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Carnegie Mellon University



574 Enhancing Transportation Policy and Planning for Safety

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16. Abstract

The project goal is to influence transport policy to improve safety. It is a continuation of Safety21 policy analysis. We have produced a policy brief with specific recommendations to improve safety for battery electric vehicles. As background for this policy analysis, we have published a literature review on battery electric vehicle safety. We continue to develop a robust empirical justification for the safety benefits of partial automation. We followed up on the previous year's editorial on roadway safety research with an editorial on railroad safety research. We have presented results at professional meetings and involved five students in our research work. We have continued to work with partners to implement the PennSTART testing and training facility for automated vehicles.

17. Key Words

Battery electric vehicle safety; roadway safety research; PennSTART; partial vehicle automation

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1. Introduction: Project Overview

This project builds upon several previous years of research, which has informed policymakers of disruptive transportation technology trends and provided guidance on policies to take advantage of opportunities and mitigate risk. The activity focus switched from mobility to safety research with the initiation of Safety21. The work builds upon relevant research conducted by Safety21.

The project accomplished several tasks:

- Research on safety policy improvements for battery electric vehicles was pursued. Audiences will be USDOT, USDOE and State officials. Safety concerns of interest include battery fires, vehicle sound, and vehicle weight.
- Effectiveness of partial automation as a means to enhance roadway safety has been a continuing focus. Drivers may over-rely on this technology reducing its effectiveness (commonly known as a ‘rebound’ effect). We have focused on empirical results of crash frequencies with and without partial automation to inform our analyses. Our goal is to establish a framework and evidence to encourage partial automation improvements and wider adoption.
- Project participants continued to work with Regional Industrial Development Corporation (RIDC) in the planning for Pennsylvania Safety Transportation and Research Track (PennSTART).
- Project participants engaged in a variety of technology transfer and outreach activities.

Project personnel included:

Chris Hendrickson, Principal Investigator, is the Hamerschlag University Professor Emeritus, Director of the Traffic 21 Institute at Carnegie Mellon University, member of the National Academy of Engineering, and Editor-in-Chief of the ASCE Journal of Transportation Engineering Part A (Systems). His research, teaching, and consulting are in the general area of engineering planning and management, including, transportation systems, design for the environment, construction project management, finance, and computer applications.

Corey Harper, Co-Principal Investigator, is an Assistant Professor at CEE and Heinz School of Information Systems and Public Policy at Carnegie Mellon University. In his role as the director of the Future Mobility Systems Lab, he leads a team of researchers who explore the infrastructure, policy, and safety implications of emerging transportation technologies

(e.g., autonomous vehicles and micromobility). The affordability analysis side of his team applies accessibility metrics to assess how policy and regulation could affect the access to transportation resources and essential services. The modeling and simulation side of his group is focused on incorporating new mobility modes (e.g., micromobility and e-commerce) into regional traffic demand models to promote better long-range planning of the transportation system.

Karen Lightman, Co-Principal Investigator, is Executive Director of Safety21 as well as the Executive Director of Metro21: Smart Cities Institute at CMU. Karen is an internationally recognized leader in building and supporting communities based on emerging technologies. Her diverse background spans the consumer, military, healthcare, manufacturing, and automotive sectors. Karen is ranked by *EETimes* as one of the top 25 “Women in Tech.” She is a passionate advocate and spokesperson for technology solutions to real-world problems and has held several board positions and is currently treasurer on the board of the MetroLab Network. She has a BA from the University of Vermont and a MS in Public Policy and Management from Carnegie Mellon University’s Heinz College.

Several undergraduate and graduate Carnegie Mellon students assisted the primary personnel, including:

- Bright Aungsuthar, MS Student, Engineering
- Lex Capestany, Undergraduate, Engineering
- Sanjeev Naiac, Undergraduate, Engineering
- Jiacheng Wang, PhD Student, Engineering
- Haoming Yang, PhD Student, Engineering

Data Management

This project involved literature review and meetings with transportation stakeholders. No datasets were developed and used in this work.

2. Battery Electric Vehicle Safety Literature Review and Analysis

Media reports regularly express concern about the safety of battery electric vehicles

(BEV). However, there is little comprehensive analysis of the comparative safety of BEV relative to comparable ICE vehicles. This task is intended to: (1) survey existing literature, including relevant regulations and changes in safety risks over time, (2) identify research gaps, and (3) consider appropriate policies to improve the safety of BEVs. It is a continuation of work started in last year's related Safety21 project.

Sales of BEVs have continued to grow in the United States. BEV are now becoming a significant fraction of vehicles on the road. In the interest of promoting roadway safety, the special characteristics of BEV need to be considered in roadway safety policy.

The literature survey taken advantage of database tools such as TRID and Google Scholar. A taxonomy of potential risks has been developed and literature relevant to each risk categorized.

Outputs of the work include a Carnegie Mellon University (CMU) policy brief and two published peer-reviewed paper. The policy brief was produced in cooperation with the Scott Institute for Energy Innovation at CMU. The works are available online.

Harper, Corey, Chris Hendrickson, and Karen Lightman (with the assistance of Sanjeev M. Naiek, Sorawich Aungsuthar and Haoming Yang), 2025, 'Improving Safety for Battery Electric Vehicles,' A Policy Brief, Safety21 and Scott Institute, Carnegie Mellon University. (https://safety21.cmu.edu/wp-content/uploads/2025/02/BEV-Policy-Guide_Feb-2025.pdf)

Harper, Corey, Chris Hendrickson, and Karen Lightman (with the assistance of Sanjeev M. Naiek, Sorawich Aungsuthar and Haoming Yang), 2025, 'Policy Insight- Improving EV Fire Safety,' Safety21, Carnegie Mellon University. (https://safety21.cmu.edu/wp-content/uploads/2025/07/One-Pager_BEV-Safety-Policy_2025.pdf)

Naiek, Sanjeev M., Sorawich Aungsuthar, Corey Harper, and Chris Hendrickson. "Battery Electric Vehicle Safety Issues and Policy: A Review." *World Electric Vehicle Journal* 16, no. 7 (2025): 365. (<https://www.mdpi.com/2032-6653/16/7/365>).

Wang, J., Harper, C. D., & Hendrickson, C. (2026). Changing US electric vehicle owner socioeconomic characteristics. *Transportation Research Interdisciplinary Perspectives*, 35, 101788. <https://www.sciencedirect.com/science/article/pii/S2590198225004671>

3. Partial Automation and Other Technical Publications

A project task has been to continue analysis of the crash experience of partial automation vehicles. Our general conclusion is that partial automation continues to provide substantial net benefits and should be encouraged both to become more widely used and also to improve

the technology. We have provided policy recommendations and peer-reviewed analysis to support these conclusions both this past year and in previous years. Papers produced in this project cycle include:

Jiacheng Wang, Corey D. Harper, Chris Hendrickson, (2026) A hybrid latent class analysis and association rule mining framework to identify injury-related risk patterns in level 2 advanced driver assistance system crashes, *Accident Analysis & Prevention*
<https://doi.org/10.1016/j.aap.2026.108631>.

Wang, J., Harper, C. D., & Hendrickson, C. (2026). Improving our understanding of contributing factors in California level 4 autonomous vehicle crashes through latent class analysis and machine learning-SHAP interpretations. *Journal of Safety Research*, 96, 19-37.

Two other publications from the project relevant to improving safety through improved policy were produced. The first surveys the most important civil and environmental engineering innovations in the past 250 years and features the interstate highway system. Interstate highways are the safest roadways per mile of travel in the United State. The second is an editorial on rail research including safety that follows up on a roadway safety editorial from last year.

National Academy of Engineering, (2026), ‘Major Civil and Environmental Engineering Innovations in the Past 250 Years’ in ‘Engineering America: Celebrating 250 Years of Innovation’, The Bridge, National Academy of Engineering, vol. 56, no. 2.
<https://www.nae.edu/500293/special-issue-summer-2026>.

Hendrickson, C and L Rilett (2026) Railway Research and the Journal of Transportation Engineering Part A Systems’, *Journal of Transportation Engineering, Part A: Systems* 152 (7), 01826001. <https://ascelibrary.org/doi/epdf/10.1061/JTEPBS.TEENG-9806>

4. PennSTART Participation

Project Co-PI Karen Lightman was the primary project contact for PennSTART activities. She actively participated in PennSTART planning committee meetings as described below. The PennSTART facility is currently under construction.

As described on the PennSTART website,¹ ‘Pennsylvania Department of Transportation (PennDOT), the Pennsylvania Turnpike Commission, the Regional Industrial Development Corporation (RIDC) of Southwestern PA, Carnegie Mellon University and Westmoreland

¹ <https://PennSTART.org/>

County are partnering to plan and design the Pennsylvania Safety, Transportation and Research Track, or PennSTART — a state-of-the-art facility envisioned to benefit emergency responders, transportation technology companies, and research institutions while supporting the local economy.

PennSTART's aim is to address safety, training, and research needs in six key areas: traffic incident management (TIM); tolling and intelligent transportation systems (ITS) technology; work zones; commercial vehicles; transit vehicles; and AV and other emerging technologies.

The facility will be built at and adjacent to the RIDC Westmoreland site in Mount Pleasant.'

Prof. Rajkumar serves on the 8-member *PennSTART Operating Committee*, which is the Governing Board for PennSTART. Karen Lightman, Executive Director of Metro21 and Safety21, serves on the *Training Subcommittee* and the *Construction Subcommittee* for PennSTART. These committees meet regularly and actively to operationalize the initial phase of PennSTART. The Construction Subcommittee engaged an engineering firm to manage the design phase of the project in the fall of 2024 and tree clearing took place in spring/early summer 2025. New track construction started in 2024 and broke ground in the fall of 2025 and is expected to be in operation in early 2027.

Organizations that are working with RIDC on PennSTART include PennDOT, Pennsylvania Turnpike Commission (PTC), RIDC, Westmoreland County, and the Westmoreland County Community College.

In collaboration with PennSTART partners RIDC, PennDOT and PTC, the PennSTART project has started to be promoted and socialized. A webpage was launched on the RIDC website. Other activities include Traffic Incident Management (TIM) training – to date there have been fourteen trainings held onsite at PennSTART; six in 2025 and three to-date in 2026.

5. Technology Transfer and Outreach Activities

Project personnel conducted a variety of technology transfer and outreach activities during the course of July 1, 2025 to June 30, 2026. These included:

- November 13, 2025 – Safety21 Deployment Partners Consortium Symposium, all Project participants, electric vehicle safety and policy briefs posters, Number 200
- January 13, 2026 – Transportation Research Board Annual Meeting, Wang, Harper and Hendrickson, poster 3067 Improving our understanding of contributing factors

in California level 4 autonomous vehicle crashes through latent class analysis and machine learning-SHAP interpretations. Number 12,000

- March 19, 2026 – Washington DC National Safety Summit of USDOT UTCs, organized by CMU – Hendrickson and Lightman, policy briefs poster, Number 200
- June 28, 2026 – Detroit American Society of Civil Engineers Transportation & Development Institute conference – Hendrickson, panel presentation on professional service opportunities, Number 80

Appendices