Measure to Protect:

Evaluating the Impact of Vulnerable Road User Safety Deployments

Panasonic

Table of Contents

Measure to Protect:

Evaluating the Impact of Vulnerable Road User Safety Deployments

Each year, pedestrians and cyclists face fatal risks on our roadways, but history shows that technology can play a pivotal role in making streets safer and saving lives. Panasonic's Smart Mobility Office (SMO) is committed to advancing solutions in this space, drawing on deep experience in applying technology to reduce transportation-related harm.

One such effort focuses on protecting vulnerable road users (VRUs) by detecting their presence and delivering real-time warnings to drivers, prompting greater caution and behavior change where it matters most. What's more, at the core of this technology is data—data that not only makes the system function but allows our team to report on system impact from dual angles: system performance and efficacy.

Take a journey with us to explore how SMO advances both deployment and accountability in road safety innovation through real-world pilots, data-driven insights, and a repeatable framework for measuring value.

Roadway Risk: State of Affairs

Approximately 1.19 million people die each year in road traffic crashes, and more than half of those fatalities (53%) involve vulnerable road users (VRUs)[1]. In transportation safety contexts, VRUs typically include individuals walking, biking, or using mobility devices who face heightened risk in traffic due to the absence of external protection[2].

Industry professionals committed to improving roadway safety use a range of tools to reduce risk for VRUs. One such tool helps identify safety risks at the individual roadway segment level, enabling more targeted and effective interventions. For example, the International Road Assessment Programme (iRAP) developed a road safety scoring system that rates paved roads on a scale from 1 (very high risk) to 5 (very safe). These ratings reflect the relative safety risk to road users based on the presence, or absence, of key design and traffic control features across both roadways and intersections[3].

Globally, the results are concerning. Only about 20% of assessed roads meet the minimum 3-star safety standard for pedestrians or cyclists, meaning nearly 80% fall short[4]. Closer to home, road segments evaluated through the U.S. Road Assessment Program (usRAP) have revealed similarly low ratings, particularly for non-motorists[5]. In Utah, for instance, several locations received just 1- or 2-star scores for pedestrian and cyclist safety, underscoring that these risks are not limited to lower-income or developing nations but that they exist domestically as well.

[1] World Health Organization. (2023). Global status report on road safety 2023 (ISBN 978-92-4-008651-7). Geneva: World Health Organization. https://www.who.int/publications/i/item/9789240086517

[1] Federal Highway Administration. (2023). Vulnerable road user research plan (FHWA-HRT-23-050). U.S. Department of Transportation. https://highways.dot.gov/sites/fhwa.dot.gov/files/FHWA-Vulnerable-Road-User.pdf

[3] International Road Assessment Programme. (n.d.). Star Ratings: Infrastructure ratings. iRAP. Retrieved July 18, 2024, from https://irap.org/rap-tools/infrastructure-ratings/star-ratings/

[4] World Health Organization. (2023). Global status report on road safety 2023 (ISBN 978-92-4-008651-7). Geneva: World Health Organization. https://www.who.int/publications/i/item/9789240086517

[5] Roadway Safety Foundation. (n.d.). What is usRAP? Retrieved July 15, 2024, from https://www.usrap.org/what-usrap

Approximately **1.19 million** people die each year in road traffic crashes, and more than half of those fatalities involve vulnerable road users.

Using Technology to Mitigate Roadway Risk

What makes roadways low performing in terms of safety? Key contributors likely include high traffic speeds, unsafe roadway design, and the absence of dedicated pedestrian infrastructure. Other contextual factors that increase the risk of crashes involving VRUs include drivers failing to yield to the right of way, distracted driving, and poor visibility caused by inadequate lighting or obstructed sightlines.

Roadway traffic professionals have instituted programs and countermeasures to positively impact road safety ratings, like the road safety scoring system mentioned above. Panasonic is also leaving a mark, works in partnership with influential players to be a part of the change in improving roadway risk.

What Technology Can Help?

With VRU safety as the focus, the question becomes: which technologies are best positioned to make a meaningful impact? Several options exist, each offering unique capabilities depending on the context and desired outcome. Optical cameras, radar, and thermal technology can provide greater roadway situational awareness depending on the desired application and outcome. As it pertains to protecting VRUs, LiDAR and V2X in addition to the technologies listed above add significant and distinct value.

LiDAR is a sensor-based technology that aims to detect object positioning accurately and with low latency. V2X adds a critical layer of communication and data sharing, enabling faster and broader alerts to roadway users about potential hazards. Coupling LiDAR with V2X has its benefits, and, as we will discuss, SMO is experienced in deploying infrastructure that utilizes both technologies to protect VRUs.

Process-Critical Data

Of course, even the best technology is only as effective as the data it produces and how that data is used. That brings us to a foundational element of our approach: data.

A key takeaway so far is that technology matters. But more importantly, for any end-to-end system built to detect, alert, and protect, the data produced by that technology is what makes accountability possible. This data not only fuels features that enhance roadway situational awareness; it also provides the foundation to quantitatively measure value. That dual function—enabling action and proving impact—is what transforms deployment into responsibility.

Pilot Deployment to Protect VRUs

To illustrate how this technology and data come together in practice, we turn to a real-world pilot focused on VRU protection.

In partnership with the Utah Department of Transportation, Panasonic deployed two operational traffic intersections. In Provo, Utah, a combination of LiDAR sensors and V2X technology are used to detect and warn drivers of potential collision hazards involving VRUs. Additional features in progress include roadside signage and in-vehicle alerting capabilities to provide real-time warnings to individuals within a risk zone. The goal of this deployment is to enhance safety by 1) identifying actual or potential conflicts between VRUs and vehicles, and 2) alerting at-risk travelers of possible collisions.

Site selection can vary based on project needs. For UDOT, important criteria included pre-installed technology and suitable equipment to enable additional hardware mounting; the location featuring a signalized intersection with crosswalks and high pedestrian traffic; and the site to be deemed high-risk for VRUs as per internal safety assessment reports and custom quantitative analyses.

Project needs should dictate site selection. In the event your team does not have access to such tools to indicate where a VRU deployment might be optimal, then alternative resources like the usRAP and iRAP safety indices for roadway segments as discussed above may suit you well.

For any end-to-end system built to **detect**, **alert**, and **protect**, the data produced by that technology is what makes accountability possible.

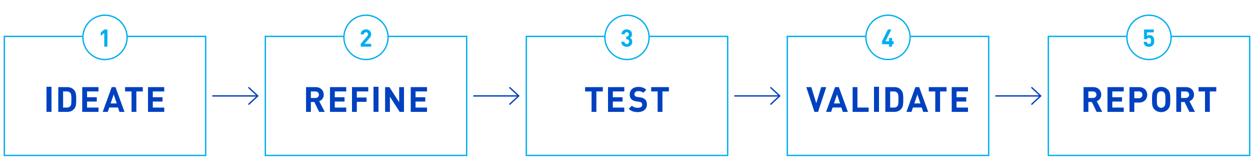
Turning Data into Measurement

Having outlined the technology and pilot deployment, we now focus on how the data generated is used to assess system performance and measure value. This step is critical to turning a technical deployment into a safety intervention with accountable outcomes.

In this deployment, a range of standardized data messages is produced, including details on sensor locations and how they map to physical risk zones, object characteristics such as velocity, size, and position, and system diagnostics that reflect operational health. By making these data streams accessible and actionable, the team moves from raw input to structured insight, applying information systematically to drive measurable safety outcomes.

Approach

To do this consistently across deployments, we follow a structured approach designed to guide measurement, refinement, and validation. When thinking about how to measure value using data, our approach is intentionally methodical. It is designed to support early action, frequent refinement, and rapid learning. At a high level, our team follows a five-stage process:



While each step builds on the last, the process is not strictly linear. Iteration is expected, especially when testing uncovers gaps or misalignment. Let's walk through each stage to share what it means in practice and the key questions we ask ourselves along the way.

1. IDEATE

In this stage, we **define the problem** and **identify the right direction**.

- What are the project's goals?
- How might industry benchmarks or best practices guide our approach?
- Which metrics would meaningfully indicate success?
- Do we have access to the data needed to support these metrics?

2. REFINE

This is where we **align as a team** and **build measurement logic**.

- Are we aligned on the next steps and scope of work?
- What exact data sources and data elements will be used?
- Have we defined how each metric will be calculated?
- What might sample code or logic look like?

3. TEST

We **prototype our approach** using real or sample data.

- Can our code generate the metrics needed?
- Do we have sufficient data coverage for the calculations?
- Are the outputs accurate and complete?

4. VALIDATE

Here, we **ensure the results hold up under realistic conditions**. This may involve a walk test, drive test, or scenario simulation.

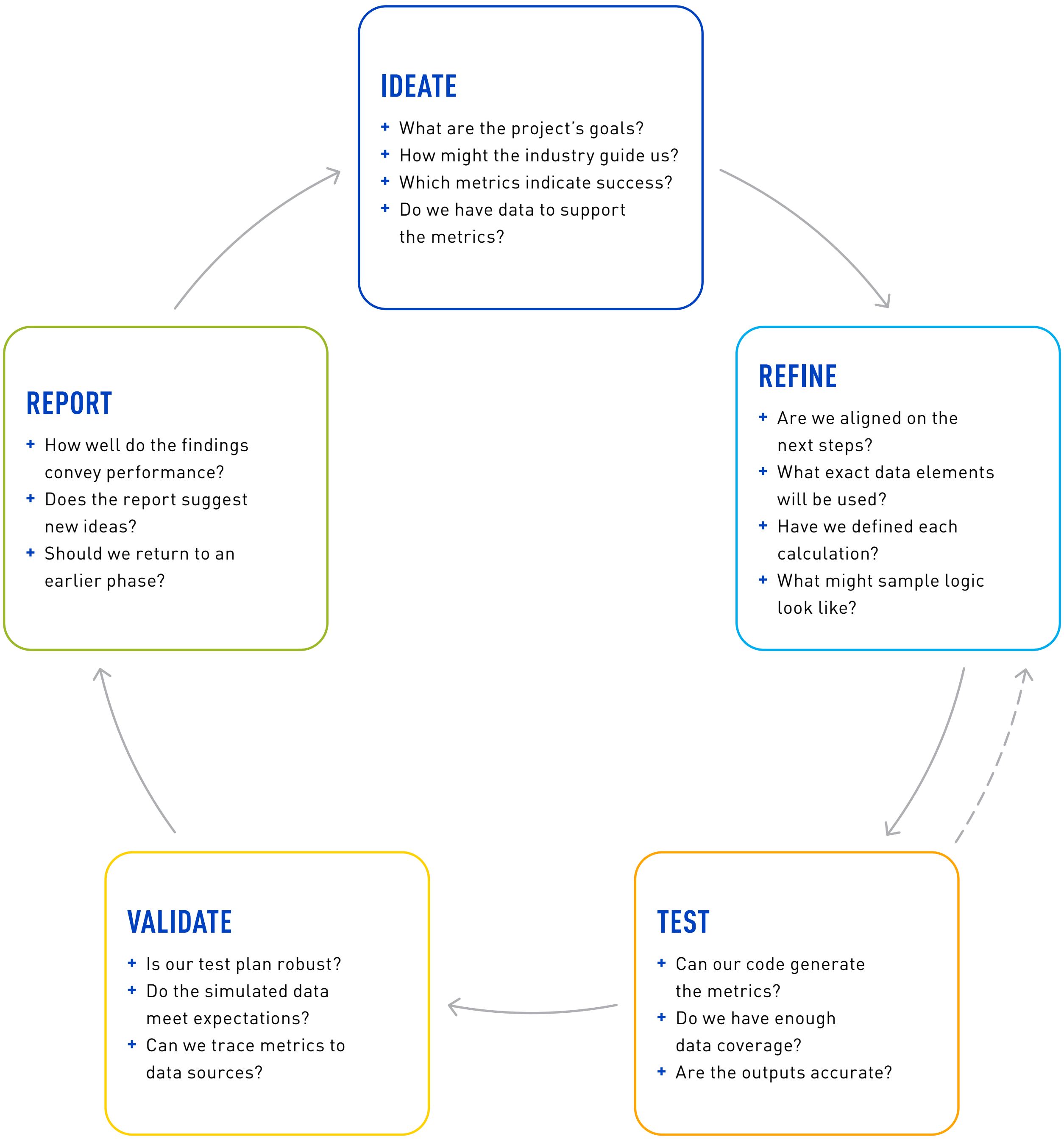
- Is our test plan robust and executable?
- Does the data generated from simulation match expectations?
- Can we confidently trace metrics back to source data?

5. REPORT

Finally, we **communicate what we've learned**. This includes early reporting to drive iteration and deeper reporting for insights.

- How well do the findings convey performance or impact?
- Does the report highlight any new ideas for refinement?
- Should we return to an earlier phase?

As mentioned earlier, while the process is structured, it is rarely linear. Testing often reveals issues that lead us back to refinement or even to a complete reframe in ideation. Collaboration and iteration are embedded in every step.



Key Metrics

Now that you've seen the process, let's turn to **how we measure value**. The team's core metrics fall into two key categories: system performance and efficacy. Each provides a different lens to evaluate the impact of a VRU deployment.

SYSTEM PERFORMANCE	EFFICACY
System performance metrics help us determine whether the **technology is functioning** as intended and **meeting operational expectations**.	Efficacy metrics help us understand whether the system is **influencing behavior** and **reducing risk for vulnerable road users**. While saving a life is the goal, that is difficult to isolate and measure in the short term. Instead, we focus on proxy indicators that reflect meaningful progress toward that goal.
For this deployment, **key metrics** include: + Ratio of objects identified: A measure of sensor accuracy and coverage. + Alert broadcast latency: The time it takes for the system to communicate potential risks. + Number of alerts generated: An indicator of both system sensitivity and activity within the risk zone.	**Proxy indicators** include: + Vehicle proximity to VRU: Helps determine the degree of spatial risk. + Driver receiving an alert within six seconds: Measures the timeliness of interventions. + Probability of a vehicle-VRU near miss: Indicates whether the system is helping prevent potential collisions.
Together, these metrics ensure the **system is operating reliably** and delivering **timely**, **relevant information** that **supports safety outcomes**.	Tracking these indicators allows us to demonstrate both the **social value** and **financial return** of VRU-focused safety interventions.

By making data streams accessible and actionable, teams move from raw input to structured insight, applying information systematically to drive **measurable safety outcomes**.

Why Does VRU Deployment Matter?

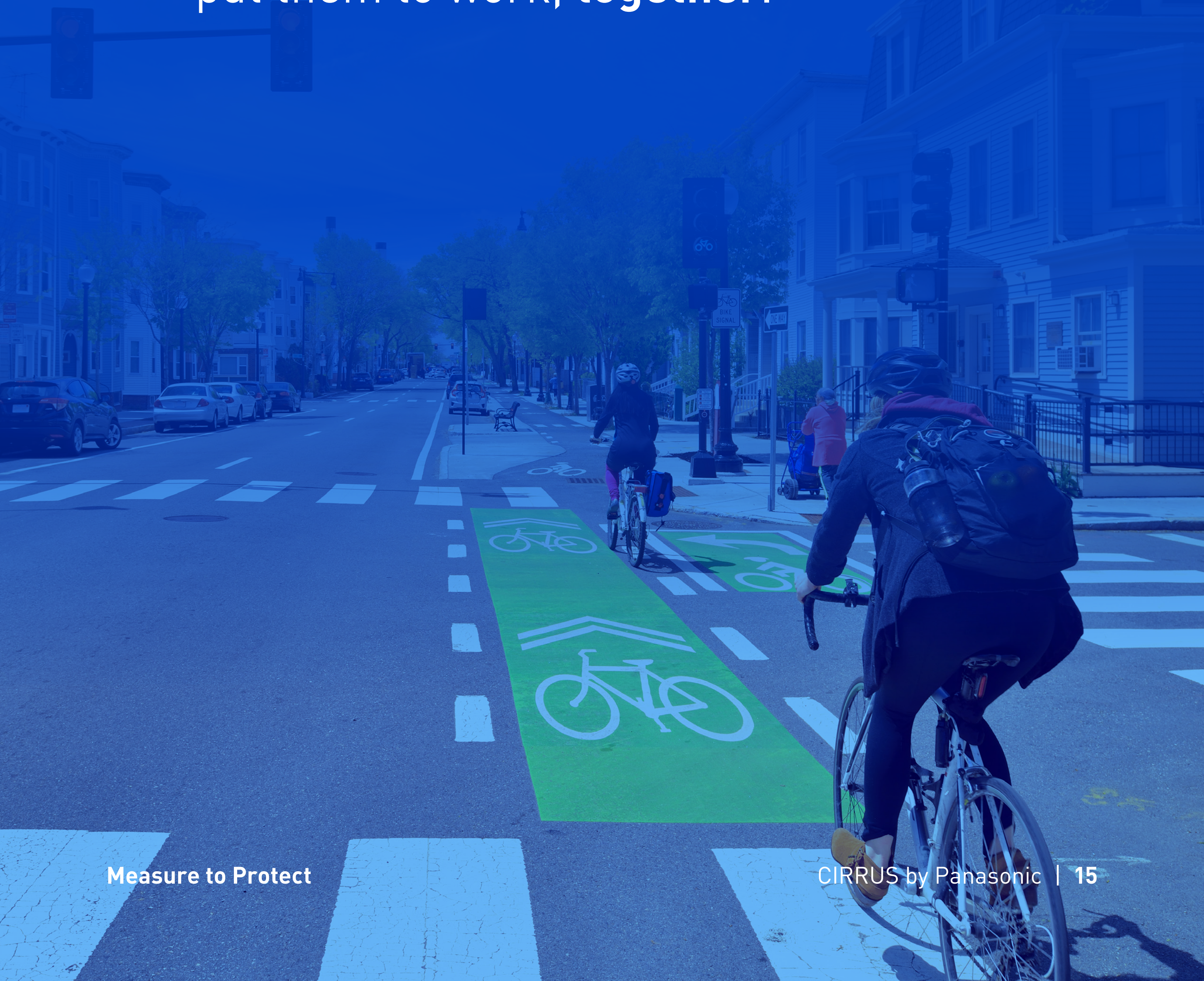
The deployment stages, paired with clear metrics, help us evaluate value in a way that is both structured and flexible. But a framework alone is not enough. Real impact depends on thoughtful application, grounded in local context and tied to real-world outcomes.

Why does this matter? Because even the most advanced deployments must contend with persistent, systemic risks on our roadways. VRUs continue to face disproportionate danger, especially in areas lacking low-speed design, visibility, or dedicated infrastructure. These risks, shaped by design gaps and driving behavior, are not easily solved through policy or enforcement alone. Technology offers a path forward, but only when deployed with a clear understanding of local risk and supported by measurable outcomes. This underscores the need for data-driven, context-aware strategies that treat VRU safety as a priority, not an afterthought. When we understand the reasons behind risk, we can focus resources where they matter most.

How Can a VRU Deployment Help You?

Technology can make a measurable difference, especially when paired with intentional design and data-driven accountability. Each deployment generates data, and with it, the opportunity to monitor, measure, and improve. We have shared our approach to building and evaluating these systems and invite others to adapt it to their unique goals. At the end of the day, the mission is simple but urgent: make roadways safer and save lives. The tools are available. The frameworks are proven. It is time to put them to work, together.

Make roadways safer and save lives. The tools are available. The frameworks are proven. It is time to put them to work, **together**.



About CIRRUS by Panasonic

CIRRUS by Panasonic is a division of the Panasonic Corporation of North America's Smart Mobility Office. Formed in 2017, our connected vehicle applications are among the first to shift signal priority applications from legacy hardware units to cloud technology.

The CIRRUS platform enables instant and safe communication between vehicles, infrastructure, intersections, and the operations teams who manage them. Our optimized, patent-pending algorithms incorporate data from edge devices, external systems, and cloud products for a scalable, complete, end-to-end solution.

Learn more a **https://mobility.na.panasonic.com/CIRRUS**.

About the Authors

Renee Philipp, Ph.D.

As the Manager of Research for CIRRUS by Panasonic, Renee leads measurement strategy, product evaluation, and data-informed storytelling to support connected mobility solutions. With 15+ years of experience across transportation, energy, government, and public safety, she has deep expertise in transforming data into insights that shape policy, technology adoption, and strategic planning. Her work spans statistical evaluations that influenced public programs, customer research that guided product innovation, and performance frameworks that enhanced operational decision-making. A recognized voice in applied research and human-centered analytics, Renee has presented original work to global audiences, including at ITS World Congress. She holds a B.S. in Psychology and a B.A. in Spanish from Oklahoma State University, and earned both an M.A. and Ph.D. in Sociology with a focus on quantitative research methods from the University of Oklahoma.

Grace Mirabito, Ph.D.

As a Senior Quantitative Researcher for CIRRUS by Panasonic, Grace leads efforts to define and measure outcomes in the connected vehicle and smart mobility sectors. With over eight years of experience across public health, psychology, and transportation, she specializes in translating complex data into actionable insights. Her work has informed health outcomes, guided product innovation, shaped public policy, and supported the development and improvement of evidence-based programs. Grace holds a B.S. in Neuroscience from Georgia State University and both an M.S. and Ph.D. in Psychology—with a concentration in cognitive aging and quantitative analysis—from the Georgia Institute of Technology.