Relatively few studies and deployments have been focused on the exploration of AI or machine learning to the development of data-driven decision support systems for traffic system management and operations.

Research Objective

The objective of this research is to leverage the state-of-the-art development in artificial intelligence and machine learning, and explore their potential to improve decision support systems mainly for transportation system management and operations (TSMO). The research should address (at a minimum) the following questions:

1. General: a) what is the state of the art about decision support systems for TSMO? b) what are the gaps of existing DSSs for TSMO? c) what is the state of the practice for the application of artificial intelligence and machine learning in DSSs for TSMO?
2. Data: a) what would be the minimum requirement about data (such as data sources, contents, spatial/temporal resolutions, and data quality) to enable AI application for TSMO? and b) are there any innovative ways to collect data (while keeping privacy) necessary to support or improve AI-enabled DSSs for TSMO applications?
3. Methodology: a) What are the suitable machine learning-based methodologies and tools for data pre-processing (e.g., cleaning, fusing) in DSSs for TSMO applications? and b) what are the appropriate AI tools that TSMO should use to solve specific functionalities?
4. Digital infrastructure: a) what kind of sensors are suitable for different functionalities to collect data for AI-enabled TSMO applications? b) what kind of communication means are required to support reliable information transmission for AI-enabled DSSs for TSMO applications? and c) what kind of computational power is needed to support timely decision making in AI-enabled DSSs for TSMO applications?

To achieve these objectives, the research tasks should include, at a minimum, the following:

- 1- Survey success stories and lessons learned from AI-enabled TSMO applications
- 2- Conduct a survey on the basic requirements for a DSS in terms of spatial context, operator engagement, decision latency, proactive capabilities, cross-facility and cross-mode coordination,
- 3- Analyze the TSMO's basic functionalities (e.g. demand prediction, travel time prediction, development of action plans and schemes, human-machine interaction, ... etc) and identify the role of AI in facilitating these functionalities based on the latest state-of-the-art and state-of-practice
- 4- Design a roadmap toward AI-enabled DSSs technology development and adoption in terms of data requirements, algorithmic aspects, validation and testing, computation needs, performance evaluation, infrastructure readiness levels, workforce training requirements,
- 5- Demonstrate the developed roadmap through the selection of two use cases to evaluate readiness, identify infrastructure, technical, and workforce gaps, and develop strategies for closing these gaps.

Urgency and Potential Benefits

Considerable advances have been witnessed in sensing technologies, wireless communications, high-performance computing, and AI/ML. We are at the right corner to explore the potential of AI for critical transportation issues, including the development of decision support systems for TSMO applications.

Results from this research are expected to help close the knowledge gap on assessing the potential of AI for transportation DSSs across a wide range of scenarios with various sources of data and levels of traffic congestion. Findings from this study should be able to provide guidance to transportation agencies to leverage the potential of AI on operational activities, resources, system needs, and decision-making, and offer insight into the development and deployment of next generation, data-driven, and AI-enabled DSSs for TSMO applications.

Implementation Considerations

The planning divisions of state DOTs and MPOs will likely be the direct users of the results and products generated from this research. The goal of the project is to help state DOTs and MPOs to understand and adopt practical data-driven procedures to incorporate AI-based TSMO applications into their long-range transportation planning process. The roadmap developed from this research is expected to be generic and flexible for implementation at different spatiotemporal scales to ensure transferability. This will help to facilitate adoption at the state level by considering the availability of data and computing resources, which may vary significantly across states. To guarantee successful implementation of the anticipated products from this research, state DOTs will need to identify and leverage their existing data sources. Data exchange and fusion from related divisions within state DOTs and MPOs are anticipated. Data sources from the private sector may be required depending on the desired level of sensitivity.

Recommended Research Funding and Research Period

Recommended Research Funding Level: \$450,000

More specifically, the funds needed to accomplish (a) literature review and/or surveys; (b) conducting surveys; and (c) analysis of TSMO's basic functionalities are around \$150,000; and the funds needed to accomplish (d) development of the roadmap and demonstration of the roadmap for two case studies are in the range of \$300,000.

Recommended Research Period: 36 months

More specifically, estimates of the time needed to accomplish (a), (b) and (c) are 12 – 18 months, and to accomplish (d) are 18 – 24 months, respectively.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

- Guoyuan Wu, University of California River Side, gywu@cert.ucr.edu, 951-781-5630.
- Khaled Abdelghani, Southern Methodist University, khaled@lyle.smu.edu, 214-768-4309.
- Osama A. Osman, University of Tennessee at Chattanooga, Osama-osman@utc.edu, 423-425-4398.

Potential Panel Members: For Each Panel Member, Provide Their Name, Affiliation, Email Address And Phone.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

- Julius Codjoe
 - 225-767-9761
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 - Louisiana Department of Transportation and Development/Louisiana Transportation Research Center
-

NCHRP Review of G-28

Reviewed By:

Camille Crichton-Summers
ccrichton-summers@nas.edu

Comments:

There is a significant gap and ample opportunities to study artificial intelligence (AI) and machine learning (ML) for TSMO applications. AI could be used to reduce congestion and improve road safety. The first three objectives are more suitable for basic research as there is no clear reason/problem identified or listed for investigating the state of practice of decision support systems (DSSs) for TSMO. As noted “what AI tools are needed to address a specific TSMO need or solve specific functionalities”? Once identified and prioritized, the research would be helpful for TSMO applications. Potentially the scope could be limited to item #4: *Identifying the Requirements of a Digital Infrastructure for TSMO Applications*. This would be a useful, incremental advancement in this research area. The timeframe and the 450K budget are reasonable since this is a relatively new research area.

Review Date:

12/17/2021

FHWA Evaluation of G-28

Reviewed By:

Huang/HRSO

Comments:

In general, the topic covers many areas of TSMO and TMC operations, so the scale of the project could be large, and the proposed budget could not support the scale. Suggest reducing scale to focus on few convincing cases which would show the benefits, the technologies, and the potentials of AI applications in TSMO and TMC DSS.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for G-28**Submitted By:**

Bud McDonald
AASHTO staff
Agency Administration Managing Committee

Priority #: N/A

Comments:

Support with comment: recommend addressing algorithmic bias, including skin tone and bicyclist recognition issues, in AI, sensors and related systems.

Submitted By:

Bud McDonald
AASHTO staff
Committee on Civil Rights

Priority #: N/A

Comments:

Support with comment: recommend addressing algorithmic bias, including skin tone and bicyclist recognition issues, in AI, sensors and related systems.

Submitted By:

Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A

Comments:

Recommend considering AI and use of technology in TSMO with respect to pedestrians and bicyclists. Consider identifying data gaps for active transportation. Recommend addressing algorithmic bias, including skin tone and bicyclist recognition issues.

Submitted By:

Chad Baker
Research Subcommittee Chair
Data Management and Analytics

Priority #: 10

Comments: N/A

Submitter Response for 2023-G-28

From:

[email: Julius.codjoe@la.gov]

Comments:

Response to FHWA comment: Thank you very much for the comment. We agree with the reviewer's suggestion that the project scale might be too large under the proposed budget level and should be reduced. Considering the comment from the NCHRP reviewer, we plan to modify the scale to focus on the original research objective #4, which is related to the Digital Infrastructure of DSS for TSMO Applications and the use of Traffic Incident Management (TIM) as a case study .

Response to NCHRP comment: Thank you very much for the comments. We agree that the first three objectives are more of basic research compared to the fourth one. However, the proposed four objectives are intertwined. For example, the type of sensors determines the content and resolution of data collected, thus affecting the choice of machine learning-based methodologies. Similarly, based on the user's needs or specific TSMO application, the desired datasets and associated AI tools also cast requirements on the digital infrastructure. Considering the budget constraint (as pointed out by the FHWA reviewer), we agree that the scope needs to be reduced. Therefore, we plan to modify the problem statement to focus on objective #4: digital infrastructure of DSS or TMC targeting a specific TSMO application (e.g., incident management). In addition, the other research objectives, including literature review, data and methodology, would be explored to some extent, depending on the available resources (e.g., budget and duration).

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**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-G-29

Problem Title

Drivers of Change and Their Impacts on Traffic Monitoring Program Management

Background Information And Need For Research

The transportation industry is rapidly evolving, especially as it pertains to data and technology. Trends that affect planning and operations for transportation agencies fall into four categories: social, environmental, technology and data analytics. The latter two are most influential as they pertain to traffic data collection/analysis programs at state DOTs and other transportation agencies.

Trends such as connected vehicles, probe-based data, artificial intelligence/machine learning and data platforms all have the potential to affect traffic monitoring programs – from collection, analysis, and visualization to distribution of data. They are, therefore, considered drivers of change for the industry. Key questions are: How will these trends affect the traditional methods for traffic monitoring programs today and in the future? How will the trends become drivers of change for traffic monitoring programs? Will more or different resources be needed to address these drivers? How can state DOTs and other traffic data agencies benefit from collaboration and joint consideration of the drivers and their impacts? How can traffic monitoring program owners benefit from increased collaboration with others within and external to their organization including the private sector, i.e., OEMs and data providers?

This research will answer these questions and prepare traffic monitoring program managers and staff with tools and opportunities for collaboration that addresses the impacts of drivers of change on traffic programs in a productive way – leveraging new opportunities and saving resources where possible.

This research statement is directly relevant to the American Association of State Highway and Transportation Officials (AASHTO) Committee on Data Management and Analytics. Per their website “The Committee on Data Management and Analytics addresses the collection, procurement, processing, analysis, reporting, and sharing of transportation data. The Committee on Data Management and Analytics is dedicated to addressing issues related to knowledge, expertise, resources and tools needed by state DOTs to implement a robust data management and analytics program within their agencies.” Relevant committee Strategic Plan goals include:

- GOAL 3
Lead in transportation data standardization efforts. (AASHTO Goal 2).
- GOAL 5

Support member departments in achieving best data practices. (AASHTO Goals 1, 2, 3, and 4).

- **GOAL 4**

Support both member agencies' decision-making data and analytics needs, and the Board of Directors needs on policy, program, regulations, and guidance related to data management and analytics (AASHTO Goals 1 and 3).

Research questions to be addressed include:

1. What are the pertinent trends and drivers of change for traffic monitoring programs as they address societal, environmental, technological, analytical and data collection issues?
2. How does each trend result in a driver of change that impacts traffic monitoring programs – across collection, analysis, reporting, distribution, and program management?
3. What are some collaboration, technical, process, and technology methods to address the impacts?
4. How can state DOTs and other traffic monitoring professionals be prepared to leverage the drivers of change (positive and negative) to obtain meaningful traffic data that continue to meet current and future customer needs?
5. What are recommendations for future study?

Literature Search Summary

At least two studies , examined related topics pertaining to specific transportation data trends. There are also several articles listing recent trends in transportation. The topic of drivers of change pertaining to traffic monitoring programs is addressed in Advancing Highway Traffic Monitoring Through Strategic Research (Transportation Research Circular E-C227).

However, a comprehensive and timely report has not been developed to explore current trends and impacts on traffic monitoring programs, and to provide guidance on how state DOT traffic managers can prepare for the future. Therefore, a review of existing literature will be conducted and summarized in a best practice, lessons learned, and current state of the practice evaluation document.

Research Objective

The expected final product will be reports consisting of: (1) The research and analysis of the identified drivers of change. (2) Guidelines to assist state DOT and other agency traffic monitoring staff and managers in applying techniques and tools to overcome obstacles and leverage opportunities for improved traffic monitoring programs. (3) Suggestions for FHWA Traffic Monitoring Guide (TMG) changes to accommodate the drivers of change. These findings will also be summarized in a final report that will moreover include the procedures used in the study.

The tasks to be conducted are:

1. Review Advancing Highway Traffic Monitoring Through Strategic Research (Transportation Research Circular E-C227) to identify specific trends and drivers of change as they pertain to Traffic Monitoring Program Management, Continuous Count Traffic Programs, Short Duration Traffic Count Programs, Weigh in Motion, Managing Large Traffic Datasets, Traffic Monitoring and Performance Measures, Data Quality and Equipment Calibration.
2. Identify, categorize, and explain trends and drivers of change. Examples include:
 - a. Traffic Data Related: improved traffic detection technologies; increased and changing demand for traffic data and more diverse models for data acquisition; applications of alternative data sources in traffic monitoring; improving data quality through process documentation; data sharing within and beyond a traditional traffic monitoring program.
 - b. Data Analytics: data management and visualization capacity; Cloud-Based Transportation Management Systems; Location of processing (edge versus cloud); Predictive analytics; AI/ML; Video analytics; Data Governance.
 - c. Technology/Transportation: continued development and adoption of connected and automated vehicles and availability of data; Data Platforms; Mobility as a Service (MaaS).
 - d. Environmental and Social: Sustainability; Equity; Damaged Infrastructure; Working from anywhere.
 - e. Resource availability: Constrained resources for research and funding.
3. Determine impacts on current and future traffic monitoring programs
4. Identify business processes that may need to be changed to accommodate the drivers of change.
5. Identify and summarize possible changes to business processes to overcome, accommodate, or leverage impacts of change drivers.
6. Obtain feedback from the traffic monitoring community and other stakeholders (agencies across the nation that include city, county, state, federal, and private entity partners.)
7. Identify and summarize possible changes to FHWA TMG to overcome, accommodate or leverage impacts of change drivers.
8. Prepare a final report documenting the results of this study that will include information pertaining to all of the above objectives and other pertinent results of the project.

Urgency and Potential Benefits

This need was first identified by the TRB Traffic Monitoring Committee ACP70 in 2016 and partially documented in Transportation Research Circular E-C227 (2017). The ACP70 Research Working Group examined the issue further and recommended the topic for future research.

This issue affects traffic monitoring programs in all state DOTs and FHWA. The impacts of not performing this research include loss of opportunity to leverage new technology and data and potential to spend unnecessary resources where leveraging impacts of change drivers can be accomplished.

Those benefiting from this research include state, county, MPO, and city traffic program managers; signal operating agencies; and the public at large (due to resource saving and increased safety and mobility due to improved data and decision-making).

Implementation Considerations

The following state DOT offices will be involved in implementing the results of this research: Planning, Programming, Traffic Operations, Transportation System Management and Operations (TSM&O), and Design. FHWA will also be impacted as revisions to the FHWA TMG will be discussed.

States will be able to implement the research by adopting lessons learned from other entities and applying the suggestions. Implementation will be supported with communication methods such as webinars, training, and peer exchanges. The AASHTO Committee on Data Management and Analytics will be a key benefactor of these results.

Recommended Research Funding and Research Period

Funding Requested: \$325,000, Research Period: 18 months.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

- Anita Vandervalk, Iteris, Inc., (850) 570-5906, apv@iteris.com
- Liz Stolz, Marlin Engineering, (303) 369-5570, estolz@marlinengineering.com
- Lawrence Klein, Klein & Associates, (714) 356-2275, larry@laklein.com

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

- Anita Vandervalk, Iteris, Inc., (850) 570-5906, apv@iteris.com
- Wenling Chen, Virginia Department of Transportation, (804) 225-3123, Wenling.Chen@VDOT.Virginia.gov

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

- Kent L. Taylor, NCDOT, kltaylor@ncot.gov , (919) 345-9829

NCHRP Review of G-29

Reviewed By:

Zuxuan Deng
zdeng@nas.edu

Comments:

The Drivers of Change in E-C227(2017) refers to institutional, regulatory and community changes. However, it appears the proposed study intends to focus on technology and data analytics changes, being more of vehicles rather than the drivers. Traffic monitoring technology is evolving quickly due to a combination of the availability of modern, low cost computing and communications technology. Making decisions on what type of hardware and supporting software to purchase for Traffic monitoring program is a critical strategic decision to many agencies. However, the need of this type of decision is rarely synchronized across different agencies. It is unlikely that this project will be of interest to at least 2/3s of the state DOTs at the same time. Note that NCHRP cannot make recommendations to federal agencies, including FHWA.

Review Date:
12/15/2021

FHWA Evaluation of G-29

Reviewed By:
T Tang/HPPI

Comments:

The write up for this proposed project is not precise. What is being provided in the background is not well connected to the objective of the proposed work. Also, deliverables are not very clear with regard to their applications and usefulness. I do not recommend this project.

Review Date:
December 17, 2021

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-30

Problem Title

Communicating Travel Time Reliability: Analytic and Visualization Methods

Background Information And Need For Research

Travel time reliability is a relatively new concept in mobility performance. It emerged from the recognition that historical measurement and modeling methods were not capturing the full scale of how users experience travel conditions. Traditional methods were geared to defining a “typical day” in terms of congestion, yet travelers experience a wide range of conditions due to variability in demand and traffic disruptions (e.g., incidents, weather, and work zones) from day-to-day. Past research has found that travelers value reliable travel over and above what they would experience on a typical day. Reliability not only provides an indication of how the transportation system functions over time, but also is a key part of the benefits for a wide range of transportation improvements including capacity expansion, Transportation Systems Management and Operations (TSMO), demand management, and multimodal investments.

Further, the Moving Ahead for Progress in the 21st Century Act (MAP-21) established national performance management requirements for state departments of transportation (DOTs) that included travel time reliability, congestion, and emissions (PM3); two of the measures are reliability-related. FHWA has provided step-by-step guidance on how the measures can be computed from empirical data, but very little is known about what constitutes a “reliable” travel time from the user’s perspective. Traditionally, level of service (LOS) is used to communicate how well or poorly transportation services perform by using categories of performance, but no consensus exists on what constitutes acceptable and unacceptable levels of reliability, or even what measures should be used for this purpose. Moreover, the computation and reporting of reliability measures can vary substantially from agency to agency. Guidance is needed on how to develop, report, and communicate measures consistently – there are many ways of going from high resolution measurements and modeling results to performance measures.

Literature Search Summary

SHRP 2 Project L03 presented a procedure for converting roadway speed and volume detector data into a variety of reliability measures, but the scope is limited to facility-level measures and does not consider how alternative data sources can be used. Elefteriadou and Cui summarize the existing definitions into two main categories: (1) reliability with respect to a failure threshold set with respect to speed limit and (2) with respect to user perception and how travelers budget their trip time. Accordingly,

researchers define reliability measures and metrics such as 90th or 95th percentile travel times, BI, PTI, coefficient of variation, and misery index. Some of the suggested measures can be expressed in terms of one another under certain assumptions. However, due to ambiguity of the failure states and subjectivity of user perceptions, the reliability measures and metrics may not give consistent reliability levels for the same travel time distributions. The lack of standard definitions and metrics presents an important challenge to the formulation of robust travel time measures. Margiotta, McLeod, and Scorsone presented a framework for defining reliability levels of service for use in the Highway Capacity Manual, but this work has not been implemented. SHRP 2 project L02 produced a Handbook for Communicating Travel Time Reliability Through Graphics and Tables, is perhaps the most comprehensive treatment of presenting travel time reliability. It covers several reliability applications and presents graphical methods for each. Many of the suggestions are statistically oriented (e.g., probability and cumulative distribution functions) and geared to technical audiences, and the issue of gradations in reliability performance is not addressed. Elsewhere, the issue of gradations in reliability performance is not addressed, though some agencies may be doing this more informally.

Several state DOTs have begun to publish various methods for presenting/visualizing reliability measures. It is likely that the Federal requirement to report the PM3 measures, two of which are reliability measures, has provided incentive to do so.

Research Objective

The objectives of this research are to develop a set of consistent procedures that: (1) produce innovative graphics and visualizations for communicating for travel time reliability; and (2) define performance levels for ranges of reliability performance measures.

Key tasks in the research would entail the following.

- Assess the economic literature on the valuation of travel time reliability as a means to define reliability levels of performance.
- Determine the basic parameters for reporting and communicating reliability, especially selection of time periods, segmentation for facility and trip performance, and aggregation procedures to broader geographic levels.
- Create performance ranges for reliability (“what is an acceptable/unacceptable reliability value?”) using a diverse set of reliability performance measures, including the Federally-mandated performance measures for National Highway System Performance and Freight Movement on the Interstate System (PM3). Multiple levels of performance in the domain of congested conditions (e.g., characterized by a queue, including queue formation and dissipation) should be considered.
- Review recent efforts by agencies and researchers to display travel time reliability graphically. Also review the use of visualization methods in fields related to transportation. Two examples include weather/climate science and electric utility management, disciplines where performance is highly time variant as well.

- Develop a set of prototype graphics and visualizations that can be used to communicate travel time reliability to both technical and nontechnical audiences. Include the performance levels in graphics where appropriate. Demonstrate how they can be used in a variety of applications including performance reports, corridor studies, long-range plans, congestion management plans, and needs analyses.
- Test the graphics and visualizations with two state DOTs and one MPO. The final product of the research will be a set of prototype graphics that can be imbedded in technical analyses that deal with congestion and reliability.

Urgency and Potential Benefits

Given the increasing emphasis on the use of emerging data sources for performance measurement, such as the use of the National Highway Performance Management Research Data Set (NPMRDS) to support the Final Rule on National Performance Management Measures, it is expected that there will be significant interest in these results from transportation agencies. Omitting travel time reliability from technical analyses misses a significant portion of the benefits of transportation improvements, especially operations-oriented ones. Understanding how different levels of reliability performance are viewed by travelers is the starting point for communicating these benefits. State of the art visualizations will greatly aid in this communication.

Implementation Considerations

Within state DOTs and MPOs, the research results will be of interest to personnel who have responsibility for:

- Performance measurement and dashboards;
- Transportation Systems Management and Operations (TSMO) because reliability is directly related to operations and maintenance strategies; and
- Developers of routine and special planning studies where reliability is used to assess project impacts.

It is expected that state DOTs and commercial vendors would develop software to implement the guidance developed by the research. Follow-on implementation of the research would involve using the computational engines developed by the research to test the various methods in a case study setting. This is seen as a precursor to the eventual development of user-grade software.

Recommended Research Funding and Research Period

\$300,000. It is estimated that 18 months would be needed to complete the research.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

Rich Margiotta, Cambridge Systematics	865-617-1770	rmargiotta@camsys.com
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Xu Zhang, University of Kentucky	859-257-8037	xuzhang_uk@uky.edu
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Lilian Wu, Kittelson and Associates 510-839-1742 lwu@kittelson.com

Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

There is a large pool of individuals that could serve on a panel for this study, including members/volunteers of the TRB Subcommittee on Travel Time, Speed, and Reliability. The most likely members would include those who authored the original problem statement (named above).

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Sam Granato, Ohio Department of Transportation 614-644-6796
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NCHRP Review of G-30

Reviewed By:

Camille Crichton-Summers
ccrichton-summers@nas.edu

Comments:

The objectives have some overlap with *NCHRP 03-142: The Impacts of Real-Time Warnings and Variable Speed Limits during Weather Events*—which focuses on conveying safety and reliability messages to road users. The study is expected to be awarded in spring 2022, therefore coordination is needed to minimize any duplication of effort. The objectives herein are intended for transportation stakeholders and other interested parties such as local government officials or citizens. This scope is more expansive and may require additional resources. Specifically, there will be an expectation that the visualization tools will be of high quality and be implementable at agencies with varied levels of maturity and limitations due to legacy systems. The deliverables must also meet the needs of a diverse set of stakeholders. Software deliverables will likely be proposed, which raises hosting and maintenance issues. The budget should be increased to 500K with a timeline of 36 months.

Review Date:

12/17/2021

FHWA Evaluation of G-30

Reviewed By:

Patrick Zhang/HPPI

Comments:

We support this research effort since a tool of analytics and visualization that handles large data sets of NPMRDS will significantly benefit the states, MPOs, and local governments. However, we prefer the vendor test the tool with two MPO and one local (the proposal indicates testing with two state DOTs and one MPO).

Review Date:

December 17, 2021

AASHTO Committee Evaluation for G-30
Submitted By:

Chad Baker
Research Subcommittee Chair
Data Management and Analytics

Priority #: 8

Comments: N/A

Submitter Response for 2023-G-30
From:

[email: sam.granato@dot.ohio.gov]

Comments:

Specific replies to FHWA comments:

made the addition suggested by the FHWA review. The sentence now reads:

* Test the graphics and visualizations with two state DOTs and two MPOs, and one city or county transportation agency.

Specific replies to NCHRP comments:

NCHRP Review: Regarding the coordination with the current NCHRP study "Evaluating the Impacts of Real-Time Warnings and Variable Speed Limits on Safety and Travel Reliability during Weather Events", there is some, but limited, opportunity for coordination. That study is about developing effective methods for real-time communication of inclement weather events to modify travelers' behavior. There is a piece that asks for evaluation and the required performance measures so that is the point of coordination. We referenced that and the need for a scan of other ongoing research.

The NCHRP suggestions go further than originally expected -- they suggest a tool as the product rather than prototype graphics, so that was added along with an increase to the budget and schedule.

NOTE: The submitter provided a revised problem statement. It has not been provided because it could not be re-reviewed by AASHTO committees or FHWA and NCHRP staff.

Contact Info:
same as above

Review Date:
2-7-22

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-31

Problem Title

Incorporating a methodology for planning and operational analysis of freeway facilities with ramp meeting strategy.

Background Information and Need For Research

Ramp metering is an efficient Active Traffic Management (ATM) strategy (Federal Highway Administration, 2020). Ramp meters are signals that control the on-ramp to freeway traffic volumes. The strategy is aimed at ameliorating the potential for traffic jams by not only regulating the on-ramp flow but also fragmenting vehicle platoons entering the freeway. This is a cost-effective solution compared to upgrading the traditional freeway's capacity. Ramp metering also offers safety benefits. The strategy is widely implemented by agencies across the nation. It was reported that ramp meters led to a rise in travel speed, a decrease in travel time, a decrease in crash experience, and a lessening of vehicular emissions in multiple large cities. They are Minneapolis/St Paul, Long Island, Portland, Denver, and Seattle (Federal Highway Administration, 2020).

The HCM 6th Edition's methodologies for freeway facilities can be used to model ramp meters; however, the lack of calibration (e.g., capacity gain at the merge points) along with practitioner-ready guidance makes it difficult to be utilized. Another significant shortcoming is the impact of ramp meters on the upstream interchange. This results in a significant bias for estimating this ATM strategy to alleviate unfavorable traffic conditions in our roadway corridors. While the types of ramp metering systems/algorithms abound, the travel time is curtailed even when accounting for on-ramp queued vehicles (Federal Highway Administration, 2020). When it comes to the use of traffic-responsive ramp meters, the travel time reliability method in the HCM should be considered to provide traffic demand fluctuations for estimating benefits. As of today, this cannot be achieved in the HCM framework. With that, multiple jurisdictions witnessed an improvement in travel time reliability as a result of implementing ramp meters. In the absence of ramp metering, the on-ramp traffic may prompt freeway mainline drivers to reduce speed or shift to the left lane to permit the entrance of the on-ramp vehicles. This reduction in the travel speed of the freeway mainline traffic may possibly give rise to clogging. With ramp meters in place, the control of the on-ramp vehicles merging onto the mainline mitigate such effects. The meters also decrease traffic occupancy, a surrogate measure of traffic density, and the time to recuperate from oversaturated conditions to undersaturated conditions. In addition, with ramp meters implemented at multiple on-ramps along a freeway facility, an area-wide strategy may be executed to enhance traffic flow efficiency throughout the facility as a whole (Federal Highway Administration, 2020). Hence, incorporating the impacts of ramp metering in the HCM's freeway facilities/reliability, as well as merge and weaving segments' chapters, is merited.

Reference

Federal Highway Administration, 2020. Ramp Metering: A Proven, Cost-Effective Operational Strategy—A Primer. Federal Highway Administration, U.S. Department of Transportation, Washington, D.C.
<https://ops.fhwa.dot.gov/publications/fhwahop14020/sec1.htm>.

Literature Search Summary

The traffic engineering literature is rich with reports and scientific peer-reviewed articles on ramp metering. In particular, the publications pertain to the operational, safety and economic benefits of implementing ramp metering systems. Following are relevant references:

Aghdashi, S., Davis, J., Chase, T., Cunningham, C., 2020. Modeling and Validating Traffic Responsive Ramp Metering in the Highway Capacity Manual Context. Transportation Research Record: Journal of the Transportation Research Board 2674 (12), 91-102. <https://doi.org/10.1177/0361198120949533>.

Asgharzadeh, M., Kondyli, A., 2020. Effect of Geometry and Control on the Probability of Breakdown and Capacity at Freeway Merges. American Society of Civil Engineers Journal of Transportation Engineering, Part A: Systems 146 (7), 04020055.
<https://doi.org/10.1061/JTEPBS.0000381>.

Chang, G.-L., Cheng, Y., Chen, Y.-Y., Chen, Y.-H., 2020. Integration of Ramp Metering and Off-Ramp Progression. Report Number MD-20-SHA/UM/5-14. Maryland Department of Transportation, Baltimore, Maryland.

Cheng, Y., Chang, G.-L., 2021. Arterial-Friendly Local Ramp Metering Control Strategy. Transportation Research Record: Journal of the Transportation Research Board 2675 (7), 67-80. <https://doi.org/10.1177/0361198121994581>.

Cho, H., Chilukuri, B., Laval, J., Guin, A., Suh, W., Ko., J., 2020. Genetic Algorithm-Based Simulation Optimization of the ALINEA Ramp Metering System: A Case Study in Atlanta. Transportation Planning and Technology 43 (5), 475-487.
<https://doi.org/10.1080/03081060.2020.1763655>.

Cho, H., Laval, J., 2020. Combined Ramp-Metering and Variable Speed Limit System for Capacity Drop Control at Merge Bottlenecks. American Society of Civil Engineers Journal of Transportation Engineering, Part A: Systems 146 (6), 04020033.
<https://doi.org/10.1061/JTEPBS.0000350>.

Frejo, J., De Schutter, B., 2021. Logic-Based Traffic Flow Control for Ramp Metering and Variable Speed Limits—Part 1: Controller. Institute of Electrical and Electronics Engineers Transactions on Intelligent Transportation Systems 22 (5), 2647-2657.
<https://doi.org/10.1109/TITS.2020.2973717>.

Frejo, J., De Schutter, B., 2021. Logic-Based Traffic Flow Control for Ramp Metering and Variable Speed Limits—Part 2: Simulation and Comparison. *Institute of Electrical and Electronics Engineers Transactions on Intelligent Transportation Systems* 22 (5), 2658-2668. <https://doi.org/10.1109/TITS.2020.2973732>.

Haule, H., Ali, M., Alluri, P., Sando, T., 2021. Evaluating the Effect of Ramp Metering on Freeway Safety Using Real-Time Traffic Data. *Accident Analysis & Prevention* 157, 106181. <https://doi.org/10.1016/j.aap.2021.106181>.

Heshami, S., Kattan, L., 2021. Ramp Metering Control under Stochastic Capacity in a Connected Environment: A Dynamic Bargaining Game Theory Approach. *Transportation Research Part C: Emerging Technologies* 130, 103282. <https://doi.org/10.1016/j.trc.2021.103282>.

Jacobson, L., Stribiak, J., Nelson, L., Sallman, D., 2006. Ramp Management and Control Handbook. FHWA-HOP-06-001. U.S. Department of Transportation, Washington, D.C.

Kotsialos, A., 2021. A Varying Parameter Multi-Class Second-Order Macroscopic Traffic Flow Model for Coordinated Ramp Metering with Global and Local Environmental Objectives. *Transportation Research Part C: Emerging Technologies* 128, 103106. <https://doi.org/10.1016/j.trc.2021.103106>.

Laval, J., Xu, T., 2020. Implementation of a Variable Speed Limit/Ramp Metering Strategy to Increase Freeway Capacity at Metered On-Ramps. Report Number FHWA-GA-20-1826. Georgia Department of Transportation, Atlanta, Georgia.

Ma, M., Liang, S., Zhang, H., 2020. A Dynamic Competition Control Strategy for Freeway Merging Region Balancing Individual Behaviour and Traffic Efficiency. *Promet – Traffic & Transportation* 32 (5), 595-609. <https://doi.org/10.7307/ptt.v32i5.3367>.

Mauch, M., Skabardonis, A., 2021. Evaluation of Coordinated Ramp Metering (CRM) Systems in California. University of California (UC) Berkeley California Partners for Advanced Transportation Technology (PATH) Report UCB-ITS-RR-2020-02. UC Berkeley, Berkeley, California.

Mizuta, A., Roberts, K., Jacobsen, L., Thompson, N., 2014. Ramp Metering: A Proven, Cost-Effective Operational Strategy – A Primer. FHWA-HOP-14-020. U.S. Department of Transportation, Washington, D.C.

Pang, M., Yang, M., 2020. Coordinated Control of Urban Expressway Integrating Adjacent Signalized Intersections Based on Pinning Synchronization of Complex Networks. *Transportation Research Part C: Emerging Technologies* 116, 102645. <https://doi.org/10.1016/j.trc.2020.102645>.

Reinolsmann, N., Alhajyaseen, W., Bris, T., Pirdavani, A., Hussain, Q., Bris, K., 2021. Investigating the Impact of a Novel Active Gap Metering Signalization Strategy on Driver Behavior at Highway Merging Sections. *Transportation Research Part F: Traffic Psychology and Behaviour* 78, 42-57. <https://doi.org/10.1016/j.trf.2021.01.017>.

Wang, Y., 2021. Freeway Traffic Control in Presence of Capacity Drop. *Institute of Electrical and Electronics Engineers Transactions on Intelligent Transportation Systems* 22 (3), 1497-1516. <https://doi.org/10.1109/TITS.2020.2971663>.

Xu, Z., Zou, X., Oh, T., Vu, H., 2021. Studying Freeway Merging Conflicts Using Virtual Reality Technology. *Journal of Safety Research* 76, 16-29. <https://doi.org/10.1016/j.jsr.2020.11.002>.

Yang, G., Wang, Z., Tian, Z., Zhao, L., Xu, H., 2020. Geometric Design of Metered On-Ramps: State-of-the-Practice and Remaining Challenges. *Transportation Letters* 12 (9), 649-658. <https://doi.org/10.1080/19427867.2019.1677067>.

Zhou, Y., Ozbay, K., Kachroo, P., Zuo, F., 2020. Ramp Metering for a Distant Downstream Bottleneck Using Reinforcement Learning with Value Function Approximation. *Journal of Advanced Transportation*. <https://doi.org/10.1155/2020/8813467>.

Research Objective

There is a pressing requirement to integrate ramp metering effects into the HCM's methodologies pertaining to freeway segments and freeway facilities and reliability methodologies. With ramp metering systems' operational and safety benefits, traffic flow performance measures, including the user delay costs and travel time reliability, are expected to be improved. In summary, the main objectives of this Research Needs Statement (RNS) are:

- Enable a traffic responsive method to evaluate the impact of ramp meters to demonstrate better its influence in improving the travel time reliability and user delay cost.
- With the addition of methods to measure the impact of on-ramp queue (as a result of metering) backing into an upstream intersection, we can better estimate the value of ramp meters
- The safety benefits of ramp meters will enable agencies to better decide on moving ahead with their ramp meter implementation projects
- By measuring the mobility and safety benefits of ramp meters, HCM can provide a solid foundation to estimate the benefit to cost (B/C) analysis for decision-makers.

The following tasks are proposed to accomplish the objective:

Task 1: Literature Review

Conduct an exhaustive literature review on the operational and safety benefits of the various types of ramp metering systems. This includes the various ramp metering algorithms impacts on the performance measures and how those impacts may be incorporated into the HCM's chapters (i.e., freeway facilities, reliability, merge and

weaving segments, and Active Traffic and Demand Management (ATDM) chapters). Moreover, this task will document different use cases of ramp metering analyses at the planning and operation levels.

Task 2: Draft Methodology and Data Collection Plan

Identify the required data to be collected to assess the impacts of ramp metering algorithms on traffic flow parameters. Also, elaborate on the data sources and method of assessing such impacts, whether analytically or via traffic microsimulation models. The data to be collected should include traffic conditions on the freeway merge point, ramp roadway, and upstream intersection. The plan should also propose ways to collect data in the absence of access to the field (e.g., simulation)

Task 3: Methodology Development

Propose a set of methods to:

- Enable planning level analysis of ramp meters. This includes a set of capacity (and speed) adjustment factors that can be inputted into a single segment (e.g., merger and weave) and freeway facilities analyses. These default capacity adjustment values can also be used to plan for future facilities or long-term improvement projects.
- Enable an operational level analysis to assist agencies in modeling their traffic responsive ramp meters and tune their parameters to achieve optimal operations. This operational level methodology should be incorporated into the oversaturated freeway facilities methodology to enable its use in the travel time reliability analysis.

Task 4: Data Collection and Model Validation

Collect the relevant data identified in Task 2. Evaluate the effects of ramp meters on operations via the approaches selected in Task 2. Validate the developed methodologies using field data.

Task 5: Update the HCM

Update all relevant HCM chapters and provide computational engines that perform the proposed methodologies' tasks.

Urgency and Potential Benefits

Substantial. This research effort will give rise to state-of-the-practice procedural methodologies for the HCM. It will overcome the shortcomings of the current HCM, which does not incorporate ramp metering effects into the freeway facilities, reliability, merge segments, and weaving segments' methodologies. Failure to fund this problem statement will result in the cost-prohibitive use of microsimulation methods.

Implementation Considerations

Since this effort will culminate in updated HCM methodologies, the target audience includes transportation engineering professionals and academic instructors.

Recommended Research Funding and Research Period

Research Funding: \$500,000

Research Period: 36 months

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Brian G. Dunn, PE Oregon DOT, brian..dunn@odot.state.or.us, 503-507-8013
 Brenton Bogard, P.E., Ohio DOT, 614-752-5575 (supporting this RNS)

NCHRP Review of G-31

Reviewed By:
 David M. Jared
 djared@nas.edu

Comments:

This research makes sense technically, and it's timely for states which have implemented ramp metering, but a significant number of states have not implemented them and may not (<https://ops.fhwa.dot.gov/publications/fhwahop14021/sec1.htm>). Since, however, ramp metering is used in many parts of the U.S., a consideration may be leveraging the Transportation Pooled Fund program in lieu of NCHRP.

Review Date:
 12/3/2021

FHWA Evaluation of G-31

Reviewed By:
 Tran, Jones/RC

Comments:

This is well written and supported by external stakeholders. FHWA has ramp metering resources and depending on the disposition, may be a resource or worthy of considering.

Review Date:
December 17, 2021

Submitter Response for 2023-G-31

From:
[email: brian.g.dunn@odot.state.or.us]

Comments:

We agree with the reviewer that the resources available from FHWA should be considered as a guidance to the development of the methodology. We also agree that the research is timely. Although ramp metering is not implemented everywhere, the development of this methodology would greatly assist agencies in deciding where and when to implement this strategy on their roadways.

Contact Info:
Brian G. Dunn, Oregon Department of Transportation, brian.g.dunn@odot.state.or.us

Review Date:
1/26/2022

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT

Problem Number: 2023-G-32

Problem Title

Signal Timing Manual: Development of the Third Edition

Background Information and Need For Research

The Signal Timing Manual (STM) has been the most widely accepted reference across the signal timing field. Since the release of its second edition in 2015 (STMv2), there have been significant advances in signal timing research and practices:

- Several NCHRP and FHWA initiatives have been implemented, and major industry references such as Highway Capacity Manual 6th Edition (2016), NEMA-TS2 Standard Version 3.07 (2016), and NTCIP 1202 v03A (2019), have been updated incorporating new computational methods and operational practices.
- New technological trends have emerged, such as applying new computational approaches to the signal timing process, developing signal timing plans using novel datasets, and instrumenting new signal timing paradigm for Connected and Autonomous Vehicles (CAV).
- The signal timing community has highlighted important topics to be addressed in a new version of the STM, including the signal timing of unconventional intersection geometries, advanced bicycle, pedestrian, and transit signal timing, cybersecurity risks tied to the signal timing procedures, and innovative signal timing design using standards-based controller features.

While the current STM edition has materially assisted traffic signal professionals, it was nonetheless developed in the previous decade, lacking coverage of the most up-to-date developments in the signal timing field. There is an urgent need to develop a new edition (STMv3) that

- incorporates outcomes of the latest NCHRP and FHWA initiatives that have advanced to successful implementation, and the latest updates of major industry references (e.g., NEMA-TS2, NTCIP 1202, and HCM6),
- provides timely coverage of new technological trends applicable to the signal timing process, and
- addresses common interests of the community with added or updated topics.

Literature Search Summary

The Highway Capacity Manual 6th Edition (HCM6-2016) provides updated procedures for computing the capacity of various highway facilities including signalized intersections. The NEMA-TS2-2016 Standard incorporates Flashing Yellow Arrow (FYA) feature, as well as associated configuration and other related information. NTCIP 1202 v03A-2019 has updated clauses on FYA and other corrections related to signal operations. The on-going NCHRP 03-125 project evaluates change and clearance intervals prior to FYA. NCHRP

Report 954 compiles the best available information on automated traffic signal performance measures and management strategies for traffic signal operations. NCHRP Web-only Document 284 provides guideline for traffic signal phasing. NCHRP 03-133 addresses the multi-modal signal timing for non-motorized users. NCHRP Report 959 presents a comprehensive guide to the design and operation of Diverging Diamond Interchanges (DDI). NCHRP 03-136 addresses performance of right-turn-on-red operations. In addition to and complementing NCHRP projects, FHWA has conducted several efforts to better support traffic signal operations, including the development of Traffic Signal Management Plan Guidance Document (FHWA-HOP-15-038), Traffic Signal Management and Capability Maturity Framework (CMF, FHWA-HOP-16-028), and the promotion of Basic Service Model concept (FHWA-HOP-09-055) highlighting the need to scale equipment and operations based on agency staff.

Research Objective

This research is to update the current STM, which will be a decade old by the time the 3rd Edition is published. The new edition will synthesize up-to-date best practices and research outcomes that have been successfully implemented after STMv2, provide proper coverage of technological trends applicable to the signal timing process, and complement existing STM structure with updated and new chapters addressing common interests of the signal timing community.

It is expected that the following topics will be properly covered:

- New technological trends relevant and applicable to the signal timing process, such as the usage of novel datasets for developing signal timing plans, new computational methods, and new signal timing paradigms for CAVs.
- Cybersecurity in the signal timing process, and related policy implications.
- Updated guidance and support systems to effectively manage, operate, and maintain traffic signals.
- Updated guidelines on FYA and signal phasing. Multimodal signal timing and performance measures, including advanced treatments for bicycle, pedestrian, and transit signal timing. Best signal timing practice for DDI, SPUI and UAID. Performance measures about right-turn-on-red operations.
- Enhancement of the current STM structure, providing proper details, references, guidelines, or illustrative examples. Candidate subjects include Dallas phasing, third-car detection for permissive/protected left turns, application of peer-to-peer communications and logic processors, innovative usage of overlaps, advanced detection logics, algorithmic details for typical transit signal priority, preemption, and transition logics.

Tasks Outline

- (1) Conduct an up-to-date state-of-the-art review. Review purpose, objectives, target users, and target usage for the STM and identify major gaps in current STM edition.
- (2) Hold Peer Review and NCHRP Panel Meetings to identify subjects, updates, and additions.
- (3) Report results of Tasks 1-2 and include recommended Phase II work plan.

- (4) Develop and publish 3rd Edition of STM.
- (5) Prepare training materials based on the new STM edition.

Urgency and Potential Benefits

This project is urgently needed to update the STM 2nd Edition released in 2015 with a new STM 3rd Edition that incorporates the latest technical advances, research outcomes, and best practices in signal timing. The new edition will add great value to the well-established STM series, facilitating the signal timing process, encouraging knowledge sharing, promoting system interoperability, and improving traffic signal maintenance, management and operations throughout the United States. A well-managed traffic signal program employing the best practices can forestall the need for expensive capacity improvements and ultimately address specific community goals and policies such as improved mobility of people and goods. The addition of new topics is essential for workforce development of the signal timing staff.

Implementation Considerations

The results of the research will be embodied in the 3rd edition of Signal Timing Manual, which will be employed by State DOT professionals maintaining and managing the day-to-day operations of traffic signals throughout the United States.

Recommended Research Funding and Research Period

Recommended Funding: \$750,000
 Research Period: 36 months

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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- Mark Taylor, UDOT Traffic Signal Systems Manager, 801-887-3714, marktaylor@utah.gov

Person Submitting The Problem Statement: Name, affiliation, email address and phone.

Cameron Kergaye, PhD, PE, PMP Utah Department of Transportation, ckergaye@utah.gov, 801-633-0359

NCHRP Review of G-32

Reviewed By:

Zuxuan Deng

zdeng@nas.edu

Comments:

The FHWA published the first edition of Traffic Signal Timing Manual in 2008. Consequently, the second edition of TSM was published as NCHRP Report 812 through NCHRP 03-103 project in 2015. If we can initiate a new NCHRP project to prepare the 3rd edition of TSM in FY23, the updated manual will be available around 2025, exactly a decade after the release of the 2nd edition of TSM. It's a timely opportunity to incorporate updated standards and to catch up with the latest technologies in order to provide practitioners and decision makers in all States up to date technical guidance on traffic signal timing issues in an emerging multimodal environment.

Review Date:
12/15/2021

FHWA Evaluation of G-32

Reviewed By:
Curtis/HOTM

Comments:

HOP participated in a cost sharing arrangement with NCHRP to complete version 2 of the Signal Timing Manual (STM). As stated in the problem statement, numerous research projects have been completed that could significantly inform needed updates to the current STM. There are also several pooled fund studies, as well as an updated Highway Safety Manual that should be incorporated into an update; from change and clearance intervals to automated traffic signal performance measures (included in the BIL).

Review Date:
December 17, 2021

AASHTO Committee Evaluation for G-32

Submitted By:
Bud McDonald
AASHTO staff
Council on Active Transportation

Priority #: N/A

Comments:

Consider safety implications and ADA accessibility. Recommend performance measures incorporate safety performance, particularly for RTOR and other signal practices that can create a conflict point for vulnerable road users.

**American Association of State Highway and Transportation Officials
Special Committee on Research and Innovation**

FY2023 NCHRP PROBLEM STATEMENT TEMPLATE

Problem Number: 2023-G-33

Problem Title

Economic Evaluations of Roadside Driving Under the Influence of Drugs (DUID) Programs.

Background Information and Need For Research

Many states are moving toward legalization or decriminalization of drugs. Doing so creates a dilemma for transportation safety professionals who recognize that these actions will likely increase death and serious injury on the nation's roads and highways. This is counter to the goals and objectives set forth in strategic planning efforts, such as: Vision Zero, Toward Zero Deaths, State Strategic Highway and Local Safety Plans. An effective countermeasure is needed to counteract drug use while driving. This research attempts to fill this gap. It should be recognized that the outcomes of crashes often become the responsibility of those who operate and design roads, so steps to reduce behaviors that lead to crashes are of benefit to transportation agencies, particularly in the context of the Safe System and the concept of shared responsibility. To assist transportation agencies, policies to deter driving under the influence of drugs (DUID) require sound scientific evidence for measuring and detecting drug prevalence. They also demand resources. Because the use of any resource has a cost, the design, implementation, and use of policies should be guided by what is both scientifically and economically sound. Economic evaluations of policy alternatives should help decide which among them can reasonably be implemented by a given jurisdiction which in turn will increase the implementation of DUID programs that lower crash potential for all concerned stakeholders and road users.

Accurate screening for drugs at the roadside is key to efforts to deter DUID. The use of oral fluid (OF) samples and Drug Recognition Expert (DRE) observations are two methodologies used to screen for DUID. Each of these present many strengths and but also weaknesses, and each are associated with specific benefits and costs. This research intends to outline these issues, benefits, and cost to highlight the value of these needed safety programs in addressing crash reduction. Moreover, given the increasing difficulties associated with recruiting police officers in general, and in training, using, and retaining DREs in particular, it would be useful to assess whether it would be more cost efficient to provide intensive training on how to collect oral fluid specimens for drug-detection to as many officers as possible and to extend the Advanced Roadside Impaired Driving Enforcement (ARIDE) training to as many officers as possible. Transportation agencies responsible for road safety will find significant benefit as effective countermeasures for reducing road deaths and serious injuries related to drugged driving are needed.

Literature Search Summary

Drug-impaired driving is a public and governmental concern in the United States.^{1 2} The 2013-14 National Roadside Survey (NRS) found 22.5% of U.S. weekend nighttime drivers positive for drugs, a significant increase from the 12.4% of drivers positive for illegal drugs measured in 2007.² Concern is specially high for cannabis as it is the most frequently detected drug after alcohol in drivers who have crashed.^{1 3} Despite some uncertainty regarding the concentrations of Delta-9-Tetrahydrocannabinol (THC, cannabis' main psychoactive component) that trigger impairment,⁴ cannabis has been found to elevate crash risk,⁵ although sometimes only when used jointly with alcohol.¹ Besides cannabis, many other drugs including anxiolytics, hypnotics, sedatives, etc., could also contribute to crash risk.⁵ In a meta-analysis of studies assessing crash risk associated with drugged-driving, Elvik reported increases in risk for most of the drugs examined.⁶

To deter drivers from DUID, the accurate screening and detection for drugs at the roadside is key. To this regard, drug screening and detection methods based on OF samples are becoming increasingly popular, as the method is minimally invasive and appears effective in detecting many types of drugs.^{7 8 9} As summarized by Lee & Huestis⁸, "oral fluid (OF) is a new biological matrix for clinical and forensic drug testing, offering non-invasive and directly observable sample collection reducing adulteration potential, ease of multiple sample collections, lower biohazard risk during collection, recent exposure identification, and stronger correlation with blood than urine concentrations." However, issues associated with the accuracy of screening technologies to identify time of drug use, and to assess whether the amount of drug detected was impairing^{7 10} limit the use of this approach.²

Developed by the Los Angeles Police Department in the 1970's, and currently managed by the International Association of Chiefs of Police (IACP) with technical assistance from the National Highway Traffic Safety Administration (NHTSA), the Drug Evaluation and Classification (DEC) program trains officers to be Drug Recognition Experts (DREs) who, following a request by a responding officer, assist the officer in determining drug impairment.^{7 11} Despite some mixed results regarding the efficiency of DREs to detect drug impairment¹², DREs have become a sound strategy for DUID detection. However, the use of DREs presents limitations of their own, including the substantial time and cost required for training DREs and a progressive reduction in the DRE force, which may be at least in part responsible for a severe decline in callouts for DREs by responding officers who get frustrated by a lack of rapid responses (or even any response at all) when reaching out for DREs.¹² Indeed, shortage of DREs has been identified in several states as the main limitation of the program.^{12 13 14}

The Advanced Roadside Impaired Driving Enforcement (ARIDE) training has been posited by MADD as a way to "bridge the gap between Standardized Field Sobriety Testing (SFST) and Drug Recognition Expert (DRE) training," and "provides police officers with the basic skills in identifying and detecting drug-impaired drivers. The training is taught by DRE instructors and also ensures the officer's SFST proficiency."¹⁵ Given the shortage of DREs, it has been posited that widening ARIDE training to

reach as many patrol officers as possible may be a sensible alternative, 12 15 This possibility needs to be assessed.

Research Objective

1. To assess the cost-effectiveness of alternative drug screening approaches. More specifically, the goal of Aim 1 is to estimate the monetized cost that would be needed to reach a specific screening target (i.e., to identify a percentage of drug-impaired drivers) by widening the ARIDE training; and compare this cost with the cost needed for the DRE/Drug Evaluation Classification (DEC) program to reach similar results. This aim will explore the cost-effectiveness of the approaches under comparison for a range of targets (i.e., the identification of a range of percentages of drug-impaired drivers) and a range of assumptions regarding the percentage of ARIDE and/or DRE training.
2. To assess the costs and benefits associated with policies requiring the collection of oral fluid at the roadside to screen and confirm all drivers suspected of impairment, compared with some law enforcement procedures that halt efforts once a suspect's BAC is determined to be at or above the per se limit. Aim 2 can be viewed as a variation of Aim 1, in which the screening for drugs is halted (or not) after impairment by alcohol is established. As with Aim 1, a range of targets and assumptions will be examined.
3. To inform traffic safety professionals about the costs and benefits associated with alternative DUID crash countermeasures. The information to be provided by this study will be useful to safety professionals in the strategic highway safety planning, development, and implementation of infrastructure and behavioral safety programs, so that holistic and cost-efficient road safety strategies can be developed to reduce fatal and serious injury crashes to greatest extent possible.

Urgency and Potential Benefits

With increasing legalization and decriminalization of drug involved impairment related crashes will increase. This makes it very difficult for agencies to meet safety goals and targets. This unfortunate rise will require a shifting of infrastructure safety dollars to reduce fatal and serious crashes related to such things as lane departures, cross centerline, and other high severity crash types. A partnership approach is immediately needed to help offset these potential negative consequences. Further, in times of dwindling resources and increasing concerns affecting the ability and willingness law enforcement agencies to make impaired driving detection a priority, determining the resource-optimal policies for DUID screening is of timely significance. The outcome of this research will assist policy makers to decide how to optimally allocate the resources at their disposal.

Implementation Considerations

The concept is to produce monetized evaluations of drug screening approaches. More specifically, the concept is to estimate how much would it cost to reach a specific outcome (proper DUIDs screening and detection) under alternative approaches. Because the cost of each alternative may vary for different targets (i.e., how efficient the approach would need to be) and assumptions, we will conduct sensitivity analyses to

achieve a more granular examination of the policies (i.e., repeat the analyses for a range of target outcomes and assumptions).

Some of the assumptions/factors that would be considered could include DUI and DUID prevalence in a community, community size, local laboratory capacity, laws and regulations, and advances in OF detection. Moreover, because policy implementation costs may vary across locations and over time, cost estimates will be obtained separately for these factors, and expressed all in 2021 dollars.

Recommended Research Funding and Research Period

A two-year effort would be required. Most of the first year will be used to review the literature, collect, clean, and integrate all databases (e.g., crash, economic, regulatory data). Most of the second year will be used for building the models, conducting analyses, obtaining estimates and results, and report findings. We expect all data to be used in this effort to be publicly available.

Funding: s \$500,000.

Problem Statement Author(S): For each author, provide their name, affiliation, email address and phone.

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Potential Panel Members: For each panel member, provide their name, affiliation, email address and phone.

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15. MADD. POSITIONS & POLICIES. Accessed 10/07/21, 2021.

NCHRP Review of G-33

Reviewed By:
Richard A. Retting
rretting@nas.edu

Comments:

The topic of Roadside Driving Under the Influence of Drugs (DUID) Programs is timely, although the extent to which drugs (other than alcohol) contribute to fatal and serious injury crashes has not been established. Drugs such as cannabis can remain detectable in oral fluids long after said drugs have been inhaled/ingested and thus may not measurably impact driver performance. We know from the impaired driving literature that roadside police enforcement can serve as an effective countermeasure. For example, a CDC systematic review of 15 high-quality studies found that sobriety checkpoints reduce alcohol-related fatal crashes by 9%. The problem statement provides solid background information and documents the need for research; a succinct literature search summary; and clear research objectives. The recommended funding seems reasonable for the stated research objectives. It is important to identify any related research projects that are planned, underway, or recently completed to avoid duplication.

Review Date:
11/23/2021

FHWA Evaluation of G-33

Reviewed By:
Pascual, Scurry/HSA

Comments:

The proposed research is both timely and necessary given the increase in State laws decriminalizing marijuana use without partner laws or methods to combat DUID. While efforts are ongoing to develop new scientific methods to detect THC (plus others) levels quickly and accurately in the field and equate those with relative impairment, those efforts are far away from field use. Focusing the research on existing methods for DUID detection and their costs will provide law enforcement and safety professionals effective tools they can use now. The proposed research does not explicitly address quantifying

the safety effectiveness of each of these treatments and might also benefit from a literature review to determine if there are any other strategies to reduce DUID, and then including those strategies in the analysis too. They may also want to include looking at the costs associated with increased laboratory toxicology processing and testing on the increased number of oral fluid samples as a result of the increased number of officers trained to collect.

Review Date:

December 17, 2021

AASHTO Committee Evaluation for G-33

Submitted By:

Kelly Hardy
AASHTO staff
Safety

Priority #: N/A

Comments:

Would this research only look at legalized recreational drugs, or can prescription drugs also be incorporated in some way?

Submitter Response for 2023-G-33

From:

[email: MiltonJ@wsdot.wa.gov]

RESPONSE TO REVIEWERS

Reviewer #1:

FHWA Evaluation of G-33

Reviewed By: Pascual, Scurry/HSA

The proposed research is both timely and necessary given the increase in State laws decriminalizing marijuana use without partner laws or methods to combat DUID. While efforts are ongoing to develop new scientific methods to detect THC (plus others) levels quickly and accurately in the field and equate those with relative impairment, those efforts are far away from field use. Focusing the research on existing methods for DUID detection and their costs will provide law enforcement and safety professionals effective tools they can use now to determine if there are any other strategies to reduce DUID. The proposed research does not explicitly address quantifying the safety effectiveness of each of these treatments and might also benefit from a literature review, and then including those strategies in the analysis too.

They may also want to include looking at the costs associated with increased laboratory toxicology processing and testing on the increased number of oral fluid samples as a result of the increased number of officers trained to collect.

Response:

We thank the reviewer for his comments.

We now added the sentences shown here below in red to Aim1:

This aim will explore the cost-effectiveness of the approaches under comparison for a range of targets (i.e., the identification of a range of percentages of drug-impaired drivers) and a range of assumptions regarding the percentage of ARIDE and/or DRE training, and the sensitivity and specificity (the percent of correct and false outcomes) demonstrated by each detection approach. We will also conduct a review of the literature to identify alternate strategies for quantifying the effectiveness of the different approaches to DUID detection.

And to section 6 (Implementation consideration):

The concept is to produce monetized evaluations of drug screening approaches. More specifically, the concept is to estimate how much would it cost to reach a specific outcome (proper DUIDs screening and detection) under alternative approaches. As indicated, this study will compare the cost and benefits associated with the ARIDE and DRE/DEC programs, as well as with the collection of Oral Fluid at roadside. We will include cost estimates associated with increased lab testing resulting from a higher level of oral fluid testing.

Because the cost of each alternative may vary for different targets (i.e., how efficient the approach would need to be) and assumptions, we will conduct sensitivity analyses to achieve a more granular examination of the policies (i.e., repeat the analyses for a range of target outcomes and assumptions). Some of the assumptions/factors that would be considered could include DUI and DUID prevalence in a community, community size, local laboratory capacity, laws and regulations, advances in OF detection, and increases in laboratory toxicology processing and testing requirements as drug detection improves. We will also review the literature to assess the effectiveness of each alternative (i.e., their sensitivity and specificity) and include this information into our models. Moreover, because policy implementation costs may vary across locations and over time, cost estimates will be obtained separately for these factors, and expressed all in 2021 dollars.

Reviewer #2:

NCHRP Review of G-33

Reviewed By: Richard A. Retting

The topic of Roadside Driving Under the Influence of Drugs (DUID) Programs is timely, although the extent to which drugs (other than alcohol) contribute to fatal and serious injury crashes has not been established. Drugs such as cannabis can remain detectable in oral fluids long after said drugs have been inhaled/ingested and thus may not

measurably impact driver performance. We know from the impaired driving literature that roadside police enforcement can serve as an effective countermeasure. For example, a CDC systematic review of 15 high-quality studies found that sobriety checkpoints reduce alcohol-related fatal crashes by 9%. The problem statement provides solid background information and documents the need for research; a succinct literature search summary; and clear research objectives. The recommended funding seems reasonable for the stated research objectives. It is important to identify any related research projects that are planned, underway, or recently completed to avoid duplication.

Response:

We thank the reviewer for his comments.

NOTE: The submitter provided a revised problem statement. It has not been provided because it could not be re-reviewed by AASHTO committees or FHWA and NCHRP staff.
