Project No. NCHRP 17-91

Assessing the Impacts of Automated Driving Systems (ADS) on the Future of Transportation Safety

Technical Memorandum on Future Research Needs

Prepared for
National Cooperative Highway Research Program (NCHRP)
Transportation Research Board of The National Academies of Sciences, Engineering, and Medicine

Booz Allen Hamilton, VHB Engineering, Quantitative Scientific Solutions

Washington DC

November 2021

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ACKNOWLEDGMENT OF SPONSORSHIP

This work was sponsored by one or more of the following as noted:

- ◻ American Association of State Highway and Transportation Officials, in cooperation with the Federal Highway Administration, conducted in the **National Cooperative Highway Research Program**
- ◻ Federal Transit Administration, conducted in the **Transit Cooperative Research Program**
- ◻ Federal Aviation Administration, conducted in the **Airport Cooperative Research Program**
- ◻ Research and Innovative Technology Administration, conducted in the **National Cooperative Freight Research Program**
- ◻ Pipeline and Hazardous Materials Safety Administration, conducted in the **Hazardous Materials Cooperative Research Program**
- ◻ Federal Railroad Administration, conducted in the **National Cooperative Rail Research Program,**

which is administered by the Transportation Research Board of the National Academies.

Introduction

This technical memorandum highlights potential future research needs, and priorities for the NCHRP 17-91 project based on findings from the research. This includes findings from phase 1 research, stakeholder feedback from phase 3, and the proof-of-concept results from phase 4. Given the nature of these suggested research needs, this document does not set the stage for a specific implementation strategy at this time. Instead, it provides a foundation for initiating/continuing conversations among transportation agencies and technology developers/providers, identifying gaps in current safety data and analysis methods, and developing research needs statements that can help further refine and strengthen the safety assessment framework that was developed as part of this project.

Future Needs Topics

There are several opportunities for future research with respect to quantifying the expected safety impacts of automated driving systems (ADS) and the safety performance of roadways with and without deployment of various ADS and other technologies. The following are a list of select opportunities to enhance the framework through future research:

- Evaluate safety effectiveness of ADS deployments (post-implementation).
- Evaluate non-crash-based measures for ADS deployments (post-implementation).
- Track ADS deployments.
- Calibrate and refine crash prediction models.
- Investigate relationships among driver, vehicle, roadway, and technology.

Each of these topics are elaborated in more detail below.

Evaluate Safety Effectiveness of ADS Deployments (Post-Implementation)

Each year, transportation agencies invest nearly $4 billion on Highway Safety Improvement Program (HSIP) projects alone to improve safety, and billions more on other transportation projects to improve mobility, enhance safety, and support economic growth. Evaluations can help to demonstrate the value of these expenditures. Demonstrating the value of past investments then justifies future funding and investments in specific programs or projects.

Rigorous post-implementation safety evaluations include the study of crash-based performance measures over several years and typically at multiple locations. The results of these studies can help to understand the impacts of individual projects or programs in terms of lives saved and serious injuries prevented. These evaluations can also help estimate the effectiveness for future planned ADS deployments. For instance, after evaluating associated pilots of an L3 Traffic Jam Drive feature, it would be possible to estimate the average change in safety performance (e.g., X% reduction in total crashes or a specific crash type or severity in a given geographic area). The L3 traffic jam drive feature allows the vehicle to act without input from the human driver at lower speeds if a preceding car can be followed.

The Federal Highway Administration (FHWA) HSIP Evaluation Guide can serve as a resource for agencies to use in planning and performing crash-based evaluations. The guide identifies common challenges in performing various levels of evaluation (i.e., project-, countermeasure-, and program-level) and opportunities to overcome those challenges. It also explains how to use the results from project, countermeasure, and program evaluations to inform future planning and implementation decisions and enhance current processes.

Relevance to framework*: Post-implementation evaluations will help to refine the assumptions used in the framework to estimate the potential safety impacts of various ADS scenarios.*

Evaluate Non-Crash-Based Measures for ADS Deployments (Post-Implementation).

While crash-based evaluations are generally preferred for estimating the safety effectiveness of projects and programs, ADS deployments are relatively new and there are limited deployments. Further, it can take several years to observe and compile enough crash data to draw statistically significant conclusions. In the near-term, there are opportunities to track and evaluate non-crash-based measures (e.g., conflicts, speeds, erratic maneuvers, etc.) to provide insights on the potential long-term safety impacts. There is not a direct established link between safety surrogate measures and crashes, but these measures can help to identify potential concerns that could lead to future safety issues. They also provide an opportunity to be more proactive and responsive to safety needs than waiting for several years of crash data.

The Institute of Transportation Engineers (ITE) Manual of Transportation Engineering Studies, 2nd Edition, can serve as a resource for agencies to use in planning and performing non-crash-based evaluations. The manual focuses on "how to conduct" transportation engineering studies in the field, particularly non-crash-based evaluations. While these evaluations are well-suited for certain situations (i.e., proactive projects and projects involving staged countermeasure implementation), they do not replace crash-based evaluations. Surrogate measures such as conflicts, speeds, and violations can serve as means to evaluate intermediate project effectiveness, but the ultimate measure of safety effectiveness should be the change in crash frequency and severity.

Relevance to framework: *Non-crash-based measures can help to refine assumptions in the sequence of events for crash mapping, specifically related to the potential for ADS features to interrupt the sequence of events or create other unanticipated events.*

Track ADS Deployments

Related to the previous two opportunities, there is a need to track and document the details of ADS deployments. Without good records of where, when, and what was implemented, it is very difficult to perform a reliable before-after analysis of any strategy. This may include collecting and documenting performance measures before the ADS deployment, so they are available for future use (e.g., operating speeds, conflicts, traffic volumes, pedestrian and bicycle counts, etc.).

Project tracking follows project deployment from planning through implementation and operations. Project tracking should begin with the planning stage as agencies and operators identify locations for potential deployment. By starting project tracking early in the planning process, agencies can document “pre-deployment” conditions and any performance measures of interest. This will expedite future evaluations.

A common challenge related to deployment tracking is limited time and resources. Many agencies do not have a dedicated staff focused solely on project tracking and evaluations. Instead, project tracking and evaluations become one of many responsibilities for agency staff. To minimize the burden, there is an opportunity to enlist support from partners (e.g., OEMs and technology providers). With the proper guidance and agreements, these stakeholders can help transportation agencies obtain the data needed to support thorough evaluations.

The FHWA HSIP Evaluation Guide can serve as a resource for agencies to use for project tracking. The guide describes general project types and practices to monitor and track individual projects, including the tracking timeline, relevant project data, use of templates, and opportunities to engage stakeholders to support the process.

Relevance to framework*: While deployment tracking does not directly support the framework, it does support evaluations, which will help to refine the assumptions used in the framework.*

Calibrate and Refine Crash Prediction Models

The American Association of State Highway and Transportation Officials (AASHTO) Highway Safety Manual (HSM), 1st Edition, provides a predictive method to estimate the frequency and severity of crashes based on the design and operations of the facility of interest. For existing facilities, the method can incorporate the historical crashes as part of the prediction. While ADS deployments will presumably affect predictions from these predictive methods, the challenge is that these methods were developed based on historical data representing traditional vehicles.

There is a need to calibrate and update these predictive methods over time to reflect a mixed fleet (i.e., one with both ADS-equipped and traditional vehicles). Initially, there is an opportunity to calibrate HSM models over time. It will be important to do so in each State/jurisdiction to account for different penetration rates of ADS. These differences in penetration rates can be due to differences in socioeconomics as well as general adoption and acceptance by public agencies and the public at large.

In the medium- to long-term horizon, there is an opportunity to refine the underlying models in the HSM. At present, it would be difficult to update the predictive methods to reflect different deployment scenarios because there is not yet enough historical data that represents ADS-equipped vehicles in various contexts. These models tend to require multiple years of data for deployments on specific facility types.

The FHWA Safety Performance Function Decision Guide: SPF Calibration vs SPF Development can serve as a resource for agencies to use for model calibration. The FHWA Safety

Performance Function Development Guide: Developing Jurisdiction-Specific SPFs can serve as a resource for agencies to use for model development.

Relevance to framework: *Rather than making assumptions about the general change in safety associated with an ADS deployment scenario, these predictive methods could be used directly to predict crashes. This would support Step 5 (Choose Analysis Methodology) of the framework.*

Understand Relationships between Driver, Vehicle, Roadway, and Technology

There is a wealth of research on the traditional relationships between the driver, vehicle, and roadway but there is a new factor to include in these relationships—ADS. There is a need to expand our current understanding of the traditional relationships using simulation, modeling, visualizations, and case studies, as ADS becomes more prevalent.

Of particular interest are the relationships that could impact safety performance, positively or negatively. For instance, if ADS-equipped vehicles can help to overcome scenarios where drivers do not properly interpret and react to the roadway environment (e.g., reduce speed for a sharp horizontal curve), then this will likely have a positive impact. However, if drivers are more likely to engage in other activities while travelling by ADS-equipped vehicle, this could lead to potential negative impacts in vehicles equipped with Level 3 ADS, especially when the system requests the driver to resume control.

Relevance to framework*: As part of the framework, analysts should develop hypotheses and identify potential crash types that could increase or decrease because of the ADS application deployed. Understanding the fundamental relationships between driver, vehicle, roadway, and technology will help to better refine the hypotheses.*

Conclusion/Summary

The framework guides agencies through the process to assess the impacts of ADS on the future of transportation safety. This process relies on several assumptions related to the expected ADS deployment rate, performance, and ability to influence the sequence of crash contributing events. Given the limited number of ADS deployments and related safety evaluations, there is not an abundance of research to support these assumptions. As such, it is necessary to use the best information available to justify decisions and to document those decisions for future refinement. There are also several opportunities to conduct future research in support of the framework. This research can help to shore up the underlying assumptions to make the framework, and resulting decisions, more reliable.