

NCHRP Project 20-102(28), “Preparing Transportation Agencies for Connected and Automated Vehicles in Work Zones”

Implementation of Research Findings and Products Technical Memorandum

**Prepared for NCHRP of the
Transportation Research Board
of
The National Academies of Sciences, Engineering, and Medicine**

NCHRP is sponsored by the individual state departments of transportation of the American Association of State Highway and Transportation Officials. NCHRP is administered by the Transportation Research Board (TRB), part of the National Academies of Sciences, Engineering, and Medicine, under a cooperative agreement with the Federal Highway Administration (FHWA). Any opinions and conclusions expressed or implied in resulting research products are those of the individuals and organizations who performed the research and are not necessarily those of TRB; the National Academies of Sciences, Engineering, and Medicine; FHWA; or NCHRP sponsors.

**Luke Neurauter¹, Tammy Trimble¹, Eric Li¹, Alejandra Medina Flintsch¹, and Paul
Pisano²**

¹Virginia Tech Transportation Institute

²Paul Pisano, LLC

**Virginia Polytechnic Institute and State University
Blacksburg, Virginia
September 9, 2022**

Permission to use unoriginal material has been obtained from all copyright holders
as needed

Background

This technical memorandum provides recommendations on how to best put the research products developed as part of NCHRP Project 20-102(28) into practice. This memorandum will identify possible institutions that might assist in the application of the research products and issues affecting the potential implementation of the research products and will recommend possible actions to address these issues. In addition, this memorandum will recommend methods of identifying and measuring the impacts associated with the implementation of the products.

The developed educational materials are suitable for use in a variety of settings and targeted at a variety of stakeholder interests, ranging from novice department of transportation (DOT) administrators to more knowledgeable subject matter experts, and they include:

- An annotated presentation providing an overview of connected and automated vehicle (CAV) and infrastructure-based technologies and how these technologies may improve work zone safety. The presentation also provides a review of infrastructure-based solutions that can be either technology- or non-technology-based that an agency can implement to facilitate CAV technologies.
- A PDF handout supporting CAVs in work zones that provides a discussion of the importance of stakeholder support, sources of technical and financial resources, and links to relevant specifications and standards.
- An annotated presentation providing a framework for assessing benefits and costs. This presentation provides a framework for those wishing to conduct their own benefit-cost assessments and serves as a tool for use in the assessment of benefits, costs, and challenges for selected work zone CAV applications. The goal of the presentation is to help practitioners to better understand the challenges, limitations, and data availability for CAV benefit-cost analyses.

Additionally, the final report includes the detailed benefit-cost analyses for four technologies (lane keeping, queue warning systems, automated truck-mounted attenuators, and work zone traveler information systems for CAVs) as well as several research problem statements.

Putting Research into Practice

It is expected that the audience for this research will be broad and include state and local policymakers, academia, and private sector consultants and researchers. The most important implementation strategy will be for state and local DOTs and will be accomplished by working with the American Association of State Highway and Transportation Officials (AASHTO).

To assist in this process, the educational materials and the final report should be made available to state and local transportation agencies and other interested parties. These documents will also be of significant help to consultants, technology developers, and researchers who study the benefits and challenges associated with CAV implementation. These materials may be modified as appropriate by users to brief senior management on the needs and potential benefits associated with CAV implementations.

The results of the project can be disseminated to state and local agencies through partnering organizations and national associations. Stakeholder representatives from national organizations, such as AASHTO and the American Road & Transportation Builders Association (ARTBA), can aid in distributing key research findings. These groups could distribute the results to members across the states and facilitate webinars to disseminate project results. Additionally, state and local

agencies, working in concert with national organizations, may seek opportunities to establish a forum for transportation agencies to have routine meetings to share experiences and engage in peer exchanges.

The results of this project are also expected to be disseminated through papers presented at TRB Annual Meetings (sessions and committee meetings) and other national and international conferences, including those hosted by the primary stakeholders. Examples of conferences and meetings to be targeted include the Automated Road Transportation Symposium, the AASHTO Annual Meeting, the Public Works Expo, and the ARTBA National Convention and regional meetings. The project team will also reach out to popular listservs such as the National Work Zone Safety Listserv operated by ARTBA and *TR News*. Finally, the project team will capitalize on events such as the National Public Works Week to share educational facts and materials via the project website and the Virginia Tech Transportation Institute's social media accounts.

Leveraging Institutions

The adoption of the final products will be accomplished in close cooperation with TRB, AASHTO, and ARTBA. With support from TRB staff and/or panel members, a series of webinars could be held to explain the research findings and the process involved in conducting benefit-cost analyses. The webinars could provide DOT practitioners with the required steps and methods for performing the benefit-cost analyses as well as barriers they might encounter. These barriers may include a lack of data needed to complete the analyses.

The research gaps identified as part of this effort can be overcome through collaboration with varying stakeholders including AASHTO, the Federal Highway Administration, the National Traffic Safety Administration, and TRB. Several TRB committees may be useful in supporting the dissemination of research products. These committees include, but may not be limited to, the following:

- ACH40 - Human Factors of Infrastructure Design and Operations
- ACH60 - Vehicle User Education, Training, and Licensing
- ACP15 - Intelligent Transportation Systems
- ACP30 - Vehicle-Highway Automation
- ACP55 - Traffic Control Devices
- AED50 - Artificial Intelligence and Advanced Computing Applications
- AJL40 - Emerging Technology Law
- AKC10 - Construction Management
- AKR10 - Maintenance and Operations Management
- AKR20 - Roadside Maintenance Operations
- AKR40 - Winter Maintenance

Identifying Issues Affecting Potential Implementation

There are several potential barriers to successful implementation, such as insufficient or inadequate data to support the benefit-cost analyses; lack of practitioner understanding of the proposed benefit-cost framework; and organizational, political, or societal resistance to the recommended framework. To mitigate the impacts of potential barriers, the project team created a risk register covering the main risks. The register includes management actions for each risk. The risks are classified with ratings for three aspects of each risk: the probability of that risk occurring;

the impact on the project cost, schedule, or scope; and the ability of that risk to be mitigated. These levels are defined in Table 1 [Note: Risks have been rated using the Intelligent Transportation Systems Joint Program Office standard (https://www.its.dot.gov/project_mang/index.htm)]. Table 2 summarizes the main challenges expected when implementing the benefit-cost analyses framework and the experienced-based strategies for mitigating a risk’s potential impact on the project. Risks are identified using a taxonomy that includes institutional, personnel, and technical risks. Table 2 also lists the anticipated risks, their ratings and probabilities, and planned mitigation strategies.

Table 1. Risk Rating and Probability Definitions

Risk Probability	Risk Rating/Impact on Cost, Schedule, and/or Scope	Ability to Mitigate Risk
4 = High Risk (>10%)	4 = Catastrophic: Major Impact	4 = None
3 = Medium Risk (Between 5% and 10%)	3 = Critical: Significant Impact	3 = Low
2 = Low Risk (Between 1% and 5%)	2 = Marginal: Low Impact	2 = Medium
1 = Negligible Risk (Less than 1%)	1 = Negligible: Insignificant Impact	1 = Excellent

Table 2. Risk Matrix

Category	Description	Risk Probability	Risk Impact	Mitigation Rating and Strategy
Institutional	Insufficient or inadequate data to support the implementation or adoption of the benefit-cost framework	1	4	2 – Mitigate risk by engaging in continual review of ongoing research efforts and consulting with a broad range of personnel with expertise in conducting benefit-cost analyses
Institutional	Organizational and/or political leadership unable or unwilling to support research effort	3	3	1 – Mitigate risk with strong coordination and education
Personnel	Lack of general knowledge needed to make CAV-related decisions and evaluations	1	3	2 – Avoid risk by providing and engaging opportunities for training including webinars, conferences, and other information-sharing activities
Personnel	Lack of personnel qualified to conduct benefit-cost analyses	1	3	2 – Avoid risk by keeping a broad range of personnel focused on project goals; provide opportunities for training via webinars
Technical	New developments in CAV technologies or data availability	2	2	1 – Accept risk and integrate new developments as appropriate into new analyses for consideration
Technical	Stakeholders unable or unwilling to support benefit-cost analysis activities	3	3	1 – Mitigate risk with strong coordination and education

Identifying and Measuring Impacts

The success of implementation will be assessed based on the acceptance of research products by members of the work zone safety community, including government agencies and safety advocacy groups. Assessment metrics will include the number of attendees at webinars sponsored in support of the education outreach efforts. Additional assessments will include the potential reach through conference and meeting presentations taking place following the project's completion. Reach also can be measured by the number of jurisdictions and/or organizations that are exposed to the research and the representativeness of those jurisdictions and/or organizations within the larger stakeholder group. Specific assessment criteria for measuring reach may include, but should not be limited to, the following:

- Number of copies of the report disseminated through TRB and follow-up inquiries.
- Number of hits for report downloads on the TRB website.
- Number and type of contacts acquired by the TRB and the members of the project team.
- Requests for and presentations of the material and follow-up calls from presentations completed by the team.

The products of this research should benefit jurisdictional DOTs by providing a framework for assessing the benefits and challenges associated with CAV applications. This framework is by design practical and actionable. The deliverables are tailored for DOT practitioners because they will be responsible for identifying technologies to include in work zone projects. Quantitative measures that may be used to assess impact include the number of agencies that adopt the framework for the assessment of benefits and challenges proposed by the project and the representativeness of those adopting the research (e.g., high population versus low population jurisdictions, urban versus rural jurisdictions) and those that do not adopt the framework.