

Work Zone Inspection Review

Final Report

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16. Abstract Work zone inspection reviews are a proven safety practice for ensuring the proper maintenance of temporary traffic control devices, yet they are substantially constrained by staffing shortages and labor-intensive manual processes. This study evaluates the potential of crowdsourced dashcam imagery and AI to augment traditional workflows through passive data collection and automated analysis. The research combined a nationwide survey of 38 state DOTs, literature review, and in-depth interviews with four technology vendors (Vizzion, Iteris, Blyncsy, and ViaSight) and three state DOT programs. Results indicate that 78.9% of responding agencies maintain formal inspection programs, yet 93.3% rely entirely on manual review processes, with nearly half reporting capacity limitations due to staffing and resource constraints. Notably, no state DOT has incorporated crowdsourced dashcam imagery and AI into inspection workflows to date. This study identified only two AI-powered tools currently capable of supporting work zone inspection and evaluated three crowdsourced imagery approaches across cost, coverage, and usability. Findings suggest that crowdsourced dashcam imagery represents a viable near-term solution for enabling remote, virtual inspections, offering measurable value while introducing tradeoffs in cost and operational effort. In contrast, AI-based tools require substantial advancement before they can support meaningful deployment in practice. To accelerate progress, state DOTs should prioritize sharing domain knowledge and open-source datasets, actively participate in technology pilot programs, and pursue collaborative pooled-fund research initiatives to develop validated, standards-based inspection tools. Finally, this study identifies 12 best practices synthesized from participating state DOTs that can strengthen work zone inspection review programs.			
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Executive Summary

Work zone inspection reviews are a proven practice for improving work zone safety by ensuring the consistent and correct application of temporary traffic control (TTC) devices. However, their effectiveness is increasingly constrained by staffing shortages and the time-intensive nature of manual processes. High turnover rates and the “silver tsunami”—the record number of baby boomers reaching retirement age—have shifted field crews toward less experienced workers, raising the likelihood that TTC devices will be installed or maintained improperly. At the same time, federal and state infrastructure investments are driving a growing volume of work zones with greater project complexity, placing pressure on state departments of transportation (DOTs) to maintain the quality, timeliness, and coverage of inspection activities. The 2024 federal code revisions mandating data-driven work zone safety management further underscore the urgency of modernized approaches. This study evaluates how crowdsourced dashcam imagery and artificial intelligence (AI) can augment traditional inspection workflows through passive data collection and automated analysis.

Study Objectives and Research Approach

The objectives of this research project were to assess the current state of work zone inspection review practices nationwide, evaluate the readiness of commercial crowdsourced data and AI technologies for inspection applications, identify best practices from state DOT programs, and develop recommendations for technology adoption and future research. The research was conducted through three methods: a comprehensive literature review of commercial technologies and academic research; a nationwide survey of state DOTs; and in-depth interviews with technology vendors (Vizzion, Iteris, Blynscy, and ViaSight) and state DOTs with established inspection programs (Montana, Oklahoma, and Virginia).

Current State of Practice

The nationwide survey received responses from 38 state DOTs and revealed that work zone inspection reviews are widely adopted, with 78.9% of responding agencies maintaining a formal program. However, current practices remain overwhelmingly manual and resource-intensive. Nearly all agencies (93.3%) conduct fully manual reviews, and 40% require more than one week to complete analysis and documentation after field visits. Nearly half of the agencies with formal programs reported that capacity is constrained by ongoing staffing and resource shortages (43.3%) and logistical challenges (36.7%). Technology adoption remains in an early phase: only two agencies reported any experience with crowdsourced video data or AI-enabled analytics for inspection applications, and none reported successful implementation. Several agencies have achieved positive results using commercial platforms and in-house systems for data entry, organization, and visualization, but these represent incremental

improvements rather than transformative change.

The survey identified two priorities widely recognized by agencies as transformative. The first is the adoption of AI-enabled workflows to automate deficiency detection, combined with geotagging, traffic control plan comparison, and report generation. The second is improved data integration to link inspection outputs with other work zone data and to facilitate more efficient, multi-stakeholder review processes. Together, these priorities reflect a shift toward integrated, technology-driven systems that support proactive work zone management without requiring additional staffing.

Commercial Technology Assessment

The literature review and vendor interviews evaluated six providers of crowdsourced dashcam data and AI-based analysis: Nexar, Vizzion, Blynscsy, Mapillary, Iteris, and ViaSight. These platforms show potential to enable passive work zone data collection and automate the detection, inventory, and mapping of TTC devices.

Three approaches for utilizing crowdsourced dashcam imagery were evaluated in detail:

- *Vizzion*, a primary data provider, offers one of the most affordable options, with pricing starting at \$3,250 per month. It supports frequent, on-demand imagery retrieval within a 10-day window and provides strong coverage on Wisconsin's high-volume interstates and major arterials (approximately 75% of imagery at 720p resolution and 25% at 1080p). However, access is API-only, which creates a technical barrier requiring programming expertise and ongoing operational support.
- *Iteris* integrates Vizzion's imagery into its ClearGuide traffic analytics platform, providing a user-friendly, map-based interface that overlays dashcam imagery with traffic performance data and eliminates the need for programming expertise. This enhanced accessibility comes at a substantially higher cost—for example, approximately \$250,000–\$300,000 annually for WisDOT (\$100,000–\$150,000 for the software base subscription plus \$150,000 for the add-on dashcam imagery). The platform's unlimited user access model, with no per-seat licensing fees, does create opportunities for cost sharing across multiple divisions within a DOT.
- *Blynscsy* aggregates dashcam imagery from multiple vendors and applies AI-based detection, offering the broadest data coverage and highest imagery quality potential. However, its cost structure renders routine imagery retrieval impractical (image collection: \$8.00 per mile; detection services: \$0.25 per mile per detection type). For example, monitoring 20 active 5-mile

work zones on a weekly basis would exceed \$88,400 annually, while a single statewide snapshot across 11,800 miles of WisDOT-administered highways would cost approximately \$188,800.

A market scan identified only two AI-powered programs with capabilities applicable to work zone inspection reviews: Blynscsy and ViaSight. It should be noted that the capabilities described below are based on vendor-reported information; no independent evaluation or validation of detection accuracy was conducted as part of this study.

- *Blynscsy*'s computer vision models detect the presence and location of channelizing devices, signs, concrete barriers, and pavement markings, with condition assessments available for signs and pavement markings. However, it cannot perform dimensional measurements due to depth-perception constraints inherent in monocular dashcam footage, and arrow boards cannot be reliably assessed due to refresh rate synchronization issues. Turnaround time from request to results depends primarily on the availability of crowdsourced data; for rural roadway inspections, this may exceed one week. Requests and results are exchanged via email.
- *ViaSight* offers a smartphone-based, drive-through workflow in which inspectors record video and receive automated reports typically within ten minutes through an interactive web-based dashboard. Its AI detects the presence, location, and condition of channelizing devices, signs, and pavement markings, and the platform currently supports measurement of lane widths and device spacing (relying on GPS coordinates that achieve approximately three- to five-meter accuracy). Planned enhancements include precise geolocation, MUTCD compliance analysis and automated comparison against traffic control plans. *ViaSight*'s current offerings demonstrate broader AI capabilities than *Blynscsy*, though at a slightly higher per-mile cost (\$10.00 versus \$8.50). Notably, its Tier 1 subscription at \$2.00 per mile provides video recording, three-year cloud storage, and a map-based dashboard, offering a low-cost option for agencies seeking to organize and archive inspection video data. However, compared with *Blynscsy*, *ViaSight* remains an early-stage product with no independently validated accuracy metrics as of March 2026.

Academic Research Findings

The literature review found that academic research largely aligns with the commercial landscape but reveals emerging potential. AI models demonstrate high accuracy in detecting and mapping common work zone elements, yet no end-to-end automated inspection solution exists. Vision-language models and multimodal data fusion show promise for complex spatial and contextual analysis but remain at proof-of-concept stages. Academic attention to work zone inspection reviews specifically remains extremely

limited, with few if any studies focusing on this critical safety practice despite its widespread adoption by state agencies.

Best Practices

Based on interviews with state DOTs operating established programs, the study identified 12 best practices organized into four categories.

- *Data Collection:* Emphasize relationship-building during field reviews, participate in emerging technology pilots, incorporate unmanned aircraft systems for aerial assessment and dimensional measurement, and adopt centralized digital inspection platforms such as Esri Survey123.
- *Data Analysis:* Implement quantitative scoring systems to benchmark performance, integrate qualitative analysis to connect trends to root causes, and conduct post-visit video review to identify details not readily apparent during field visits.
- *Reporting and Communication:* Adopt dynamic visual formats such as Esri StoryMaps, use annotated reporting with color-coded plan references, and automate stakeholder notifications.
- *Continuous Improvement:* Frame inspections as safety improvement tools that demonstrably connect field observations to policy changes, and leverage inspection reviews as structured training and mentorship opportunities to address workforce turnover and diminishing institutional knowledge.

Conclusions and Recommendations

No state DOT has yet incorporated crowdsourced imagery or AI-driven analysis into routine inspection processes. The technology landscape is evolving rapidly, but significant gaps remain between what is commercially available and what is needed for comprehensive, standards-based work zone inspection. The study offers the following implementable recommendations.

For near-term adoption, the most viable option is Iteris ClearGuide, which provides access to crowdsourced dashcam imagery through a map-based interface alongside integrated traffic performance data, enabling remote virtual inspections. However, the substantial subscription cost requires clear return-on-investment justification, particularly for state DOTs that do not already maintain a base ClearGuide subscription. Blyncsy's AI capabilities remain limited in scope, best serving as a supplemental tool for periodic assessment of specific items on selected work zones rather than as a replacement for existing inspection processes. ViaSight warrants continued monitoring as its capabilities mature.

For the research community and technology vendors, key research and development gaps include methods for extracting dimensional measurements from imagery, nighttime retroreflectivity assessment, AI systems that incorporate contextual understanding and engineering judgment, improved detection performance and robustness under adverse field conditions and when processing low-resolution imagery, and system-level integration capabilities such as automated plan comparison and seamless dashcam data integration.

State DOTs and transportation agencies are uniquely positioned to shape the direction of AI development for work zone inspection reviews. Agencies possess deep domain knowledge—such as the relative criticality of different inspection items and the nuanced criteria inspectors apply in the field—that technology vendors and researchers need to build truly effective tools. By making this knowledge publicly accessible, agencies can accelerate innovation toward the highest-value applications. Specifically, the study recommends that agencies provide consensus-based guidance on inspection-item prioritization, based on safety criticality, frequency of deficiencies, and difficulty of manual assessment, to direct AI development toward areas of greatest need. Agencies should also establish clear assessment expectations and benchmarking criteria for high-priority items and share open-source datasets to accelerate model development.

The study recommends that state DOTs consider a multi-state pooled-fund study or NCHRP effort to support the development of open-source AI tools for work zone inspection. Given the limited competition in this emerging field, collaborative investment could yield practical solutions while stimulating market competition and improving the cost–benefit calculus for agencies. Academic involvement is particularly valuable in this regard, as it emphasizes rigorous solution validation and transparency, supporting reproducibility and long-term knowledge growth in a field where independent benchmarking is currently lacking.

Finally, workforce development deserves sustained attention. Agencies face compounding challenges of growing work zone volumes, rising project complexity, high staff turnover, and diminishing institutional knowledge—factors that together threaten the long-term effectiveness of inspection programs. Future research should explore sustainable workforce models, such as technology-assisted training and mentorship frameworks, that help agencies maintain inspection quality and institutional continuity amid these pressures.

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Technical Report

1. Background

Work zone safety depends on the consistent and correct application of TTC devices. State departments of transportation (DOTs) routinely conduct work zone inspection reviews — structured evaluations in which agency personnel visit active work zones, assess compliance with traffic control standards, and document their findings on standardized forms [1]. These reviews are guided by the Manual on Uniform Traffic Control Devices (MUTCD), the Quality Guidelines for Temporary Traffic Control Devices and Features, and related agency-specific guidance. When deficiencies are identified, corrective action is initiated promptly, and aggregated inspection data are analyzed over time to detect recurring issues and inform updates to standards, policies, and training programs [2].

Work zone inspection reviews serve an important regulatory function. Federal provisions under 23 CFR 630.1110 require each state to maintain a level of inspection sufficient to ensure that TTC devices meet established quality guidelines. Additionally, 23 CFR 630.1008(e) directs states to assess and monitor work zone safety and mobility performance through a data-driven approach, and inspection review results frequently serve as evidence of compliance in programmatic reviews. (Note: Following 2024 regulatory revisions, Process Review has been formally replaced by Programmatic Review to emphasize a more systemic, comprehensive approach.)

Unlike inspections conducted by field engineers or construction contractors, these reviews are often carried out by the same agency personnel who are involved in developing work zone standards and policy. Work zone inspection reviews give them direct insight into how standards are interpreted and applied across varied field conditions. This makes the reviews especially effective at identifying systemic deficiencies that can be addressed through broader policy and specification changes.

Despite their value, current inspection review processes at many agencies remain labor-intensive. At the Wisconsin Department of Transportation (WisDOT), for example, staff drive to work zones, record conditions using a GoPro camera, later review the video footage, and manually enter ratings into a database for each traffic control device and attribute. Deficiencies are then communicated to regional engineers, and the collected data are queried to identify trends for standards development and training. The current workflow remains fully manual, constraining the number of inspections that can be conducted each year and introducing variability when different reviewers assign inconsistent ratings to identical conditions. There is a need to integrate emerging technologies, such as crowdsourced data collection and automated video analysis, to enhance the efficiency, consistency, and scalability of the inspection process.

2. Research Objectives

The objectives of this research are to:

- Document current work zone inspection review practices across state DOTs to understand the range of approaches, tools, and procedures in use nationwide.
- Identify technologies and platforms that enable the collection of work zone video footage through crowdsourcing methods.
- Evaluate artificial intelligence (AI) technologies capable of analyzing work zone video footage to detect deficiencies in temporary traffic control.

This report is organized into the following sections:

- Chapter 3 presents a literature and market review examining how work zone inspection reviews are currently conducted at state DOTs and assessing how emerging innovations in crowdsourced data collection and AI could improve these processes.
- Chapter 4 describes the findings of a nationwide survey of 38 state DOTs, documenting current practices, tools, and procedures related to work zone inspection reviews.
- Chapter 5 summarizes interviews conducted with four technology vendors, focusing on the technical capabilities, limitations, and implementation considerations associated with applying crowdsourced data and AI to work zone inspection workflows.
- Chapter 6 presents case studies of three state DOTs selected for their experiences adopting technology-driven approaches
- The report concludes with a synthesis of best practices and actionable recommendations for agencies seeking to modernize their work zone inspection review processes.

3. Literature Review

This literature review draws on agency reports, vendor materials, and peer-reviewed studies published in the past decade (2016–2025) to describe current work zone inspection review practices at state DOTs and to assess how crowdsourced data and AI could improve these processes. The review is organized into three subsections covering the state of the practice, the commercial technology landscape, and the academic state of the art.

3.1 Overview of Work Zone Inspection Reviews

In 2021, the FHWA conducted case studies of state DOT work zone process review processes, including detailed analyses and recommendations for work zone inspection reviews [3–5]. Best practices identified through this work can be summarized into three areas. The first is representative sampling, which

involves selecting samples that are large and diverse enough to capture a meaningful cross-section of conditions. The second is the use of quantitative scoring systems, which convert inspection findings into formal scores that can be used to benchmark performance, track progress objectively, and visualize improvement over time. The third is integrated qualitative analysis: while aggregated scores provide a high-level view of performance, qualitative documentation such as field notes and interviews offers deeper insight into why deficiencies occur to inform targeted improvements.

The benefits of work zone inspection reviews are well documented. The Oregon DOT provides a notable example. In its 2019 and 2021 work zone Reviews [6,7], the agency repeatedly identified flagger performance as the lowest-scoring category. After attributing this result to issues inherent in manual flagging, Oregon DOT undertook a series of actions to adopt Automated Flagger Assistance Devices (AFADs). The impact of this data-driven change was confirmed in the agency's 2023 review, which reported that flagger performance showed the largest quality improvement of any evaluated category. This example illustrates how work zone inspection reviews can function as leading indicators, enabling program-wide corrections before adverse outcomes arise. Beyond early detection, these reviews also serve as validation tools by quantitatively demonstrating the impacts of policy changes.

Despite the recognized value of work zone inspection reviews, state DOTs reported several obstacles that limit practical implementation:

- **Resource constraints.** Persistent staff shortages and limited funding restrict program capacity [5,8–10].
- **Process inefficiency.** Current workflows remain labor-intensive and administratively burdensome. Manual steps (coordinating field visits, site travel, and data organization) divert skilled engineers from higher-value task of interpreting findings to drive systemic improvement.
- **Growing number of work zones.** Agencies face a sharp rise in work zones requiring review, driven by the Infrastructure Investment and Jobs Act (IIJA) and state revenues [11].
- **Increasing work zone complexity.** Project complexity is rising, reflected in more extensive inspection checklists and the need to evaluate evolving elements such as smart work zone technologies [12].

Collectively, these pressures are expanding the scope of work zone inspection reviews beyond what current agency resources can support, creating an urgent need for technology modernization to streamline workflows and improve efficiency.

3.2 Market Reviews of Existing Technologies

This market review focuses on two categories of technologies: crowdsourced dashcam video collection, which offers a passive way to gather work zone data with broad geographic coverage, and AI-based analysis tools, which can automate deficiency detection and improve consistency. Researchers identified five relevant vendors: Nexar, Vizzion, Blynscy, Mapillary, and Iteris.

3.2.1 *Nexar*

Nexar is a technology company that provides road imagery and telemetry from a network of consumer dashcams. As of late 2022, the company reported that its network captured more than 200 million miles of driving per month. Nexar data can be accessed through CityStream, a web-based platform that provides near-real-time, ground-level views of roadway infrastructure, or through an application programming interface (API) that allows programmatic queries by address, date, camera heading, and change-over-time parameters for integration with enterprise systems. CityStream's built-in AI capabilities relevant to work zones include automated detection and mapping of work zone segments and individual traffic control elements, as well as the creation of inventories and mapping of road signs and traffic lights with the ability to review current and historical imagery, as documented in a Texas A&M Transportation Institute study [13]. Several applications illustrate Nexar's use in transportation contexts. A 2021 peer-reviewed study used 6,326 Nexar images to train deep-learning models for detecting pavement distresses, concluding that crowdsourced dashcam imagery offers a cost-effective monitoring approach for transportation agencies [14]. The Nevada DOT partnered with Nexar in 2017 to create a statewide vehicle-to-vehicle network by installing the app on state vehicles for roadway hazard detection, though results have not been publicly disclosed. Similarly, the Ohio DOT initiated a project with Nexar in 2021 along the US 33 Smart Mobility Corridor to identify and monitor work zones with lane closures and digitally map road signs, with results also not publicly disclosed.

3.2.2 *Vizzion*

Vizzion is a data company that collects, enhances, and distributes roadway imagery and associated data. Its network integrates stationary roadside traffic cameras with on-vehicle cameras. The on-vehicle camera network transmits data packets to Vizzion's servers approximately every 15 seconds; each packet includes GPS coordinates, heading, speed, a timestamp, and an anonymized vehicle identifier. Data can be accessed through a Desktop Video Wall, a standalone Windows application providing real-time image snapshots, live video streams, and advanced analytics such as automated detection of reduced visibility, or through an API that enables programmatic integration with enterprise systems using camera metadata and geographic or route-based queries.

Several applications demonstrate Vizzion's relevance to transportation agencies. In a 2023 one-week study across four North Carolina freeway segments, Vizzion's on-vehicle camera imagery helped confirm nearly half of all documented crash and road work incidents (Figure 1), uncovered six previously unreported work zones, and supported assessment of fog alert severity [15]. A 2024 university study evaluating Vizzion's coverage on Indiana interstates over six weeks found that at least one equipped vehicle was observed daily on 56% of interstate miles during daytime and 35% at night, with weekly coverage reaching 100% during the day and 92% at night, highlighting the platform's potential for monitoring active work zones along high-volume corridors [16]. Despite these capabilities, several limitations have been reported [16]. Data are stored locally on vehicle cameras and accessible for only about 10 days before being overwritten. Image capture stops when vehicle speed falls below approximately 10 km/h, creating gaps in areas of heavy congestion or stopped traffic. Coverage is also biased toward high-volume routes, as the network relies on commercial truck traffic and is therefore stronger on interstates and more limited on lower-volume or non-commercial roads.

3.2.3 Blyncsy

Blyncsy operates an automated roadway monitoring system that uses AI and crowdsourced imagery for roadway maintenance, asset inventory, and work zone inspection. The company maintains a data-sharing partnership with Nexar to ingest imagery from its dashcam network and indicates it draws on additional crowdsourced video sources that are not publicly specified. According to company-reported figures from October 2024, Blyncsy's interstate highway mapping system processes imagery from roughly one million vehicles. Data can be accessed through an API for integrating detections and metadata into enterprise systems and automated workflows, or through Blyncsy Map, a web-based platform for viewing roadway imagery and AI outputs, as shown in Figure 1.

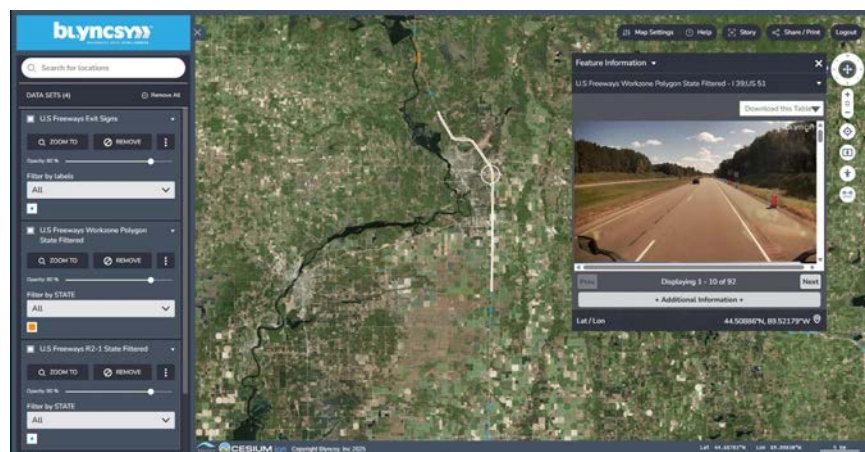


Figure 1. Screenshot of Blyncsy Map: a web map dashboard with layer controls on the left and a feature imagery/information panel on the right

Blyncsy is among the few vendors claiming AI capabilities directly relevant to work zone inspection reviews. According to the company, the platform can identify and catalog TTC devices using MUTCD classifications, assess the visibility, placement, and condition of these devices, and track crew locations in near real time. Published case studies report detections of work zone elements including barrels, cones, barricades, warning signs, portable changeable message signs, and arrow boards, along with condition assessments of sign reflectivity and damage and pavement marking quality. Blyncsy has partnered with a growing number of transportation agencies (Table 1), with applications ranging from pavement condition assessment and sign inventory to roadway anomaly detection and maintenance monitoring.

Table 1. Blyncsy partnerships with transportation agencies and stated purposes.

Partnership	Purpose
Utah DOT (2021)	Identify road segments needing maintenance; generate repair lists; integrate with maintenance management software.
Port Authority of New York & New Jersey (2022)	Pavement condition assessment; sign asset inventory with MUTCD classification; sign retroreflectivity.
City of Plano, Texas (2023)	Roadway asset inventory; missing/damaged signs; lighting outages; faded crosswalks; roadway anomalies.
New York City DOT (2023)	Lane markings; crosswalk paint visibility; pavement condition analysis.
City of Fort Worth, Texas (2024)	Streetlight condition and brightness; road sign condition and retroreflectivity; pavement marking visibility; automated inventory and inspection updates.
Alaska DOT (2024)	Pavement conditions; guardrail damage; street-light outages; snow removal monitoring; roadway asset inventory.
Hawaii DOT (2025)	Roadway condition assessment; guardrail condition; vegetation encroachment.
Alabama DOT (2025)	Guardrail presence and damage; vegetation encroachment; debris; pavement distress.

Only one independent evaluation of Blyncsy has been reported [13]. Although that study focused on general traffic control infrastructure rather than work zones, several findings about limitations may be relevant to inspection review applications, including inaccurate sign locations on the map, duplicate detections of the same sign, failure to identify sign types, difficulty downloading data for multiple features, and overall dataset immaturity for capturing the needed traffic control infrastructure data. Additional limitations have been reported or indicated in Blyncsy's own case studies regarding detection accuracy and crowdsourced data coverage. In a 2023 case study with the City of Plano, Texas, the system failed to detect 31 of 38 roadway maintenance issues identified by human inspectors, and the company acknowledged the continued need for manual surveys to provide engineering judgment and catch issues that the automated system may miss [17]. The system can also flag a missing sign or light only if it previously appeared in historical imagery, limiting its ability to detect newly required elements. Coverage constraints are also evident: early case studies conducted prior to 2024 appear to have relied solely on

crowdsourced networks, but more recent initiatives in states such as Alabama and Hawaii specifically mention the deployment of vehicles equipped with standardized dashcams, suggesting that crowdsourced coverage alone remains insufficient in areas where inputs are sparse or inconsistent.

3.2.4 *Mapillary*

Mapillary is a cloud-hosted platform for sharing and analyzing crowdsourced, street-level imagery. It processes geotagged photos from a variety of devices, including smartphones, action cameras, 360° cameras, and dashcams, to build a global visual representation of road networks. Image capture can be performed manually or through automated modes in the Mapillary mobile application, and uploaded images are placed on a map using geographic metadata and processed by computer vision models designed to extract 97 categories of roadway assets. The resulting imagery and derived map data are freely available for both commercial and non-commercial use. Data can be accessed through a browser-based web platform for exploring and overlaying imagery and extracted features, or through an API that supports bulk export of detected features and metadata in standard geospatial formats such as Shapefile and GeoJSON for integration into enterprise systems.

Notable public-sector applications demonstrate Mapillary's versatility. The Washington, D.C. Department of Public Works has used the platform since 2023 to capture annual street-level imagery for monitoring leaf-collection progress, sharing data across city agencies via an ArcGIS Pro plugin. The Connecticut DOT partnered with the University of Connecticut in 2019 to support statewide inventories of street signs and road networks and to underpin a road-safety analysis tool. In Clovis, New Mexico, a single GIS staff member completed a comprehensive traffic-sign inventory in 2018 at substantially lower cost than traditional vendor-based methods.

Despite these applications, several limitations have been reported in independent evaluations and academic studies. An evaluation by TTI researchers found highly variable detection accuracies for common traffic signs, ranging from 26.9% for speed limit signs to 64.7% for yield signs [13]. Because any user with any device can contribute, image quality can be inconsistent. Geographic coverage is skewed toward urban areas, with an average global coverage rate of 8.88% compared to 2.65% in rural areas, and imagery in less-traveled areas may be outdated [18,19]. Contributions also show strong seasonality, with lower volumes in winter and clustering around commute peaks, which can reduce temporal consistency for year-round monitoring [20]. Data collection is further concentrated among a small number of highly active users; for example, Washington and San Francisco had 192 and 143 unique contributors respectively, while Detroit had only 26 [21].

3.2.5 *Iteris*

Iteris is a technology provider in the intelligent transportation systems (ITS) sector. Its ClearMobility Platform is a cloud-enabled ecosystem that offers end-to-end tools to monitor, visualize, and optimize transportation networks using traveler information, smart sensors, and mobility analytics. Within this ecosystem, ClearGuide serves as the analytics and visualization application. In 2025, Iteris introduced a *Dash Cam Imagery* capability for work zone detection and monitoring. This feature integrates anonymized, front-facing dashboard camera imagery into ClearGuide. The images are sourced from commercial fleets—such as delivery and service trucks—that utilize on-vehicle cameras. While specific data providers are not publicly named, a 2023 pilot study with North Carolina DOT [15] suggests that Iteris may have collaborated with Vizzion to obtain crowdsourced data. As the feature was only recently introduced, no case studies or independent evaluations have yet been reported.

3.3 Academic Literature Review

3.3.1 *Crowdsourced Data in Transportation and their Usage*

Crowdsourced data has become a core resource for transportation research. Among these sources, dashcam video is one of the most visually rich, enabling detection of roadway assets, behaviors, and events. A significant share of academic work leverages dashcam footage posted on social media platforms, particularly YouTube, to assemble diverse, large-scale datasets.

- ALAM et al. [22] collected dashcam videos from 565 cities around the world from YouTube to analyze global pedestrian behavior patterns.
- Jaradat et al. [23] sourced dashcam compilation videos from YouTube and annotated them for crash, near-miss, and non-crash segments. They then applied deep learning techniques and multimodal large language models to detect and analyze safety-critical events captured in these videos.
- Parikh et al. [24] introduced RoadSocial, a VideoQA dataset derived from social media videos and tweets specifically focused on road event understanding.
- Minh et al. [25] created a complex fusion system integrating user-submitted images from mobile applications with 537 surveillance camera feeds across Ho Chi Minh City. The integrated data was then processed through ResNet18 deep learning classification pipeline to generate a unified view of traffic conditions.

Navigation app data represents another major category of crowdsourced transportation information, collected through mobile applications that users employ for real-time navigation and traffic updates.

- Zhang et al. [26] utilized smartphone-based navigation apps such as Amap and DiDi to collect GPS location data and vehicle speed information.
- Hoseinzadeh et al. [27] demonstrated freeway level-of-service estimation using multiple Waze data streams including Waze speed and travel time data combined with alert information.

Probe vehicle data represents a distinct category of crowdsourced information consisting of GPS and cellular phone location data collected from vehicles traveling on roadways. This data type differs from navigation app data in that it focuses specifically on vehicle positioning and movement patterns.

- Kamyab et al. [28] utilized probe vehicle data collected by HERE Technologies through the Michigan DOT. This data consists of continuous GPS speed measurements from vehicles traveling on roadways. The data was used to develop a Work Zone Mobility Audit framework analyzing 264 work zones, processing speed observations into performance metrics including delay hours, congestion mile hours, and queue mile hours to inform traffic control device placement optimization and enable agencies to optimize work schedules based on quantified impacts.
- Day et al. [29] analyzed segment speed data from INRIX, consisting of minute-by-minute average speeds for 0.5 to 1 mile segments, and connected vehicle data from Wejo, comprising GPS waypoints every 3 seconds from connected vehicles. The data was used to investigate replacing traditional radar sensors in work zone Queue Warning Systems at six Iowa work zones, with connected vehicle data demonstrating superior performance in detecting congestion onset and achieving higher agreement with sensor-based warnings for queue detection applications.

Despite their promise, crowdsourced data pose several technical challenges that affect reliability and operational use:

- Contributions may be demographically or geographically skewed, limiting generalizability [30].
- Live traffic video sharing introduces complications related to network capacity, bandwidth, latency, and security [31]. Also, the lack of real-time updates regarding ongoing construction or maintenance activities can hinder the effectiveness of work zone monitoring and management [32].
- Issues of redundancy, such as multiple reports of identical incidents, exacerbate data noise and complicate analysis [33].
- Large video corpora require substantial computation for storage, validation, and real-time integration with agency systems [34].

3.3.2 *Computer Vision and Analytics for Traffic Control Devices Inspection*

Detecting Work Zone Elements. The application of AI, particularly computer vision, is a primary method for identifying and monitoring elements within a work zone. Research in this area has largely focused on the automated detection of TTC devices. Among these, the You Only Look Once (YOLO) family of object detectors is frequently employed due to its speed and efficiency. Studies have successfully used YOLO models to identify a wide range of work zone assets, including traffic cones [35–38], barrels, barricades, construction signs, and traffic signs and construction workers [39,40]. A key application of this detection capability is in real-time safety systems. For instance, Cui et al. [41] developed a system that uses roadside cameras to detect work zone boundaries and transmit real-time alerts to connected vehicles. Their field study in Edmonton, Canada, demonstrated the feasibility of integrating live traffic camera feeds with connected vehicle technology for dynamic work zone monitoring.

To improve the performance and overcome the challenges of AI's real-world deployment, researchers have developed several advanced techniques:

- Prior studies adapt pre-trained models using domain data to improve detection accuracy for specific objects. Oh et al. [42], for example, used transfer learning to fine-tune a YOLOv5 model specifically on a traffic barrel dataset, significantly enhancing barrel detection accuracy. Rezapour and Ksaibati [43] applied transfer learning to models like InceptionV3 and DenseNet121 to classify different types of roadside barriers (e.g., box beam, cable, concrete), achieving meaningful results even with limited training data.
- A common challenge in developing robust models is the lack of diverse training data. To address this, Seong et al. [44] employed a synthetic data generation method called "content swapping." By superimposing images of construction signs onto various background scenes, they artificially expanded their dataset, improving the YOLOv3 model's robustness and ability to generalize to new environments.
- Vision-based systems can be enhanced by incorporating other data sources. Saillaja et al. [45] proposed augmenting CNN analysis of live video with data from Internet of Things sensors. This multimodal approach allows for real-time monitoring of parameters like location, ambient brightness, and traffic volume to provide more context-aware hazard warnings.

Segmenting and Mapping Work Zone. Beyond simply detecting individual objects, advanced computer vision techniques show potential to define the precise boundaries, scale, and spatial layout of a work zone. Mask R-CNN, for example, has been used to not only detect but also segment TTC devices [46]. It outlines each object and assigns a pixel-level label (e.g., cone pixels in red, person pixels in green). This pixel-level detail is valuable for understanding the placement and extent of TTC elements. Researchers have developed multi-stage approaches for work zone mapping. One such pipeline [47] begins with a

binary classification algorithm to detect the presence of a work zone. Once a work zone is confirmed, Mask R-CNN is employed for detailed object segmentation within that detected area. For applications requiring rapid processing, such as from dashcam footage, lightweight models have been developed. RTTCNet, by Hu et al. [48], efficiently detects common work zone devices and lane markings, then reasons about lane boundaries, infers blocked lanes, and triangulates GPS positions using structure-from-motion techniques. Field tests in Shanghai reported a localization accuracy of 3.86 meters. Other methods use the spatial relationships among detected objects to infer work zone presence. Zuo et al. [49] developed a topology-based inference method with an XGBoost classifier. The approach computes a “topology complexity score” from the relative placement of detected objects and combines it with clusters of work zone objects to classify a scene as a work zone. They also introduced a reference-free method to estimate work zone size by relying on the standard heights of common work zone equipment.

Asset Condition Assessment. Although object detection and mapping are well established, the automated assessment of asset condition remains a developing area with limited research, especially for TTC devices. The literature review identified only one closely related study [50]. In this study, researchers investigated the use of a standard YOLO model to identify multiple types of guardrail defects, including deflection, leaning, missing posts, and tears. The model achieved only moderate detection rates (41%–63%), a level of performance the authors concluded was insufficient for reliable, large-scale safety screening [50]. To address these limitations, the study evaluated Vision-Language Models (VLMs) that pair visual recognition with text-based descriptions. Compared with the YOLO baseline, VLMs achieved markedly higher accuracy in recognizing and describing defects, but at the cost of substantially higher computational latency. An example of a VLM-generated narrative assessment is shown in Figure 2.



Figure 2. Vision-Language Model (VLM) analyzes an image of a concrete barrier and outputs a qualitative text evaluation.

AI-generated evaluation: “The barrier appears to be a substantial concrete retaining wall or channel lining, likely part of a roadway or drainage system. It's showing signs of aging and degradation, particularly associated with exposure to the elements and potentially freeze-thaw cycles if located in a

colder climate. The condition is concerning and warrants prompt investigation and potentially significant maintenance.”

Limitations and Future Research Directions. Although progress is notable, automated work-zone detection systems still face obstacles that limit their reliability. Key limitations include:

- Insufficient data diversity. Models trained on narrow datasets often generalize poorly to new geographies, work-zone layouts, seasons, and camera configurations [47].
- Detection accuracy drops sharply at night [51] and in adverse weather such as rain, snow, or fog [52,53].
- Complex, dynamic road scenes. Camera motion from moving vehicles (ego-motion), rapidly changing backgrounds, and partially occluded objects (occlusion) hinder consistent and accurate detection [54].

Future work should target these gaps to build more robust systems:

- Improve performance in low light and adverse weather [38,48,51,55,56] and develop methods to mitigate motion blur caused by vehicles traveling at speed [35,38,56].
- Establish larger, more varied, and well-annotated datasets spanning regions, seasons, weather conditions, sensor types, and mounting configurations [35,47,55]. Such datasets are fundamental for training models that generalize effectively across real-world scenarios.

3.4 Concluding Remarks

Analysis of state DOT work zone process review reports confirms the value of work zone inspection reviews. However, realizing system-wide safety improvements demands a shift toward representative sampling integrated with quantitative and qualitative analysis — an approach aligned with 2024 federal code revisions mandating data-driven work zone safety management. Manual, time-intensive field reviews remain the primary barrier to implementation.

Commercial technology offers promise but with notable limitations. A review of five vendors — Nexar, Vizzion, Blyncsy, Mapillary, and Iteris — reveals a growing market for crowdsourced dashcam video and automated analysis. These platforms show potential to enable passive work zone data collection and automate the detection, inventory, and mapping of TTC devices. However, their readiness for standards-based inspection review assessment remains uncertain. Most platforms prioritize general asset detection rather than the nuanced compliance analysis that requires spatial measurement, condition assessment, and contextual application of standards with engineering judgment. Only Blyncsy explicitly markets capabilities specific to work zone inspection reviews, yet these remain limited relative to typical

inspection checklist requirements. Peer-reviewed evidence on crowdsourced data coverage is limited to a single study demonstrating promising performance by Vizzion on Indiana interstates, and geographic and seasonal coverage variations present additional challenges. State DOTs have typically addressed coverage gaps by supplementing vendor networks with dedicated vehicles equipped with standardized cameras.

Academic research largely aligns with the commercial landscape while revealing new potential. AI models demonstrate high accuracy in detecting and mapping common work zone elements, yet no end-to-end automated solution for work zone inspection reviews currently exists. Vision-language models and multimodal data fusion show potential for the complex spatial and contextual analysis these reviews require, but remain at proof-of-concept stages.

Overall, despite limited explicit focus on work zone inspection reviews in both the commercial and academic sectors, AI and crowdsourcing technologies offer substantial potential to augment current practices. Further assessment is needed to determine viability within the operational environments of state DOTs.

4. State DOT Survey

The research team conducted a nationwide survey to assess current practices among state DOTs related to work zone inspection reviews. The primary objective was to identify best practices, particularly regarding the integration of emerging technologies that enhance inspection quality, coverage, and timeliness.

4.1 Research Methods

Researchers distributed the survey through the Qualtrics platform via email between September 17 and October 17, 2025, receiving complete and valid responses from 38 state DOTs. Figure 3 illustrates the geographic distribution of responding agencies. The survey targeted state-level personnel responsible for work zone safety, and a screening question prompted recipients not directly involved in work zone inspection reviews to forward the invitation to a more appropriate contact within their agency. Analysis of validated responses confirmed that respondents were primarily traffic safety and operations engineers or managers, construction and project engineers, and work zone safety and operations engineers, supervisors, or managers.

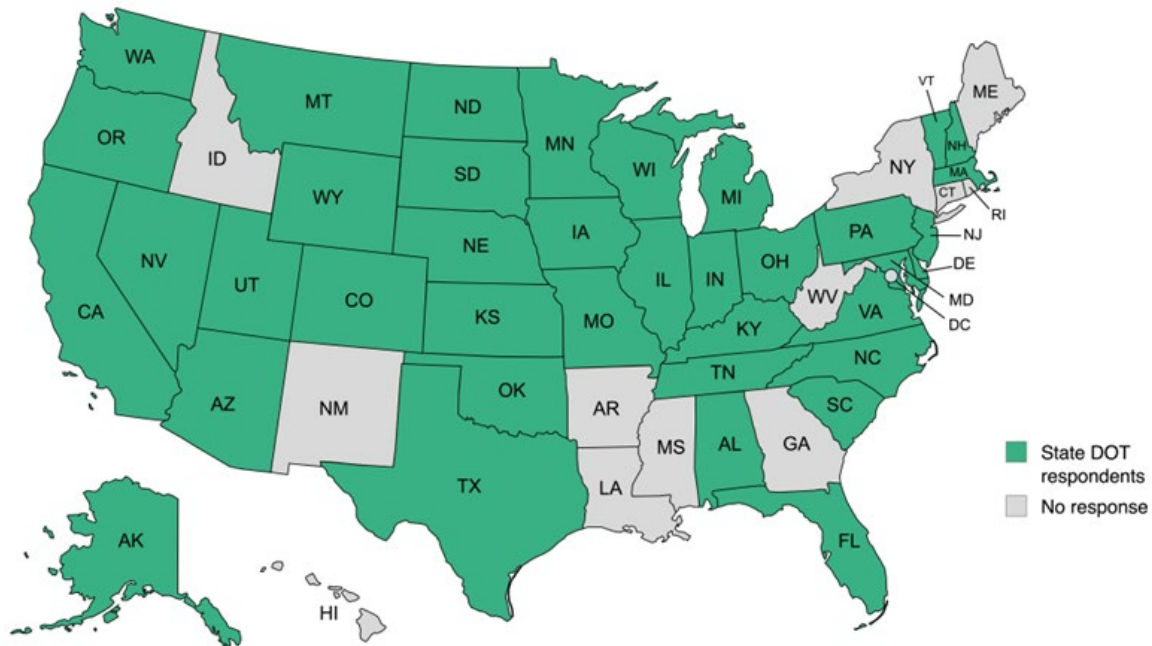


Figure 3. Geographical distribution of survey responses.

4.2 Survey Results

The survey included three primary sections. The first section investigated the general procedures and administration of work zone inspection review programs. The subsequent sections focused on the adoption of emerging technologies for field data collection and data analysis, respectively.

4.2.1 Program Overview

Questions 1 and 2 investigated the extent to which state DOTs have adopted formal work zone inspection review programs. As illustrated in Figure 4 (inner ring), a significant majority of state DOTs (78.9%) have established such a program. It should be noted that this study's scope was limited to state-level programs. The frequency of program implementation, however, varies considerably (Figure 4, outer ring). Nearly a quarter of agencies (23.3%) were unable to provide specific inspection counts. Among the remainder, activity ranged from infrequent (23.3% conducting 10 or fewer reviews annually) to highly active (23.3% conducting over 200). These disparities in work zone inspection implementation likely stem from state-specific differences in resource allocation, program maturity, and technology adoption.

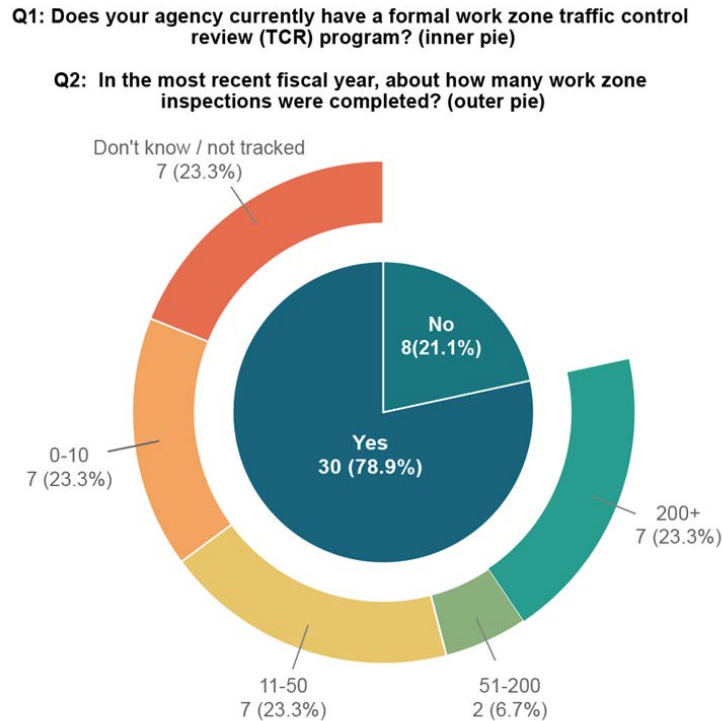


Figure 4. Status of state DOT work zone traffic control review programs. (N=38)

Question 3 investigated the criteria state DOTs use to select project sites for work zone inspection review. Because agencies often employ multiple strategies, respondents were permitted to select all that apply. Among the 30 agencies with formal programs, 25 (63.3%) employ at least one proactive selection strategy. As shown in Figure 5, common proactive methods include random sampling of active projects (63.3%), targeting high-risk projects (46.7%), and ensuring diverse project coverage (33.3%). Despite the widespread use of proactive protocols, a significant number of selections are still driven by reactive factors, such as logistical convenience (63.3%) or in response to specific issues like public complaints or high crash rates (56.7%). With only four agencies relying exclusively on reactive methods, the findings indicate that a hybrid model combining both proactive and reactive strategies is the dominant practice.

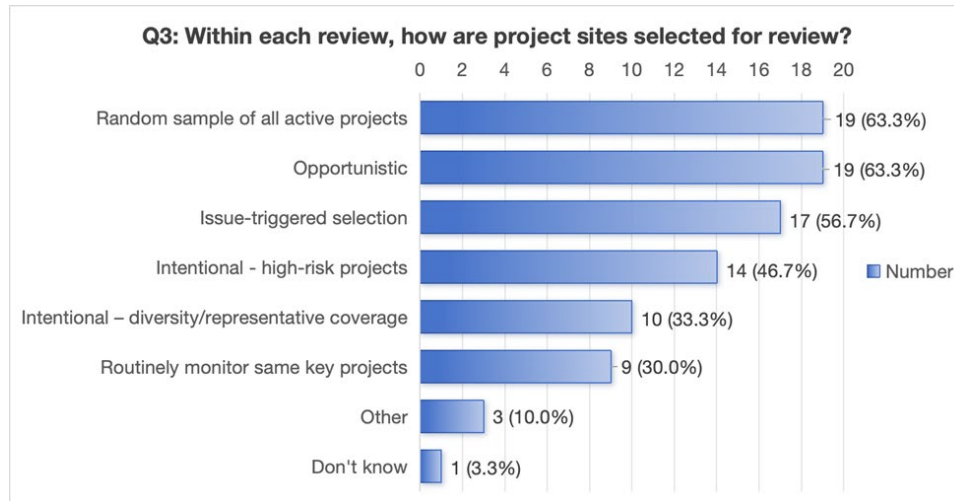


Figure 5. Project site selection methods for work zone inspection review. (N=30)

Question 4 asked agencies that use criteria-based sampling methods to identify the specific factors they consider. Respondents could select all applicable criteria. The results (Figure 6) show the most influential factors are all related to the physical context of the work zone, including project type (70.0%), work zone complexity (70.0%), geographic location (66.7%), and road type (63.3%). This top tier of factors indicates that agencies prioritize the inherent risks associated with a project's design, scope, and location.

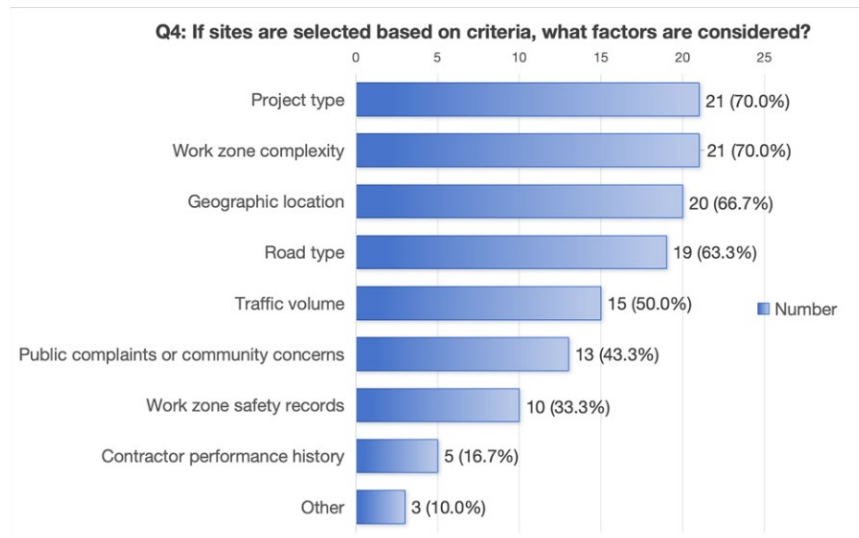


Figure 6. Ranking of factors used for work zone inspection review site selection. (N=30)

Question 5 examined the operational conditions under which work zone inspection review are typically conducted. Respondents were able to select all applicable options. The results (Figure 7) highlight a substantial majority, 22 of the 30 agencies (73.3%) with formal programs, report conducting reviews

under both daytime and nighttime conditions. Beyond standard conditions, 40.0% of agencies specifically target high-traffic periods to assess performance under peak-load stress. In contrast, reviews during inclement weather and special events are far less common. This suggests a potential gap in assessing work zone resilience, as these high-risk scenarios are the least likely to be formally reviewed.

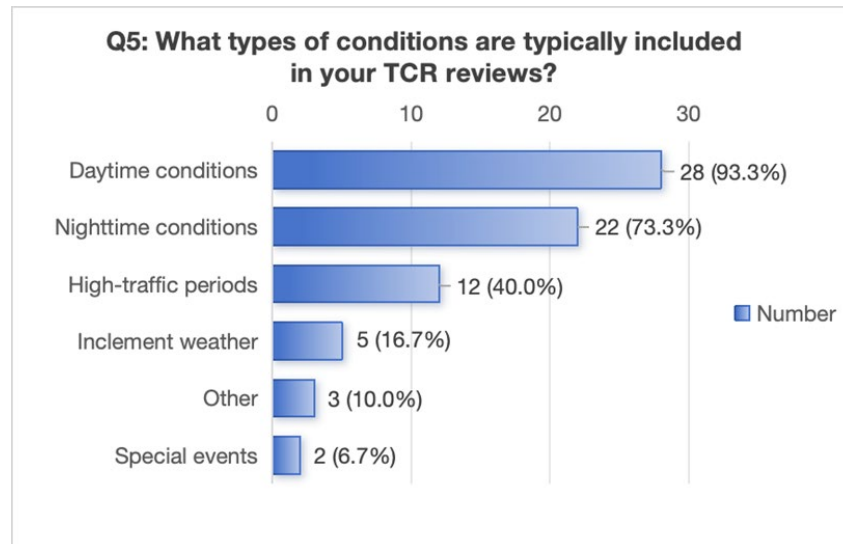


Figure 7. Frequency of work zone inspection reviews by operating condition. (N=30)

Question 6 was an open-ended question that prompted respondents to identify the primary challenges and barriers faced while conducting work zone inspection reviews. A thematic analysis of these responses identified four primary challenges:

- **Limitation of staff and resources** (N=13). Respondents frequently cited insufficient staffing, time constraints, high personnel turnover, and the ongoing need for training to keep reviewers competent with evolving standards. As one respondent explained, “We have a large state and a smaller work zone-specific staff. These factors make it challenging to do strict and robust work zone reviews.”
- **Logistical challenges** (N=11). Coordinating and scheduling reviews presented significant logistical hurdles. Agencies pointed to challenges such as managing long travel distances to dispersed project sites and aligning inspection times with active construction periods and the availability of multiple parties. One agency noted, “Finding time in the short construction season where all team members can attend when active projects are going on remains a persistent barrier.”
- **Inconsistent applications** (N=7). A notable concern was the lack of uniformity in how inspection standards were applied across different districts and contractors. This issue was often compounded by variability in inspector training and experience, leading to inconsistent field-level

findings.

- **Lack of perceived purpose** (N=3). A fundamental challenge arises when inspections are perceived primarily as a compliance exercise rather than as a tool for achieving tangible safety improvements. To address this, respondents recommended increasing the transparency of inspection data and the resulting policy changes. If inspectors can clearly see how their findings contribute directly to meaningful safety outcomes, their sense of engagement and ownership is likely to grow.

Question 7 was an open-ended question that prompted respondents to share best practices from their agencies regarding work zone inspection reviews. Responses clustered into three themes. The most frequently cited theme involved new or improved processes (14 responses). These included formalizing procedures, increasing inspection frequency, sharing lessons learned statewide, and enhancing staff training. Three innovations stood out: one agency now uses dashcam footage to conduct virtual follow-up meetings with project stakeholders; another divides its review team into multiple vehicles of three to five members each, providing varied perspectives, fostering richer post-review discussions, and ensuring all participants have meaningful opportunities to contribute; and a third agency promotes a model that treats field visits as relationship-building opportunities with field staff, emphasizing collaboration over formal scoring or targeted evaluation. The second theme involved new or improved data collection tools (seven responses). These advancements included leveraging dashcams for visual records, updating standardized forms, and deploying mobile applications for efficient data entry. One notable example is an agency currently developing a statewide virtual application for work zone reviews that will allow tracking and automatic generation of reports sent immediately to engineers. The third theme involved new or improved data analysis and visualization tools (six responses). These practices focused on developing systems for tracking inspection review results over time and across projects to identify broader trends and opportunities for improvement.

4.2.2 Data Collection for Work Zone Inspection Reviews

Question 8 investigated how state DOTs record their observations during a field inspection. Respondents could select all applicable options. As shown in Figure 8, the most common forms of documentation are images (83.3%), field notes (73.3%), formal checklists (66.7%), and video footage (60.0%). One agency specifically noted that they mark deficiencies directly onto traffic control plans. A key finding is that a typical review is supported by several data collection methods. On average, respondents selected 3.1 different methods, and 21 states utilized three or more types of documentation for a single review.

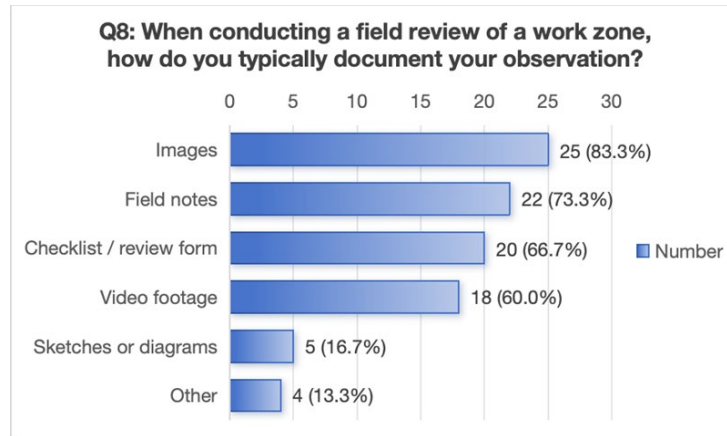


Figure 8. Prevalence of documentation methods for work zone reviews. (N=30)

Question 9 investigated the hardware used for field documentation. Respondents could select all applicable hardware options. As shown in Figure 9, smartphones or tablets (66.7%) are the most frequently used devices, closely followed by digital cameras (56.7%). Dashcams also represent a significant tool category (40.0%), with some agencies specifying the use of vehicle-mounted digital cameras as dashcams, possibly due to better resolution. Similar to the use of multiple documentation methods, agencies typically employ a suite of hardware, with 20 states reporting the use of more than one type of device.

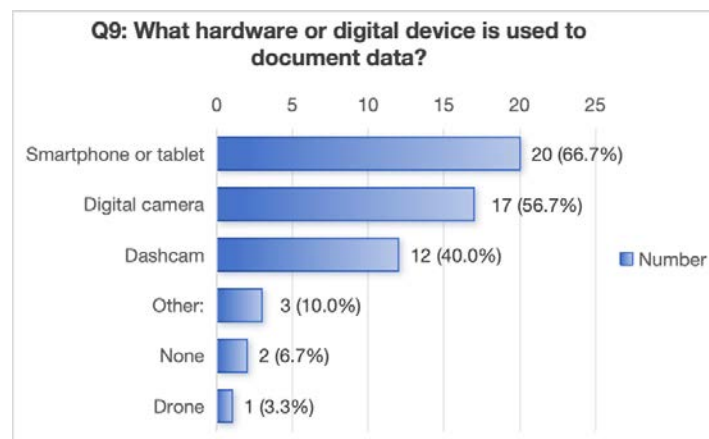


Figure 9. Technology used for field data capture during work zone reviews. (N=30)

Question 10 investigated the software used for field documentation. Out of 30 valid responses, only six (20.0%) reported using software or mobile applications for data entry. The digital tools reported include the Maryland DOT's State Highway Administration TTC Inspection Rating System, the Delaware DOT's TTC Inspection Report system, and ArcGIS Survey123.

Question 11 explored the use of alternative data sources to supplement in-person work zone inspection

reviews. The findings (Figure 10) reveal that traditional field reviews remain the dominant practice, with 63.3% of responding agencies relying on them exclusively. Among agencies that incorporate other data, the most common sources are work zone intelligent transportation systems and sensor data (23.3%), which provide direct operational metrics from sources such as traffic cameras and data-sharing platforms like the Regional Integrated Transportation Information System, and public-facing applications such as Waze and state 511 systems (20.0%), which offer insights into the real-time road user experience. The nature of these sources suggests they are primarily used to flag potential areas of concern for subsequent in-person reviews, rather than serving as a direct substitute for field inspections. Adoption of more advanced data sources remains nascent. For instance, only one agency reported using third-party dashcam video providers (3.3%).

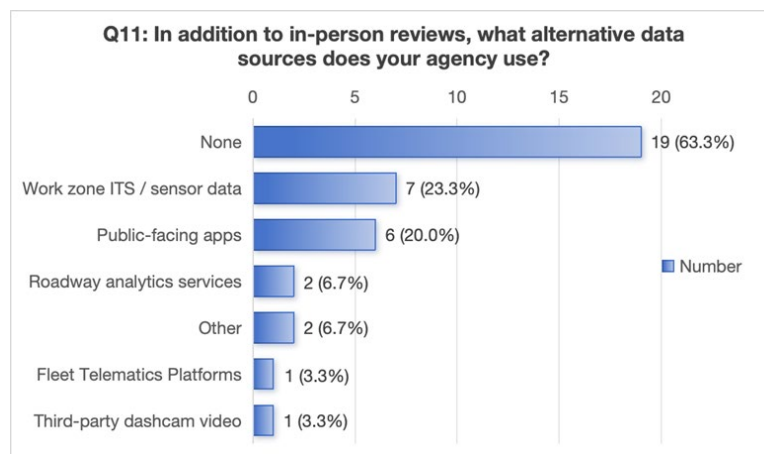


Figure 10. Alternative data sources used for work zone monitoring. (N=30)

Question 12 was an open-ended question that prompted early adopters to share their experiences with data collection technologies. Common technical challenges reported include inadequate crowdsourced dashcam data coverage in rural areas, rendering this solution non-viable for projects outside major corridors; difficulty aligning exported dashcam videos with specific map locations; the risk of footage being overwritten by dashcam loop recording features if not downloaded promptly; dashcam image resolution too low to reliably read signs; and at an institutional level, agency IT firewalls frequently identified as a significant barrier to accessing and integrating third-party data.

Question 13 asked agencies to share their future priorities for improving inspection data collection. Responses highlighted a clear direction focused on leveraging technology to streamline the process. The strongest interest was in crowdsourced data (six responses), particularly third-party dashcam services with the ability to conduct near-real-time virtual site reviews from the office and access specialized analytics such as automated nighttime retroreflectivity checks. Data integration and organization was also a priority (four responses), including integrating digital inspection forms with GPS, automating the filing and

geotagging of photos, and linking data streams from contractor equipment directly to agency systems. Three respondents emphasized the need for advanced hardware such as high-resolution dashcams effective at speed and at night, alongside drones for enhanced aerial coverage. One agency highlighted the importance of effective data presentation, noting the need to move beyond lengthy reports by using dynamic tools like Esri's StoryMaps, observing that traditional review reports of 20 to 30 pages are not being read and that more engaging formats are needed to foster user engagement and retention.

4.2.3 Post-Review Analysis and Documentation

Question 14 asked respondents to report the typical time elapsed between conducting a field review and completing all documentation. The results (Figure 11) reveal a significant divide in reporting efficiency across state DOTs. A substantial portion of agencies (46.7%) demonstrate efficient workflows, completing all analysis and documentation within three days of the field review. In contrast, a similarly large group (40%) experiences significant delays, with reporting taking more than one week.

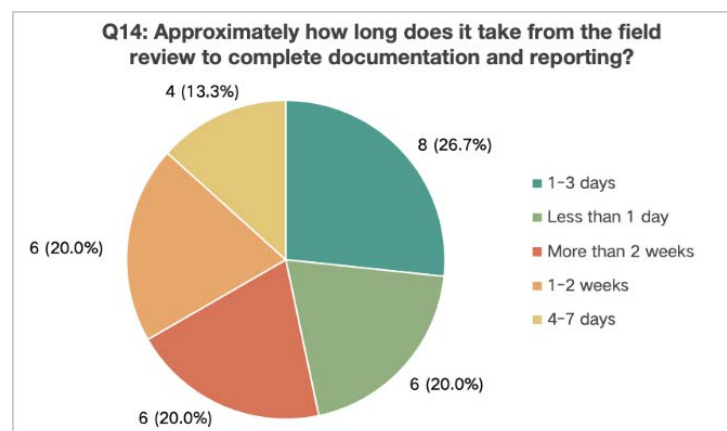


Figure 11. Distribution of reporting timeliness for work zone inspection reviews. (N=30)

Question 15 asked respondents to characterize their video/image review process. The vast majority of agencies (93.3%) conduct fully manual reviews, in which staff watch footage and compile notes and reports. Two agencies (6.7%) employ aided manual processes. Notably, no respondents reported using fully automated or AI-assisted analysis tools.

Question 16 asked respondents to identify software used for analyzing inspection data and generating reports. Although two agencies indicated using aided manual review processes in Question 15, neither specified software tools. Seven agencies identified software platforms used to edit, organize, and store inspection data, including Adobe Lightroom, Delaware DOT's TTC Inspection Report system, ArcGIS Survey123, Microsoft Power BI, Oracle, and the Regional Integrated Transportation Information System.

Question 17 asked early adopters to share lessons learned from their experiences. Respondents reported

positive outcomes with several platforms, including ArcGIS Survey123, the RITIS User Group, and Delaware DOT's inspection report system. However, agencies identified implementation challenges. For ArcGIS Survey123, the primary barrier was obtaining ArcGIS accounts for all staff, which hindered adoption across field personnel. A second challenge centered on workflow compatibility, as technology must adapt to the routines of mobile field staff. One agency illustrated this with its dashcam system, noting that the requirement to download data at a set location created issues with quick access and prevented field reviewers traveling throughout the week from filing timely reports.

Question 18 asked respondents to identify the single technology or process with the greatest prospective impact on the future of work zone inspection reviews. Two dominant themes emerged. The most frequently cited was AI-enabled workflows (eight responses), with agencies envisioning AI as a transformative force through automated detection and summarization of deficiencies from video or image feeds, automated comparison of field conditions against approved plans, automated generation of reports and dashboards, and seamless integration with crowdsourced dashcam or fleet data. The second theme was data integration (seven responses), with priorities including direct linkage of inspection outputs with crash and performance data, enhanced geo-referencing capabilities to improve interpretation and sharing of findings, integration with construction management systems such as AASHTOWare Field Manager, and multi-stakeholder participation in post-construction reviews to support collaborative decision-making. These priorities collectively signal a potential shift toward integrated, data-driven, semi-automated systems that enable proactive work zone safety management.

4.3 Concluding Remarks

Survey results show that work zone inspection reviews are widely adopted, with 78.9% of responding agencies maintaining a formal program, reflecting broad recognition of their value for work zone safety. However, current practices remain largely manual and resource-intensive. Nearly all agencies (93.3%) conduct fully manual reviews, and 40% require more than one week to complete analysis and documentation after field visits. Nearly half of the agencies with a formal program reported that capacity is constrained by ongoing staffing and resource shortages (43.3%), while others cited logistical challenges (36.7%). The combination of recognized value and constrained capacity underscores the urgent need for automation. However, technology adoption remains in an early phase. Only two agencies reported experience with crowdsourced video data or AI-enabled analytics for work zone inspection review applications, and none reported successful implementation. Several agencies, however, have achieved positive results using commercial platforms for data entry, organization, and visualization.

The survey identified two transformative priorities that were widely recognized across responding

agencies. The first is the adoption of AI-enabled workflows to automate deficiency detection, combined with geotagging, traffic control plan comparison, and report generation. The second is improved data integration to link inspection review outputs with other work zone data and to facilitate more efficient, multi-stakeholder review processes. Together, these priorities highlight a shift toward integrated, technology-driven systems that support proactive work zone management without requiring additional staffing or resources.

5. Technology Vendor Interviews

This chapter presents findings from semi-structured interviews with four technology vendors — Vizzion, Blynscy, Iteris, and ViaSight —to describe the technical capabilities, limitations, and implementation considerations associated with the use of crowdsourced data and AI in work zone inspection practices. The four vendors were selected to represent a range of roles and maturity levels within the emerging technology landscape. Vizzion was selected as a market leader in imagery data aggregation for transportation applications. Blynscy was selected as the only reviewed vendor that explicitly markets AI capabilities for work zone compliance assessment and as one of the most active vendors partnering with state DOTs. Iteris was selected for its recent integration of crowdsourced dashcam data from Vizzion into its established platform, representing an emerging trend toward user-friendly access to crowdsourced imagery within tools already familiar to DOT practitioners. ViaSight was included as a startup offering purpose-built AI functionality specifically designed for work zone inspections, although the company has limited public visibility. Each interview lasted approximately 60 minutes.

5.1 Vizzion Dashcam Imagery Data

5.1.1 Data Network

Vizzion is a road imagery provider that aggregates road-facing camera feeds into a single, real-time data stream. Its on-vehicle camera network includes approximately 30,000 commercial vehicles, primarily long-haul freight trucks, supplemented by parcel delivery vehicles and maintenance fleets. These vehicles operate during normal business activities and collectively provide broad roadway coverage. Each equipped vehicle checks in with Vizzion’s servers every 15 seconds, transmitting location, timestamp, speed, heading, and a unique vehicle identifier. This frequent check-in enables precise indexing of imagery and supports targeted retrieval of specific images associated with known locations and times. Cameras are capable of capturing images at one-second intervals. Image resolution varies across the fleet, with approximately 25% of cameras capturing at 1080p and 75% at 720p. Figure 12 shows example footage from a Wisconsin work zone. Imagery is available in near real time—typically within 20 seconds of image capture—and is retained for up to 10 days following capture, enabling agencies to conduct

short-term retrospective analyses of roadway and work zone conditions.



Figure 12. Example dashcam image by the Vizzion network within Wisconsin.

5.1.2 Data Access Workflow

Vizzion's standard business model requires customers to access imagery through an API — a standardized digital interface that allows a client to programmatically submit data requests to a vendor's system and receive results without manual file exchanges. Data retrieval follows a two-step process:

- **Location Query.** Users specify the geographic area of interest and time window through a structured request template. The API processes the query and returns a list of matching vehicle identifiers, each associated with specific locations and timestamps where dashcam imagery is available.
- **Image Request.** Using the returned vehicle identifiers and timestamps, users submit requests for specific images captured at selected locations and times. All retrieved images include metadata such as exact capture coordinates, vehicle speed, vehicle heading, and timestamp. As the images are stored on the edge, the typical response time for a series of images is 20 seconds.

APIs enable DOTs to automate repetitive data requests without requiring staff to manually contact vendors, and facilitate direct integration with existing platforms such as GIS systems, asset management databases, or traffic management centers. Standardized data formats also improve consistency and reduce errors associated with manual data handling. However, adopting API-based workflows requires a degree of technical capacity. Thus, staff may need training in programming and API configuration. In addition to the API, Vizzion has developed the 'Desktop Video Wall', an application that visualizes vehicle locations and enables image viewing and downloading. However, until Vizzion commits additional development work to commercially support this platform, it currently serves as a demonstration tool. The API remains the primary mechanism for operational access to Vizzion imagery.

5.1.3 Spatial Coverage Analysis

Researchers identified 12 active work zones across Wisconsin and provided these locations to Vizzion for evaluation of connected vehicle dashcam data coverage over a preceding 10-day period. For each work zone, a five-mile segment was defined, and Vizzion returned data including vehicle density expressed as visits per hour and total miles covered within each segment. As shown in Table 2, coverage varied considerably across locations. Vehicle densities ranged from 0.12 visits per hour on US 151 in Iowa County to 1.64 visits per hour on IH 94 in Jackson County, while total miles covered spanned from 241 to over 6,150 across the 10-day window. Interstate highways (IH) consistently demonstrated the strongest coverage. All five IH segments outperformed U.S. routes (US) and Wisconsin state highways (WIS) in both vehicle density and total miles covered. This pattern aligns with the composition of Vizzion’s network, which draws heavily from commercial fleet vehicles concentrated along high-freight corridors.

Table 2. Vizzion Data Coverage Across 12 Wisconsin Work Zones Over a 10-Day Period

#	Highway	County	Vehicle Density	Total Miles Covered
1	IH 41	Outagamie	0.93 vehicle visits per hour	1891
2	WIS 29	Marathon	0.84 vehicle visits per hour	2844
3	US 53	Chippewa	0.36 vehicle visits per hour	483
4	US 151	Dodge	0.73 vehicle visits per hour	2381
5	IH 94	Jackson	0.61 vehicle visits per hour	3032
6	IH 41	Brown	1 vehicle visit per hour	2507
7	IH 90	Sauk	1.28 vehicle visits per hour	3228
8	IH 43	Manitowoc	0.48 vehicle visits per hour	2045
9	WIS 57	Door	0.12 vehicle visits per hour	520
10	US 51	Lincoln	1.04 vehicle visits per hour	3006
11	US 151	Iowa	1.64 vehicle visits per hour	6150
12	WIS 145	Milwaukee	0.84 vehicle visits per hour	241

Geographic context and corridor function also play meaningful roles. For instance, WIS 145 in Milwaukee County recorded 1.28 visits per hour, likely benefiting from proximity to the Wisconsin Dells corridor and associated commercial traffic. In contrast, US 151 in Dodge County, a rural peninsula with limited through-traffic, recorded the lowest density at 0.12 visits per hour, indicating minimal dashcam coverage in remote or seasonal traffic areas. These findings suggest that Vizzion imagery is well suited for near real-time situational awareness on high-volume interstates and major arterials. On moderate-coverage corridors—averaging roughly 0.5 to 0.9 visits per hour—the data can support periodic assessments but may not sustain continuous monitoring without supplementation. On low-coverage routes, particularly lower-classification or remote roadways, agencies should expect longer data accumulation windows and potential gaps that limit time-sensitive inspection.

5.1.4 Temporal Coverage Analysis

A statewide temporal analysis was conducted across three observation intervals — 20 minutes, one day, and one week — to illustrate how Vizzion data accumulates over time. Results are shown in Figures 13, where blue lines indicate roadway segments where Vizzion-equipped vehicles traveled and collected imagery. In a 20-minute snapshot (Figure 13.a), active dashcam vehicles were sparse across northern and central Wisconsin, with coverage primarily concentrated along major interstate corridors. Over a one-day accumulation (Figure 13.b), coverage expanded substantially to reveal most interstates and many U.S. and state routes. At the one-week level (Figure 13.c), the network filled in considerably, extending to lower-classification roads and more remote areas, with approximately 620 unique vehicles observed operating statewide, though this count is approximate due to vehicles crossing state boundaries. The progression from minutes to days further illustrates high-volume corridors can support rapid assessments within hours, while comprehensive statewide coverage requires multi-day accumulation periods.

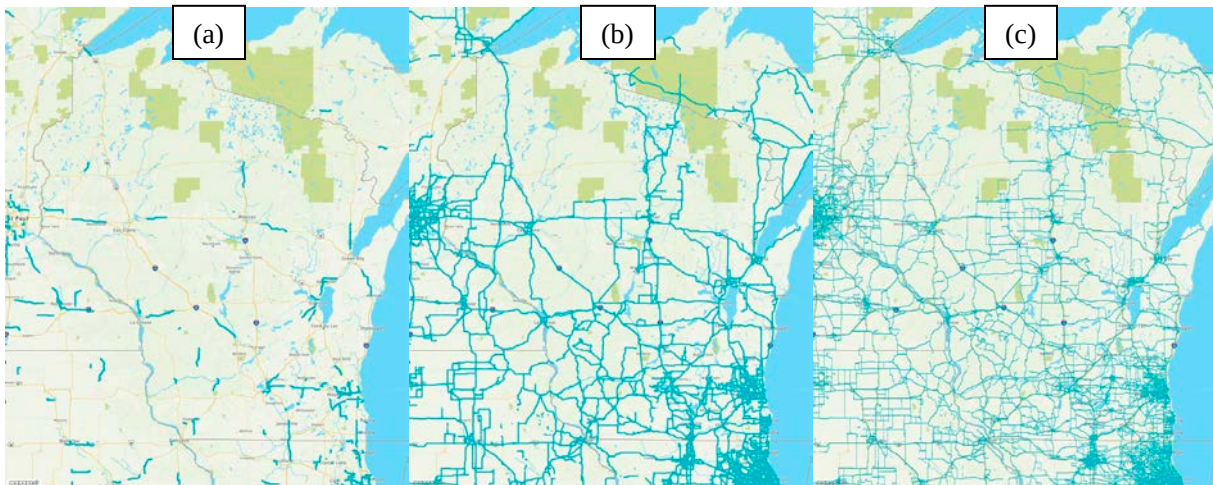


Figure 13. Cumulative spatial coverage of Vizzion dashcam across Wisconsin over (a) 20-minute, (b) one-day, and (c) one-week periods.

5.1.5 Pricing Structure

Vizzion charges their users a monthly subscription fee. The price is based on the number of concurrent requests that a user is allowed to make to their API at a time. Concurrent requests are requests for data and imagery that are processing at the same time. A corollary to Vizzion’s pricing model is a home internet plan. Homeowners pay a fixed monthly fee for a service package that allows them to use a certain amount of bandwidth at a time. The total amount of data that is actually used over the month is not a factor in the price. Homeowners benefit from predictable pricing and do not incur overage fees if their activity exceeds the allotted bandwidth.

- Minimum tier: 10 concurrent requests for \$3,250 per month. If all concurrent requests are in use, additional requests return an error until an ongoing request completes. Requests can be re-tried once the bandwidth becomes available.
- Additional increments of 10 concurrent requests can be optionally added for an additional \$3,250 per month.

Both steps of the data retrieval process (location queries and image requests) consume concurrent requests. One request can be used to make 1 data call or to retrieve 1 image. Users typically retrieve data in cycles. They will make a batch of requests, and when those requests complete and the data/images are returned, the user will then initiate the next batch of requests. To illustrate, consider a user with 10 concurrent requests who wishes to collect imagery from 10 work zones. The user first sends 10 location queries (one per zone), using all 10 concurrent requests. Once these return a few seconds later, the requests are released. The user then requests images for each location sequentially: retrieving a single location's image set (e.g., 10 images) uses all 10 requests during download, after which the requests free up for retrieving more images from the same work zone, or for acquiring images from the next work zone. The process repeats until all zones are covered.

Vizzion estimates the effective cost at approximately \$0.33 per mile of roadway imagery. The following calculation estimates the feasibility of obtaining approximately 10,000 miles of monthly coverage at the minimum pricing tier:

- Images per mile: At an average of 62 feet between images, one mile (5,280 feet) requires approximately 85 images.
- Throughput at 10 concurrent requests: 10 images every 20 seconds yield 30 images per minute, or 1,800 images per hour (assuming ideal operating conditions).
- Time to collect 10,000 miles: $850,000 \text{ images} (10,000 \text{ miles} \times 85 \text{ images/mile}) \div 1,800 \text{ images/hour} \approx 472 \text{ hours}$.
- Feasibility within one month: A 30-day month provides 720 hours; 472 hours represents approximately 66% utilization, equivalent to roughly 16 hours per day of continuous API usage.

This suggests that 10,000-mile coverage at the minimum tier is achievable within a single month, provided that background processes maintain connection to API for the majority of each day. Agencies requiring faster turnaround or more frequent refresh cycles would need a higher-tier allocation to reduce total collection time proportionally.

5.1.6 Summary

Vizzion's strengths lie in its broad spatial coverage along freight-intensive corridors, rapid image availability, and a price model that offers cost-effective per-mile pricing. However, coverage varies considerably across roadway classifications and geographic settings, and the 10-day imagery retention window limits retrospective analysis to relatively short time horizons. Agencies must therefore carefully align their use cases with corridor characteristics and data collection timing. Additionally, accessing Vizzion data through its API requires programming expertise and sustained technical oversight, which agencies should account for when planning integration into existing inspection workflows. Agencies seeking to minimize technical barriers can access Vizzion data through platforms that have already integrated the API, such as Iteris' ClearGuide and the CATT Lab's RITIS platform. Additionally, Blynscy utilizes Vizzion imagery for AI-powered work zone object detection.

5.2 Iteris ClearGuide

Iteris is a technology company specializing in data-driven mobility infrastructure management, with a portfolio of software-as-a-service (SaaS) platforms. This review focuses on the ClearGuide platform, specifically its recent integration of third-party dashcam imagery.

5.2.1 Dash Cam Data Source

Dashcam imagery in ClearGuide is sourced from Vizzion. Figure 14 illustrates 5-minute interval review of dashcam coverage in Wisconsin as of February 11, 2026, at 5:10 PM, with black camera icons marking locations where imagery was available at that moment. When multiple vehicles traverse the same corridor within a monitoring period, imagery from all available sources is accessible. According to Iteris, the company is evaluating additional crowdsourced dashcam providers to expand geographic coverage and data density.

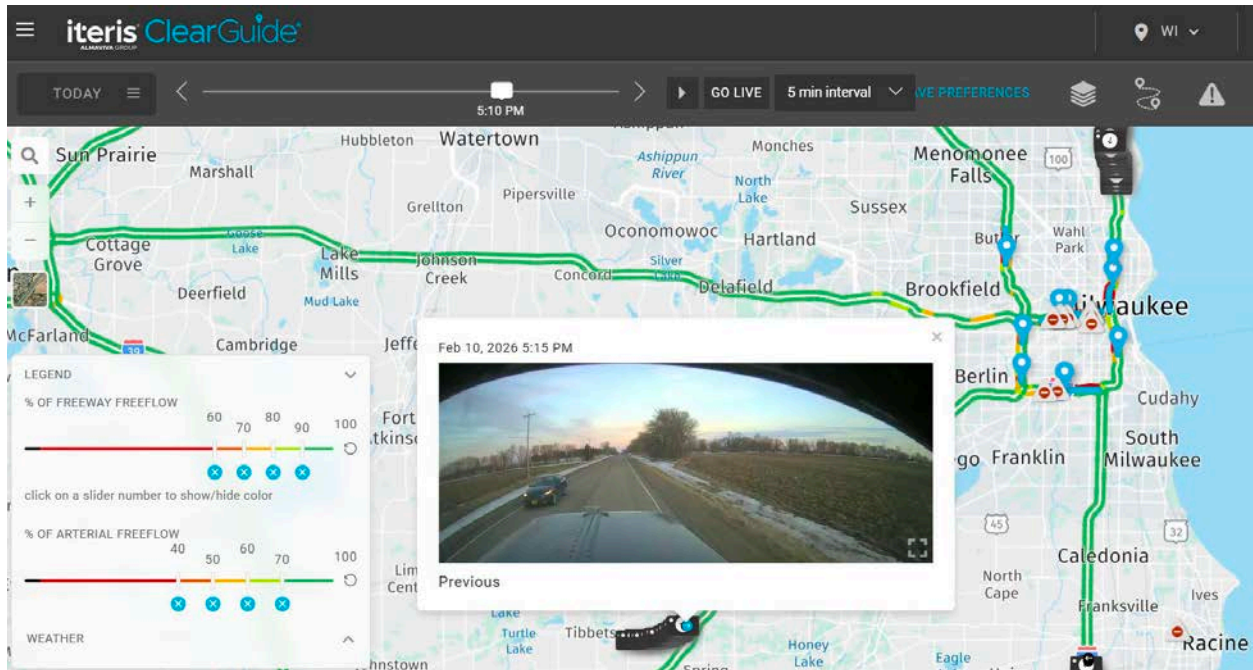


Figure 14. ClearGuide Platform Interface Displaying Dashcam Imagery Integration

5.2.2 Client Workflow

ClearGuide is Iteris's cloud-based analytics platform that integrates probe vehicle data, incident feeds, CCTV systems, and dashcam imagery into a unified map-based interface for both real-time monitoring and retrospective analysis. Users can query by corridor, geographic area, or time period and overlay multiple datasets. Dashcam imagery integrates seamlessly into these workflows: as illustrated in Figures 14 and 15, activating the dashcam layer displays spatially referenced image locations alongside traffic metrics for the selected time window, with historical imagery retained for approximately ten days. This enables efficient verification of operational anomalies flagged by congestion or bottleneck indicators through immediate visual confirmation. In a typical application, users navigate to a corridor of interest, review performance indicators to identify issues such as ramp closures causing congestion (Figure 15) and activate the dashcam layer to document and assess actual work zone configurations.

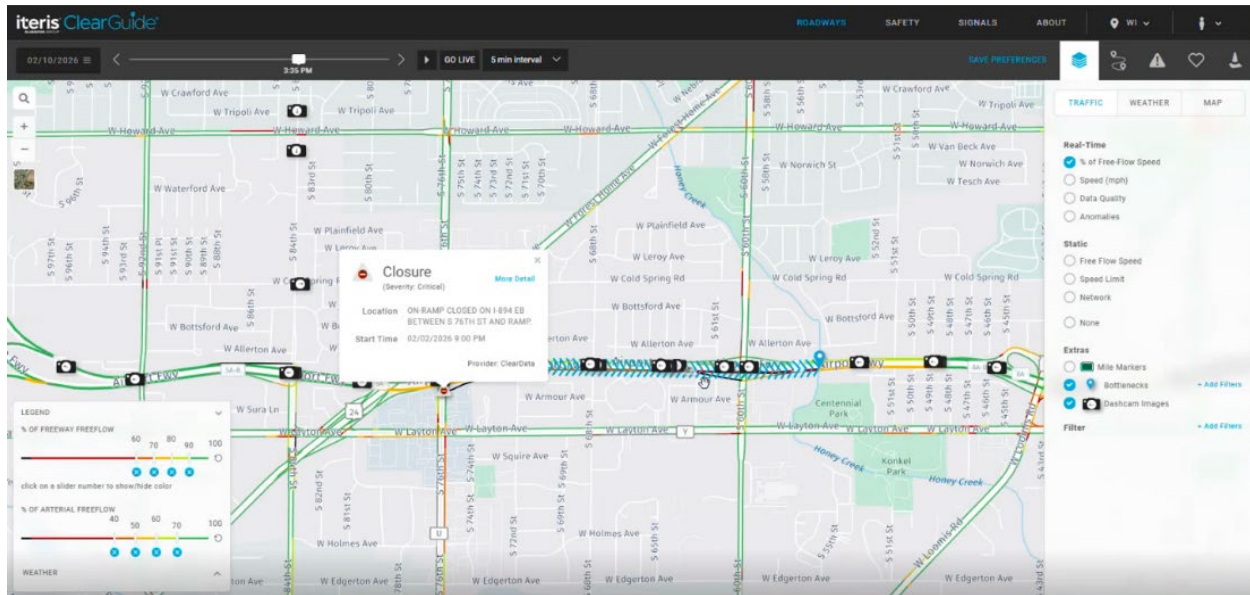


Figure 15. Work Zone Closure Detection and Dashcam Integration

5.2.3 AI Capability

Iteris is developing AI capabilities to automate work zone detection in dashcam imagery. These features remain in an exploratory phase and are not yet commercialized. The vendor has outlined a two-phase R&D roadmap. Phase 1 focuses on detecting active work zones by identifying traffic control devices, construction equipment, roadside personnel, and related indicators, with the goal of flagging candidates for user validation and reducing manual review. Phase 2 explores compliance assessment against the MUTCD and agency-specific standards. If commercialized, these tools would integrate directly into ClearGuide. No formal commercialization timeline has been announced. The Utah Department of Transportation (Utah DOT) is piloting Iteris' AI-based work zone detection using dashcam imagery. The pilot generates comparison reports evaluating AI outputs against manual ground truth. Utah DOT leverages agency-controlled high-definition dashcam imagery for verification, model training, and validation.

5.2.4 Pricing Model

ClearGuide Roadways is licensed using population-based tiers within defined geographic boundaries. For agencies such as WisDOT, annual costs typically range from \$100,000 to \$150,000. Multi-year agreements are available, with unlimited user access included. Dashcam imagery is priced separately as an add-on. Through the Eastern Transportation Coalition, participating state agencies can obtain this capability for approximately \$150,000 annually, plus a setup fee. Iteris has indicated willingness to engage in collaborative pilot projects, which may be pursued independently of a full platform

subscription, with pricing subject to negotiation.

5.2.5 Summary

ClearGuide offers an integrated environment that combines probe data analytics with spatially indexed dashcam imagery, enabling remote verification of roadway conditions and supporting efficient work zone monitoring. While AI-driven automated work zone detection shows strong potential, it remains in development. A key adoption barrier for many agencies is cost: for those without an existing base subscription, combining the core platform with the dashcam add-on could total \$200,000–\$250,000 annually. Agencies should weigh these costs against operational benefits.

5.3 Blynscsy Video Review Program

Blynscsy is a technology vendor that leverages crowdsourced dashcam imagery and AI-based computer vision to support roadway and work zone inspection.

5.3.1 Client Workflow

Clients initiate an analysis by submitting an email request to Blynscsy that includes a base map defining the geographic area of interest and a list of requested detection items (e.g., presence of channelizing devices). Blynscsy's data and delivery team first validates the submitted map to ensure correct formatting and suitability for analysis. Once approved, imagery collection is initiated on an on-demand basis. Collection timelines depend largely on traffic volumes: high-traffic roadways are typically fulfilled within one day, while lower-traffic facilities may require approximately one week to accumulate sufficient imagery coverage. Through partnerships with select imagery providers, Blynscsy can also access imagery captured up to 10 days prior to the commissioned collection date, enabling retrospective analysis when needed. Collected imagery is processed using Blynscsy's proprietary machine learning and computer vision models to detect roadway assets and conditions. Results are delivered to clients via email in multiple formats, including Web Feature Service (WFS) and Web Map Service (WMS) links (compatible with ArcGIS and QGIS), shapefiles, GeoJSON files, and CSV tables. All outputs also include key metadata such as geographic coordinates, vehicle heading, and timestamp.

Blynscsy does not provide downloadable imagery files. Instead, imagery remains accessible through WFS/WMS links alongside detection results. This approach enables agencies to visually reference field conditions when communicating with contractors or maintenance teams while reducing potential liability exposure. The vendor has observed cases in which agencies possessing downloadable imagery of damaged infrastructure (e.g., broken guardrails) faced liability when repairs were not completed

promptly. In addition, Blynscy stores all collected imagery indefinitely. This long-term retention supports longitudinal analysis, allowing clients to conduct before-and-after comparisons over extended timeframes.

5.3.2 *Dashcam Data Source*

Blynscy relies on crowdsourced dashcam imagery sourced from multiple dashcam vendors including Vizion, with most cameras providing up to 1080p resolution. Several conditions can reduce imagery availability and extend collection windows, including nighttime operations, adverse weather (e.g., rain), and temporary traffic pattern changes such as lane closures. When multiple constraints—work zones, nighttime operations, and adverse weather—occur simultaneously, substantially longer collection windows are required to meet coverage thresholds. Quality issues do occur in crowdsourced imagery, including rain-obstructed views and dirty windshields. Images that do not meet quality thresholds are automatically culled and excluded by Blynscy from analysis. Only imagery of sufficient quality to support accurate detection is retained, which is particularly important for tasks requiring visual clarity, such as reading sign text or assessing sign condition.

5.3.3 *AI-Based Inspection Capabilities*

Blynscy's computer vision models support inspection of multiple roadway elements relevant to work zone inspection activities. These capabilities are summarized in Table 3. Four types of channelizing devices can be detected: drums, cones, tubular markers, and vertical panels. Detection of these devices forms the basis for identifying work zone presence in imagery. Signs can be identified by type and message content. Condition assessments for signs include detection of physical damage, broken or fallen signs, graffiti, vegetation obstructions, and retroreflectivity (binary pass/fail). For pavement markings, supported condition assessments include detection of missing segments and retroreflectivity (binary pass/fail). More granular retroreflectivity ratings are under development.

Table 3. Blynscy Supported Detection Capabilities

Inspection Item	Detection capacities			
	Presence	Location	Condition	Measurement
Channelizing Devices	✓	✓	—	—
Signs	✓	✓	✓	—
Pavement Markings	✓	—	✓	—
Concrete Barriers	✓	✓	—	—
Work zone	✓	✓	—	—

5.3.4 *Current Technical Limitations*

Despite broad detection coverage, several limitations remain. Blynscy cannot currently provide reliable

dimensional measurements such as taper length, device spacing, sign spacing, lane width, or pavement marking width, due to depth-perception constraints inherent in monocular dashcam footage. The company has indicated a potential entry into LiDAR-based data collection in late 2026, which could enable such measurements, though LiDAR requires dedicated static collection runs rather than the near-real-time coverage provided by continuously operating fleet vehicles. Arrow boards and portable changeable message signs are difficult to assess because flashing light refresh rates may not synchronize with image capture timing, resulting in blank or partially illuminated displays and missed detections. Concrete barrier presence can be reliably detected, but identifying barrier damage remains challenging, as dashcam viewing angles make it difficult to distinguish cracks from surface scuff marks

5.3.5 *Pricing Model*

The pricing model consists of two components:

- Image collection: \$8.00 per mile (one-time cost, single direction).
- Detection services: \$0.25 per mile per detection type.

For example, analyzing 100 miles of roadway in one direction costs \$800 for imagery collection. If both directions are required, the total distance doubles to 200 miles. Adding sign detection (\$0.25/mile) and channeling device detection (\$0.25/mile) results in a total cost of \$8.50 per mile. A key advantage of this model is that imagery collection is a one-time cost; multiple detection types can be run on the same imagery without recollection. Detection pricing is structured by the underlying AI model. For example:

- Channelizing device presence is treated as a single detection layer (\$0.25/mile).
- Sign detection (all signs) is one layer (\$0.25/mile).
- Sign condition assessment is an additional layer (\$0.25/mile), totaling \$0.50/mile for detection plus condition.

Blyncsy can process client-provided imagery at the same pricing structure. The pricing does not distinguish between client-provided imagery and imagery collected through Blyncsy's network. For example, one detection type would cost \$8.25 per mile regardless of the imagery source.

5.3.6 *Summary*

Blyncsy leverages dashcam imagery from multiple vendors, which can provide broader coverage and faster request fulfillment compared to single-source providers. Access to multiple imagery sources also allows Blyncsy to select higher-quality images for analysis. However, the cost of imagery per mile is significantly higher than direct purchase from data vendors. Blyncsy's AI models can detect the presence

and location of traffic control devices and perform a limited set of condition assessments, primarily for signs and pavement markings. A major limitation is the inability to perform dimensional measurements. More broadly, the scope of what can currently be detected and assessed remains limited relative to the extensive range of items typically evaluated during a full work zone inspection.

5.4 Viasight

ViaSight offers a smartphone-based, AI-driven solution for automated inspection of TTC devices.

5.4.1 Client Workflow

To conduct an inspection, the user mounts a standard smartphone on the vehicle windshield near the rearview mirror and launches the ViaSight mobile application. Recording begins upon entering the work zone. The system is designed to operate reliably at freeway speeds under bright, sunny daytime conditions. Upon completion of the drive-through, the video recording is uploaded to ViaSight's cloud servers via a cellular or Wi-Fi connection. Once processed, a complete inspection report becomes available through the platform's web-based dashboard — typically within six to ten minutes under good connectivity conditions, though longer work zones may require additional processing time. The ViaSight mobile application is currently available on the Google Play Store. As shown in Figure 16, the dashboard features an interactive map displaying geolocated markers for each detected deficiency. Users can click any marker to view the corresponding photographic evidence, description of the issue, and justification for flagging the item as deficient. Results are filterable by location, time, type, and severity.

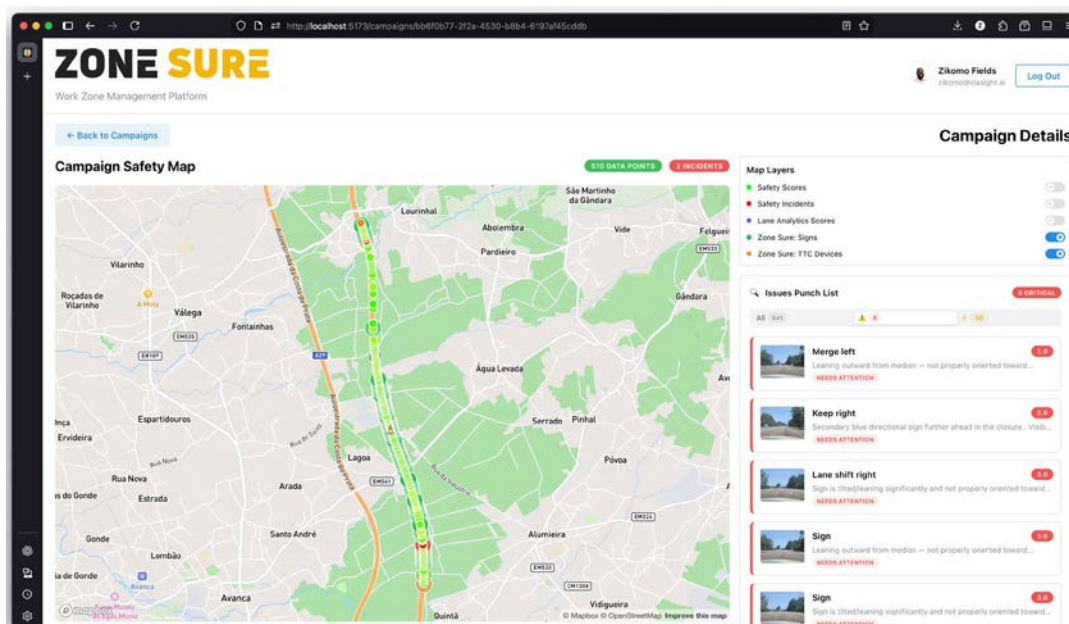


Figure 16. ViaSight web-based dashboard, showing markers for detected device deficiencies

5.4.2 *AI-Based Inspection Capabilities*

ViaSight's AI engine is purpose-built for work zone TTC inspections. As reported by the vendor in March 2026, the system can detect the presence, location, and condition of most TTC devices. Specific capabilities include the following:

- Channelizing devices (e.g., cones, drums): Assessment of upright status, knocked-over, missing, or damaged condition; detection of retroreflective tape deterioration.
- Signs: Identification of upright, knocked-over, missing, damaged, heavily leaning, or grossly mispositioned signs (including signs located within drivable travel space).
- Concrete barriers: Detection of damage.

The platform currently supports measurement of lane widths and device spacing. For device spacing, the system relies on geolocated markers and their associated GPS coordinates, which currently achieve approximately three- to five-meter accuracy. This precision is obtained by capturing GPS readings at half-second intervals during the drive-through and correlating them with recorded video frames to triangulate the positions of individual device. Upcoming enhancements planned for June 1, 2026 include the integration of GPS data with visual odometry techniques to improve relative device-spacing accuracy to approximately one meter, as well as additional dimensional measurements such as taper length. Certain inspection items are not currently supported. The system cannot assess arrow-board functionality — specifically, whether individual lights are out, whether the board appears dim or is not visible, or whether it is operating in an incorrect mode. This limitation stems in part from the rapid on/off duty cycle of LED displays, which can cause a camera to capture a blank frame even when the sign is functioning normally.

5.4.3 *Data Security and Compliance*

The ViaSight platform is hosted primarily on Amazon Web Services (AWS), with select processing functions utilizing Google Cloud Platform (GCP). All data storage resides on AWS. The system was designed from inception to comply with the European Union's General Data Protection Regulation (GDPR).

While GDPR compliance establishes a high standard of data protection and privacy, some of its requirements may need to be relaxed for optimal usability by U.S. agencies. For example, GDPR currently prohibits using customer feedback to improve detection algorithms — a practice that is permissible and potentially valuable under U.S. regulatory frameworks. Overall, ViaSight's current privacy controls exceed those typically required for domestic transportation-agency applications.

5.4.4 Pricing and Service Tiers

ViaSight employs a tiered, per-mile pricing model with four service levels corresponding to increasing AI-enabled inspection capabilities (Table 4). Tier 1 provides recording-only functionality at \$2.00 per mile. Tier 2, the current AI-enabled offering as of March 2026, includes detection, classification, and condition assessment of work zone assets — such as identifying knocked-over cones, damaged signs, or signs positioned within drivable travel space — at \$10.00 per mile. Tier 3 adds AI-driven measurement capabilities including dimensional analysis and comparison against MUTCD standards, such as device spacing within tapers and taper length assessment. Tier 4 would allow agencies to upload traffic control plans directly into the processing pipeline for automated comparison against observed field conditions, enabling full customization to agency-specific standards. Both Tier 3 and Tier 4 are under development with a targeted release of June 1, 2026, and pricing has not been finalized.

Table 4. ViaSight Pricing and Service Tiers

Tier	Per Mile	Minimum	Includes
Tier 1	\$2.00	No minimum	Video recording, 3-year storage, dashboard (map of recordings)
Tier 2	\$10.00	50 mi/mo (\$500/mo) Overage: \$7.50/mi	Tier 1 + AI classification and condition assessment, GPS location, PDF reports, stakeholder notifications
Tier 3	<i>TBD</i>	50 mi/mo Overage <i>TBD</i>	Tier 2 + MUTCD compliance, AI detection of sign placement, taper length, channelizer spacing
Tier 4	<i>TBD</i>	50 mi/mo Overage <i>TBD</i>	Tier 3 + localized compliance beyond MUTCD, TCP/MOT plan compliance

All tiers except Tier 1 are subject to a monthly minimum usage requirement of 50 miles per user license, with a discounted overage rate applied to usage exceeding that threshold. As a specific example for Tier 2, the first 50 miles are charged at the standard rate of \$10.00 per mile, while each additional mile beyond the minimum is charged at a reduced rate of \$7.50 per mile. The pricing model is structured on a per-user-license basis, with each licensed user maintaining a separate account and monthly minimum usage obligation. By way of illustration, an agency deploying two inspectors at Tier 2 would incur a minimum monthly cost of \$1,000 — two licenses at 50 miles each at \$10.00 per mile.

5.4.5 Pilot Study Opportunity

ViaSight is actively seeking pilot partnerships with state DOTs to accelerate the development and market readiness of its Tier 3 and Tier 4 offerings. The preferred pilot duration ranges from three months to one year, allowing sufficient time for data collection, iterative evaluation, and feature refinement. Structured touchpoints would be established throughout the engagement, including regular meetings to review

performance data, discuss accuracy metrics, and address operational issues. During the pilot, ViaSight would also provide access to beta and experimental features for early testing and feedback, enabling the partner agency to contribute directly to the platform's development trajectory. The proposed pilot configuration consists of five user licenses and 200 miles of usage per month, utilizing Tier 3 and Tier 4 capabilities as they become available. The estimated monthly cost for this configuration is \$7,500.

5.4.6 Summary

ViaSight represents a promising, low-infrastructure approach to supplementing traditional work zone inspections with AI-assisted, drive-through data collection and reporting. The platform's smartphone-based workflow requires no specialized equipment, and its tiered pricing model offers flexibility for agencies seeking varying levels of analytical capability. However, it should be noted that ViaSight is still an early-stage product: many features remain under development, and no case studies or independently validated accuracy metrics are available as of March 2026. The planned June 2026 release of measurement and plan-comparison features (Tiers 3 and 4) could represent a meaningful update to the platform's capabilities. ViaSight is actively seeking U.S. state DOT pilot partners to validate and refine these higher-tier capabilities, though it would also require a financial commitment during the development phase.

6. State DOT Case Studies

This chapter presents case studies of three state DOTs – Montana, Oklahoma, and Virginia – selected for their experiences with technology adoption in work zone inspection review processes. The Oklahoma DOT was selected because it reported the second-highest inspection volumes among survey respondents and has experience with diverse technologies, including Blynscsy and Iteris. The Montana DOT was selected for its experience with crowdsourced dashcam data and its documented coverage limitations in rural areas. The Virginia DOT was selected because it has successfully deployed ArcGIS Survey123 for editing, organizing, and storing inspection data. Semi-structured interviews were conducted with representatives from each agency, with durations ranging from 45 to 60 minutes.

6.1 Montana Department of Transportation

6.1.1 Inspection Workflow

Since approximately 2019, Montana DOT has observed a notable shift in the experience profile of its field workforce. Historically, field crews consisted of a balanced mix of personnel with varying levels of tenure, often ranging from a few years to several decades. This mix enabled informal knowledge transfer, with seasoned staff mentoring newer employees through daily operations. More recently, the workforce

has become considerably less experienced, resulting in diminished institutional knowledge at the project level. As a result, work zone inspection reviews have become increasingly critical—not only to ensure compliance with safety and mobility standards, but also to serve as a structured mechanism for training, mentorship, and professional development.

Montana DOT conducts work zone field reviews using a structured, four-visit escalation model:

- Initial Visit – Preliminary observation and identification of deficiencies requiring correction.
- Second Visit – Clear, directive communication outlining required corrective actions.
- Third Visit – Verification of compliance; most projects achieve acceptable configuration by this stage.
- Fourth Visit – Documentation of final conditions for inclusion in a comprehensive report.

This predictable review cadence reinforces accountability, as project managers understand that formal documentation will be generated and retained for their project. Montana DOT uses multiple complementary methods to document work zone conditions during field reviews. The primary method involves driving through the project in both directions while recording high-definition video using an iPhone mounted at driver eye level, capturing the motorist's perspective for assessing signing, channelization, and overall work zone legibility. In urban environments, drive-through reviews are supplemented with walk-up inspections to evaluate pedestrian traffic control and accessibility features. Montana DOT also uses unmanned aircraft systems (UAS) to obtain aerial imagery, enabling direct comparison of field conditions with traffic control plans and precise dimensional measurements for identifying and communicating deficiencies such as spacing or alignment issues to contractors.

Following field visits, video footage is downloaded and reviewed in a controlled setting. This post-review analysis has proven particularly effective for identifying indicators of driver confusion that may not be evident during real-time observation. For example, video review of a location where traffic queues were forming revealed heavy skid marks and evidence of evasive maneuvers, signaling operational deficiencies that required corrective action. After completing the desktop analysis, reviewers return to the project site to communicate recommended modifications to field inspectors. Video documentation is also reused for training purposes, reinforcing its value beyond immediate inspection needs.

Montana DOT's field reports emphasize visual communication, combining aerial/field imagery, and annotated markup. A color-coordinated annotation system links observed deficiencies directly to elements in the traffic control plan. For example, as shown in Figure 17, blue annotations on aerial imagery correspond to specific callouts in the traffic control plan, while green annotations reference another element. This approach ensures that deficiencies are communicated clearly for informed correction.

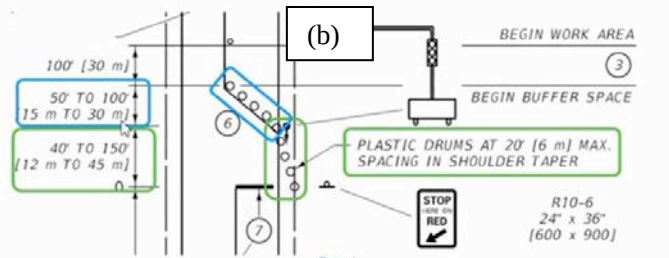
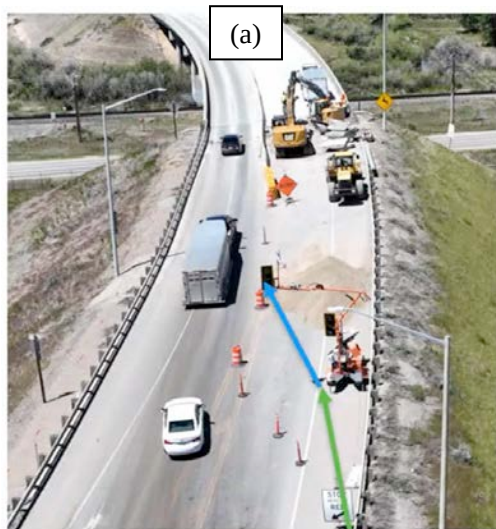


Figure 3 shows an excerpt from MDT Detail Drawing 618-13 the blue and green notations in figure three correspond with the green and blue notations in figure two. It is best practice to follow these drawings. The detail drawings also offer important information regarding spacing of devices. Drums in the shoulder taper and one-lane two-way taper for this set up should be spaced at a spacing to not exceed 20 feet.

The taper circled in blue is the one-lane two-way traffic taper. This taper's purpose is to indicate closure of a portion of the roadway so that the remaining roadway must accommodate traffic in both directions. Placement of a one-lane two-way traffic taper is in advance of an activity that occupies part of a two-way roadway. The activity requires closure of a portion of the roadway so that the remaining roadway must accommodate traffic alternately in both directions. The purpose of this taper is to alert drivers of potential head-on conflicts with a one-lane two-way traffic pattern. Typically, these tapers are installed when flaggers or temporary traffic signals control traffic. It is important to install this taper correctly because the function of this taper is not to merge traffic but, to stop traffic by giving the appearance of a restricted alignment.

Figure 17. Aerial imagery of a work zone with color-coded annotations linking observed field conditions to the traffic control plan.

6.1.2 Workforce Development as a Best Practice

Montana DOT has implemented a structured mentorship approach as part of its work zone inspection program. After completing formal training, new engineering project managers participate in accompanied field visits with the statewide work zone engineer. During these visits, trainees are asked to identify deficiencies, recommend improvements, and locate relevant specifications to support their decisions. Although this approach requires additional time investment, outcomes have justified the effort. Compliance rates have improved substantially, with most issues resolved by the next review cycle. More importantly, the mentorship model has transformed field communication patterns. Personnel now have an identifiable point of contact, and inquiries have evolved from basic questions about locating specifications to sophisticated consultations where field staff present complex issues along with potential solutions, seeking concurrence rather than direction.

6.1.3 Evaluation of Emerging Technologies

Montana DOT evaluated crowdsourced dashcam data between approximately 2021 and 2022, testing Nexar along a major tourist route between Helena and Glacier National Park and a remote project in eastern Montana. The objective was to enable preliminary remote assessments to determine whether in-person visits are necessary. Results indicated insufficient data frequency for effective work zone monitoring: the tourist corridor produced only one to two usable data points per week, while the remote site yielded one to two per month, far short of the multiple daily observations needed to capture dynamic

work zone conditions such as daily lane closures. Data also represented only one travel direction. Montana DOT concluded that crowdsourced dashcam technology does not currently present a favorable cost-benefit proposition for work zone inspection, as data procurement costs were prohibitively high relative to the frequency obtained and pricing structures are typically per-request rather than programmatic, making expenditures difficult to justify for construction-season monitoring.

Montana DOT also engaged with Blynscy between approximately 2023 and 2025 to explore AI applications for work zone inspections. Desired capabilities extended beyond current vendor offerings to include automated device counts, measurement of sign spacing and taper lengths, detection of barrier rail placement and end terminal impacts, and identification of malfunctioning devices such as incorrect message boards or missing equipment. An additional challenge involves traffic control plan compatibility, as contractors are permitted flexibility in developing their own plans, complicating the ability to upload standardized plans for AI-based comparison between designed and implemented configurations.

6.1.4 Exploring Multimedia Approaches for Inspection Reporting

Montana DOT conducts a relatively small volume of inspections each year, but each one produces in-depth reports—often exceeding 50 pages—to ensure clear communication and documentation of field conditions. However, Montana DOT acknowledges that lengthy reports may discourage thorough reading. To address this challenge, the agency is exploring alternative content delivery methods, specifically ArcGIS StoryMaps incorporating video content. Short-form video formats align with the consumption preferences of a newer workforce that favors immediate, highlight-focused content. The visual nature of work zone deficiencies suggests that video-based communication would be more effective than written documentation alone. A proposed format would incorporate drive-through video footage with voiceover narration highlighting specific observations in real time. This approach would deliver meaningful learning content in approximately three-minute segments while substantially reducing documentation development time compared to traditional written reports.

6.2 Oklahoma Department of Transportation

6.2.1 Work Zone Inspection Process

Oklahoma DOT's field inspections are primarily conducted as drive-through reviews with video recording. Site visits represent the most time-intensive component of the inspection process due to driving hour limitations, travel time to and from project locations, and time required for video recording in the field. Despite these constraints, Oklahoma DOT completed 435 work zone inspections in 2024, demonstrating a high inspection volume. The agency currently employs two full-time work zone

reviewers, with the state divided geographically into north and south regions. One reviewer is assigned to each region. A third individual, the original work zone reviewer who has since transitioned into other responsibilities, provides consultation support and assists in emergency situations. This individual also contributes valuable institutional knowledge to the program.

After field visits, reviewers return to the office and conduct detailed video reviews. Reviewers can pause, replay, and closely examine recorded footage, allowing for a more thorough inspection than would be possible in real time during field drives. During this process, video observations are also compared against design plans displayed on a separate monitor to verify consistency between planned and implemented traffic control. An Excel-based inspection spreadsheet template is used to document observations and compare them against established quality and standards guidelines. The post-visit analysis and reporting process typically requires one to three days to complete. A significant portion of this time is spent on data preparation, including transferring video files from recording devices to agency servers. Even with high-speed internet connections, upload times remain a challenge due to file size.

6.2.2 Current Technology Usage

Oklahoma DOT currently uses Microsoft Power Automate to support communication. When a review document or video is added or updated, the appropriate resident engineer automatically receives a notification. An example is shown in Figure 18. Access controls are applied so that residents can view only their assigned project folders.

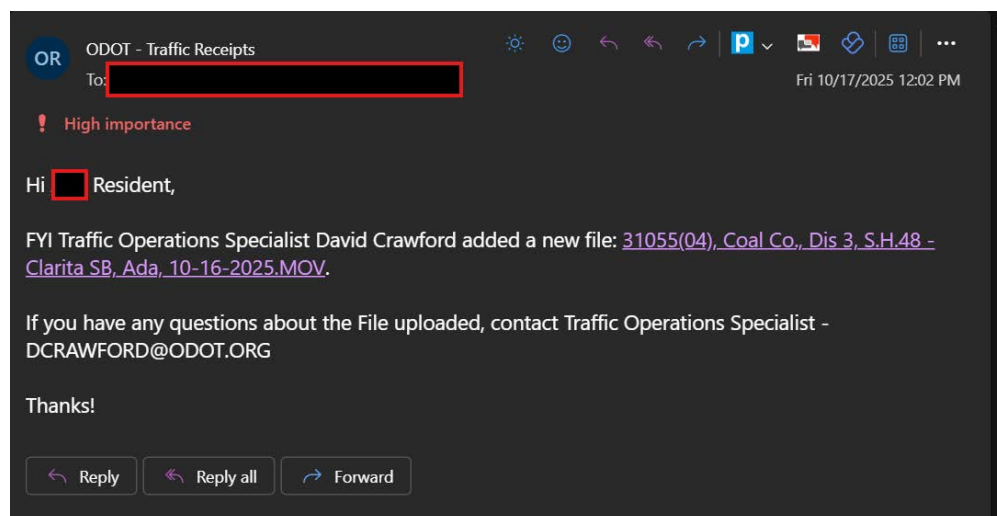


Figure 18. Automated notification email sent to resident engineers via Microsoft Power Automate when new inspection videos or reports are uploaded to project folders.

6.2.3 *Evaluation of Emerging Technologies*

Oklahoma DOT has explored several emerging technologies to enhance inspection capabilities. The agency conducted demonstrations of Blynscy across its eight districts, with each selecting approximately 100 miles of roadway for evaluation. Most districts focused on striping and sign analysis rather than work zone applications, resulting in limited experience with Blynscy's work zone functionality, and the cost of statewide coverage was identified as a significant barrier to adoption. Oklahoma DOT also explored the feasibility of a geofenced automatic upload system to initiate video uploads when inspection vehicles entered designated parking areas, but no practical solution was found that could reliably handle large video files across the wide geographic distances between reviewer locations and district offices. The agency is additionally considering 360-degree cameras as current forward-facing video does not always capture the full environment experienced during drive-through inspections, and a 360-degree view could allow reviewers to better document conditions and communicate issues to resident engineers.

Based on current practice, Oklahoma DOT has identified several needs that could improve inspection efficiency and safety. First, crowdsourced technologies that reduce the amount of time staff spend driving through active work zones would improve operational efficiency and enhance employee safety. Additionally, automated or AI-assisted tools could help reviewers identify issues that may be missed during manual review, particularly in lengthy or complex videos. Tools that support objective measurements, such as retroreflectivity of signs and pavement markings, would help verify compliance with visibility and performance standards.

6.3 Virginia Department of Transportation

For approximately 30 years, Virginia DOT relied on a paper-based work zone inspection checklist that remained fundamentally unchanged in format. As mobile technology advanced, some districts independently converted the checklist into fillable PDF forms on tablets, but this resulted in inconsistent documentation practices and siloed inspection data stored across individual project folders at the agency, regional, and project levels, limiting the ability to analyze work zone performance over time. Recognizing the need for centralized data management, Virginia DOT developed and implemented a work zone inspection application using Esri Survey123 in 2024. The platform was selected because Virginia DOT maintains a statewide Esri license eliminating additional software costs, state IT policies favor platforms supporting external user access for consultants and contractors, and the Esri ecosystem provided reliable image handling and accessibility outside Virginia DOT's internal network. The application was piloted in multiple districts with positive feedback from field staff.

The Survey123 application enables inspectors to complete work zone inspections electronically in the field. Inspectors typically videotape work zones from multiple directions, extract still images, and upload them into the inspection report. The application is organized into distinct question groups containing more than 200 checklist items, each with a dedicated comment field and speech-to-text functionality for dictating notes while driving or during brief stops. Each question group supports two photograph uploads, with unlimited additional photographs available at the end of the survey. Inspection reports are generated automatically as Word documents through the ArcGIS cloud service, with question groups where no items were selected automatically excluded and displayed as "not reviewed at this time." The application performs well on both tablets and larger smartphones, and project locations can be geotagged, although individual photographs are not currently geotagged.

While the application represents a substantial improvement over previous practices, several limitations remain. Access to Virginia DOT's ArcGIS environment must be formally requested and approved, which may limit rapid onboarding of new users. The next phase of implementation — encouraging or requiring consultant inspectors and contractors to use the electronic form — has been deferred due to the organizational complexity of mandating consistent adoption across all parties, which would require coordinated policy, training, and change-management efforts.

7. Best Practices and Recommendations

7.1 State DOT Best Practices

The following recommended practices for work zone inspection reviews are based on a synthesis of processes observed across participating state DOTs. Best practices are organized into Data Collection, Data Analysis, Reporting and Communication, and Continuous Improvement.

7.1.1 Data Collection

Emphasize Relationship-Building During Field Reviews. Approach field visits as opportunities to build collaborative relationships with project staff and contractors. When reviews are framed as supportive rather than adversarial, field personnel are more likely to engage openly, share operational challenges, and act on recommendations.

Participate in Emerging Technology Pilots. Engage with technology vendors offering pilot study opportunities to build internal technical capacity, inform how tools develop before broader deployment, and ensure that new technologies align with operational needs.

Use Unmanned Aircraft Systems (UAS) for Aerial Assessment. Incorporate UAS to obtain aerial imagery

that enables direct comparison of field conditions with traffic control plans, particularly for dimensional measurements.

Adopt Centralized Digital Inspection Platforms. Standardize data collection and eliminate siloed documentation through platforms such as Esri Survey123, which support electronic field inspections with organized question groups, speech-to-text functionality, photograph uploads, and automated report generation.

7.1.2 Data Analysis

Adopt Quantitative Scoring Systems. Convert inspection findings into numerical scores to benchmark performance across projects, districts, and time periods. Quantitative scoring enables objective tracking of improvement trends and supports visual communication of results to leadership and stakeholders.

Integrate Qualitative Analysis with Quantitative Scores. Supplement aggregated scores with field notes and post-review discussions to understand why deficiencies occur, not just where. Connecting performance trends to root causes supports targeted, actionable improvements.

Conduct Post-Visit Video Review. Details such as skid marks, evidence of evasive maneuvers, and unexpected traffic queuing patterns become more apparent when footage can be paused, replayed, and examined closely.

7.1.3 Reporting and Communication

Adopt Dynamic, Visual Formats. Move beyond lengthy written reports by using interactive tools such as Esri StoryMaps. Short-form video content, such as drive-through footage with voiceover narration, can deliver meaningful observations in approximately three-minute segments.

Use Annotated Reporting with Color-Coded Plan References. Structure reports around visual communication by combining aerial imagery, field photography, and annotated markup. Color-coded annotations on aerial imagery can correspond to distinct callouts in the traffic control plan, ensuring each deficiency is clearly communicated and traceable to its design intent.

Automate Stakeholder Notifications. Use workflow automation tools such as Microsoft Power Automate to notify relevant project staff when inspection documents or videos are added or updated.

7.1.4 Continuous Improvement

Frame Inspections as Safety Improvement Tools. Position inspection reviews as instruments for achieving

tangible safety outcomes. Increase the transparency of inspection data and resulting policy changes so that inspectors can see how their findings lead to meaningful actions, such as updates to standards, specifications, or training. Demonstrating this connection strengthens inspector engagement and fosters ownership over the quality improvement process.

Use Inspections for Training and Mentorship. Leverage inspection reviews for professional development, particularly as agencies face workforce turnover and diminished institutional knowledge. Pair new engineering project managers with experienced inspectors for accompanied field visits in which trainees identify deficiencies, recommend improvements, and reference relevant specifications. Over time, this builds technical competence and transforms field communication patterns—staff progress from basic procedural questions to presenting complex issues alongside potential solutions, seeking concurrence rather than direction.

7.2 Recommendations on State DOTs using Existing Technologies

7.2.1 Crowdsourcing Technologies

This study identified three approaches for utilizing crowdsourced dashcam imagery in work zone inspection reviews: procuring imagery directly from a data provider (Vizzion), accessing imagery through a third-party software-as-a-service platform with visualization and analytics capabilities (Iteris), and engaging an AI-powered program that integrates dashcam data with automated detection features (Blyncsy). Table 5 and narrative summarize the relative strengths and limitations of each approach across key evaluation criteria.

Table 5. Comparison of Crowdsourced Dashcam Data Providers

Criteria	Vizzion	Iteris	Blyncsy
Data Coverage	★★ High-traffic corridors; limited rural	★★ Same with Vizzion	★★★★ Higher coverage via multiple data providers
Data Quality	★★ 720–1080p, 1 FPS	★★ Same with Vizzion	★★★★ Higher quality via multi-providers
Retrieval Frequency	★★★★ On-demand; 10-day window	★★★★ On-demand; 10-day window	★ Per-request basis; costly with frequent retrieval
Inspection Capability	★ Remote visual inspection only	★★ Remote visual inspection only; integrated traffic data	★★★★ Built-in AI detection features
Cost	\$ ~\$3,250/month	\$\$\$ ~\$250K–\$300K/year	\$\$ ~\$85/pass; scales rapidly

Ease of Use	★ API-based; requires programming	★★★ Map-based GUI; user-friendly	★★ Email-based requests
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Vizzion requires exact work zone locations to request imagery efficiently. Coverage is concentrated along high-traffic corridors and populated areas, with less reliable availability in rural locations. Imagery resolution (720–1080p at 1 FPS) supports remote inspection of select items such as taper presence and sign absence or knockdown. It supports frequent imagery retrieval within a selectable 10-day window. At approximately \$3,250 per month, it is the most affordable option. However, it requires programming to interact with its API and ongoing effort to request, store, organize, and filter raw imagery.

Iteris offers a user-friendly, map-based interface that requires only approximate locations for browsing and retrieving imagery. It utilizes Vizzion’s dashcam imagery but provides integrated analytics that overlay dashcam imagery with traffic performance data. However, it carries the highest cost: \$100,000–\$150,000 annually for the software subscription, with dashcam imagery as an add-on at approximately \$150,000 per year. An unlimited user access model with no per-seat fees allows cost sharing across divisions, which may partially offset the investment.

Blyncsy is suited for targeted, limited-scope inspections with infrequent data retrieval. It offers the highest data coverage and quality potential due to partnerships with multiple crowdsourced data providers, and the platform includes built-in AI features for detecting channelizing devices, signs, sign condition, and pavement marking condition. Interaction is relatively straightforward, conducted through email correspondence with customer service. However, costs are prohibitively expensive at scale: for example, a statewide snapshot across 11,800 miles of WisDOT-administered highways would cost approximately \$188,800. While a single pass of a 5-mile project costs roughly \$85, monitoring 20 active projects weekly would exceed \$88,400 annually.

7.2.2 AI Technologies

A market scan conducted as part of this study identified only two AI-powered programs with demonstrated capabilities applicable to work zone inspection reviews: Blyncsy and ViaSight. These programs differ fundamentally in their data acquisition approach, inspection workflow, and analytical capabilities. Blyncsy processes crowdsourced dashcam imagery collected through a network of data providers and delivers results via emailed geospatial files. ViaSight uses a smartphone-based, drive-through workflow in which inspectors record video during field visits and receive automated inspection reports through a web-based dashboard. Table 6 and narrative summarize the relative strengths and limitations of each program.

Table 6. Comparison of AI-Powered Work Zone Inspection Programs

Criteria	Blyntsy	ViaSight
Data Source	★★★ Crowdsourced; no field visit required	★★ Inspector-recorded smartphone video
Detection Scope	★★ Devices, signs, markings, barriers	★★★ Devices, signs, barriers, with more condition detail
Measurement Capability	★ Not currently supported	★★ Device spacing and lane width; taper length planned
Turnaround Time	★ Days to one week	★★★ Minutes after upload
Reporting and Usability	★★ Emailed geospatial files (GIS-compatible)	★★★ Interactive dashboard with map, photos, and filtering
Cost	\$\$ ~\$8.50/mi	\$\$\$ ~\$10/mi (Tier 2)
Maturity	★★★ Established; operational deployments	★ Early-stage; no independent validation to date

Blyntsy leverages crowdsourced dashcam imagery from multiple vendors, enabling analysis without requiring a field visit. Its computer vision models detect the presence and location of channelizing devices, signs, concrete barriers, and pavement markings. Condition assessments are available for signs (physical damage, fallen signs, graffiti, vegetation obstruction, and binary retroreflectivity) and pavement markings (missing segments and binary retroreflectivity). However, Blyntsy cannot currently perform dimensional measurements such as taper length, device spacing, or lane width; LiDAR-based measurement capabilities are anticipated in late 2026. Arrow boards and portable changeable message signs also cannot be reliably assessed due to refresh rate synchronization issues with dashcam image capture. Results are delivered via emailed geospatial files compatible with ArcGIS and QGIS, but raw imagery is not downloadable. Imagery collection costs \$8.00 per mile per direction, with detection services at \$0.25 per mile per detection type. While per-pass costs appear manageable for individual projects (approximately \$85 for a 5-mile project), inspection frequency compounds expenses rapidly: monitoring 20 active projects weekly would exceed \$88,400 annually.

ViaSight offers a smartphone-based, drive-through inspection workflow requiring no specialized equipment. Inspectors mount a standard smartphone on the windshield, record video while traversing the work zone, and upload footage to cloud servers. Processed inspection reports are typically available within six to ten minutes through an interactive web-based dashboard featuring geolocated deficiency markers, photographic evidence, issue descriptions, and filtering by location, time, type, and severity. The AI engine reportedly detects the presence, location, and condition of channelizing devices, signs, and pavement markings, including identification of upright, knocked-over, missing, damaged, heavily leaning,

or mispositioned items. The platform currently supports measurement of lane widths and device spacing using GPS-correlated positioning at approximately three- to five-meter accuracy, with enhancements planned for June 2026 to improve relative spacing accuracy to approximately one meter. Planned Tier 3 and Tier 4 capabilities would add MUTCD compliance analysis and automated comparison against uploaded traffic control plans. Tier 2 pricing is \$10.00 per mile with a 50-mile monthly minimum per user license. While the per-mile cost exceeds that of Blyncsy, this premium may be justified by ViaSight's broader AI detection scope, interactive reporting interface, and dedicated mobile application. Tier 3 and Tier 4 pricings have not been publicly released but is expected to approximately double the Tier 2 rate. ViaSight remains an early-stage product: many features are under development, and no case studies or independently validated accuracy metrics are available as of March 2026.

7.3 Recommendations for Future Research and Development

This section outlines key recommendations for advancing work zone inspection technology. Recommendations are organized by intended audience: researchers and technology vendors and state DOTs/transportation agencies.

7.3.1 *For Researchers and Technology Vendors*

Several research and development gaps remain in work zone inspection technology that warrant further investigation. State DOTs interviewed in this study identified several areas as high-priority technology innovations, yet these remain either underdeveloped in current commercial offerings or insufficiently addressed in academic research:

- **Dimensional Measurements:** Methods for extracting precise measurements-such as device spacing and taper length-from video or image data require further development. This represents a particularly critical deficiency, as these measurements are difficult and time-consuming to evaluate manually.
- **AI Capabilities:** Research is needed on the nighttime retroreflectivity of various TTC devices and the detection of surface damage such as scratches on concrete barriers. Additionally, the assessment of arrow boards and portable changeable message signs presents unique challenges, as flashing light refresh rates may not synchronize with image capture timing, resulting in missed or inaccurate detections.
- **Contextual Assessment:** Future research should explore how AI systems can move beyond object detection to incorporate contextual understanding of work zone conditions, interpret

applicable policies and standards, and approximate the engineering judgment required for meaningful compliance evaluation. This includes evaluating the potential of vision–language models to automate qualitative condition assessments and contextual compliance analysis for work zone inspections.

- **Robustness under Field Conditions:** Further efforts are needed to improve overall detection performance under challenging field conditions, including nighttime operations, adverse weather such as rain, snow, and fog, partial occlusion of objects, high vehicle speeds, low-resolution imagery, and low-light environments.
- **System Integration and Workflow Enhancement:** Future development should also target higher-level capabilities that AI tools can provide, including automated comparison of field conditions against approved traffic control plans and seamless integration of AI tools with crowdsourced dashcam imagery. Beyond AI-specific features, complementary tools are needed to help track active work zone locations, manage multi-party review team schedules, and account for availability constraints during peak construction seasons. Organizational tools would further streamline inspection data management through user-friendly video uploads to cloud storage, automated geotagging of photographs, and automated notifications.

7.3.2 *For State DOTs and Transportation Agencies*

State agencies typically maintain standardized inspection forms comprising 60 to over 100 individual items. These items differ in safety criticality, frequency of deficiency, and difficulty of manual assessment, meaning that some stand to benefit far more from AI-powered assistance than others. For example, this study found that dimensional measurements represent one of the AI capabilities most desired by state DOTs. Even within this category, the needs are nuanced: not only is the spacing of channelizing devices important, but the overall length and alignment of tapers are equally critical. Such knowledge remains largely tacit and is not well understood by current technology vendors and researchers. This is evidenced by the fact that most commercial solutions focus on lower-complexity tasks such as detecting the presence of a device—a capability that provides relatively limited value because it does not meaningfully augment inspector judgment. AI tools should aim to support the analysis of both crowdsourced dashcam and self-recorded videos in ways that enhance, rather than replicate, tasks inspectors already perform efficiently. It is the responsibility of state DOTs and transportation agencies to make such domain knowledge publicly accessible. Specifically, agencies should:

- **Prioritize Inspection Items by Value to the Agency:** Rank inspection checklist items by safety

criticality, frequency of deficiency, and difficulty of manual assessment to guide AI development toward the items that deliver the greatest value.

- **Provide Benchmark:** For high-priority inspection items, define expectations regarding what exactly needs to be assessed, criteria, and the level of accuracy and consistency required for results to be meaningful. This benchmarking framework is particularly important because this study found it difficult to conduct side-by-side comparisons of different vendor offerings due to inconsistent vocabulary and standards.
- **Share Resources:** Share open-source datasets for the highest-priority items, encompassing multiple work zone configurations and environmental conditions, to enable AI models that generalize effectively to real-world scenarios.

It is also important to note that academic attention in this area remains extremely limited. Few if any studies focus specifically on work zone inspection reviews, despite these being critical safety practices conducted by state agencies nationwide. This gap matters for several reasons. Technology vendors typically start from practical problems, whereas academic researchers tend to leverage emerging technologies and novel ideas that could introduce fundamentally new concepts and approaches to the field—a distinction that is particularly important given the rapid pace of technological advancement. Additionally, current proprietary solutions carry high price points that arguably exceed the value they can deliver at this stage, and collaborative investment in open-source solutions could stimulate competition and fundamentally improve the cost–benefit calculus for DOTs. Finally, academic research emphasizes rigorous solution validation and transparency, supporting reproducibility and long-term knowledge growth in the field. For these reasons, it is strongly recommended that state DOTs consider **a multi-state pooled-fund study or an NCHRP effort to develop open-source AI tools** for work zone inspection.

Finally, **workforce development** deserves particular attention. Agencies face a growing volume of work zones driven by increased federal and state infrastructure investment, alongside rising project complexity. At the same time, high turnover has shifted the composition of field crews toward less experienced workers, with the consequence that temporary traffic controls are more frequently executed improperly. Inspection teams are typically short-staffed, and the challenge extends beyond conducting inspections: translating results into corrective actions, targeted education and training, and policy updates requires substantial expertise and institutional knowledge. As experienced personnel retire, the risks of knowledge loss and diminished mentorship capacity grow. Future research should explore sustainable workforce models that address these compounding challenges.

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