OKLAHOMA
Transportation

Office of Research and Implementation
FFY2025 Request for Proposals

Reference SPR Item # 2299

Research Problem Statement Title:

Assessing and Enhancing the Traffic Count and HPMS Program

Problem Statement:

The Highway Performance Monitoring System (HPMS) is mandated by federal laws (23 U.S.C. 315, 23 CFR 1.5, and 23 U.S.C. 502(g)) to provide comprehensive data reflecting the state of the Nation's highways. State departments of transportation (DOTs) are responsible for data collection and reporting to the FHWA headquarters using FHWA-developed submittal software. Although FHWA receives, screens, and utilizes this data, it remains the state's responsibility to ensure its quality and meet federal reporting requirements. Collaboration between state agencies, local governments, and metropolitan planning organizations (MPOs) is encouraged for effective data collection, assembly, and reporting. States must certify public road miles annually by June 1st and submit previous year's HPMS data to FHWA by June 15th to comply with federal requirements. Traffic monitoring data plays a crucial role in the HPMS. FHWA mandates 48-hour counts on a 3-year cycle for national highway system (NHS) and principal arterial roadway sections, and a 6-year cycle for non-NHS lower functional roadway sections.

Proposed Research:

The project aims to assess and enhance the Oklahoma HPMS program by evaluating existing traffic count locations and incorporating potentially new sites while eliminating unnecessary ones. It seeks to integrate emerging technologies and data sets to minimize data collection costs. The project aims to directly enhance the Oklahoma HMPS traffic data collection program by providing statistically representative and non-redundant traffic count locations to meet HPMS reporting requirements. It will identify missing roadway segments and remove unnecessary collection locations. Additionally, it aligns with the Department's mission to create a safer, sustainable, and efficient transportation system by reducing field trips for census staff, increasing data quantity, and enhancing data quality.

Suggested Tasks (to include but not limited to):

Task 1 Conduct a review of existing literature relating to this subject.
Task 2 Assessing if current traffic count locations adequately cover Oklahoma HPMS roadways.
Task 3 Explore collaboration with local governments and MPOs to integrate their data into ODOT's count program for HPMS reporting.
Task 4 Evaluate if continuous count locations are sufficient for factoring short-term traffic counts.
Task 5 Review emerging technologies and data sources suitable for Oklahoma's HPMS reporting needs.
Task 6 Summarize evaluation results of existing traffic data collection locations and technologies used in the Oklahoma HPMS Program. Prepare shapefiles following ODOT GIS group's format. Prepare and submit the Final Report.

Implementation:

The results of this study will be implemented into the current ODOT systems.

Benefits:

The project's findings will improve HMPS field traffic data collection practices by optimizing the utilization of existing data and resources. Additionally, it will facilitate the deployment of new technologies for field traffic data collection at reduced costs.

Deliverables:

All projects require the submission of the following reports:

- Monthly Progress Reports
- Multi-Year Projects require a Year-end Annual Report
- Copies of the project Draft Final Report in Microsoft Word and ADA accessible Adobe Acrobat pdf electronic formats
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The Year-end Annual Report, Draft Final Report, Final Report and Color Article should be submitted to satisfy all federal and state requirements pertaining to the accessibility of documents including but not limited to:

- Oklahoma State Statute 62 § 41.5e and the Americans with Disability Act (ADA) of 1990, 42 USC 12.01 et seq.

The PI must also participate in the following project meetings:

- New project initiation meeting
- Semi-annual project meeting
- Close-out project meeting
- Continuing project meeting

Estimated completion time eighteen months.

Existing Research found in light literature search:

University of Texas at Austin Center for Transportation Research (2024)
"An Exploration of the Use of Artificial Intelligence for Enhanced Traffic Management, Operations and Safety"
https://rosap.ntl.bts.gov/view/dot/73558
This project explored the use and value of artificial intelligence and machine learning (ML) in transportation taking a multi-pronged approach that includes a literature review, a workshop, a survey, the development of3 prototype ML models for four high-priority use cases, and the field testing of one of the prototyped models. Initial tasks were exploratory in nature and led to a better understanding of the current and prospective uses of ML in transportation, corresponding data needs, and specific use cases of interest to TxDOT. Prototype model development was used to assess the value, challenges, and limitations of implementing several types of machine learning models to support the use cases prioritized by TxDOT. The prototypes leveraged emerging and traditional data sources: Wejo event data was used along CRIS data to build supervised and unsupervised learning models for understanding safety hot-spots and evaluating the effects of the pandemic on safety and traffic patterns; a microsimulation environment was used to explore the feasibility of adjusting traffic signal timing plans in real-time in a frontage road setting using reinforcement learning models; probe-based speeds from INRIX were combined with traffic volume data from TxDOT's ITS to generate short term travel time predictions on I-35, which could lead to more accurate driver information. Short -term travel time prediction models were selected for field testing given the promising results found during the prototyping and the maturity and widespread availability of the involved data sources. In our preliminary models ML experienced travel time predictions were 40% more accurate during peak periods that those from traditional approaches. Field testing included the training of additional models in Austin and El Paso, and the development of a framework to expedite model training, testing, and evaluation, and to support real-time deployment. Real-time predictions were shared with TxDOT through a web-based application that also facilitated model evaluation. The performance evaluation of the newly trained models considered the ability to correctly identify the fastest route among competing alternatives, and predictive ML models were found to be correct more often than traditional approaches.

Federal Highway Administration (2023)
"Review of Traffic Management Systems – Current Practice"
https://rosap.ntl.bts.gov/view/dot/72446
The purpose of this report is to provide an appreciation of the current practices, new methods, emerging technologies, and approaches to improve the active management and operation of a traffic management system (TMS). As agencies plan to implement or explore improving a TMS, they are facing a number of challenges, such as performance, costs for expanding system coverage, costs for enhancing supported services, costs for operating and maintaining the 2 system, and demands on staff resources and their capabilities to operate and maintain the

system. This report examines the basic functions of TMSs and supported operational strategies to identify how their current system compares to others; the range of capabilities existing in their practice; the motivation for agencies making investments in TMS functions or capabilities; the challenges and lessons learned from other agencies; and how to help agencies identify potential areas of improvement for their systems.
New technologies and data collection methods offer the potential to advance TMS capabilities and offer entirely new functions or services. These new opportunities can position agencies to implement emerging operational strategies and prepare for automation and next-generation TMSs. Effective practices include GDOT's multiagency signal operations, VDOT's data-sharing system, Caltrans shared TMS functions, and Niagara International Transportation Technology Coalition's shared traffic information system. Emerging data sources include third-party and service provider data, and crowdsourcing data.

Pennsylvania Department of Transportation (2023)
"Highway Performance Monitoring System Quality Review"
https://gis.penndot.pa.gov/BPR_pdf_files/Documents/Traffic/Highway_Statistics/HPMS/2023_Quality_Review_Report.pdf
Each year, an annual quality review of Pennsylvania's HPMS is conducted. The review is performed by the Bureau of Planning and Research's (BPR) HPMS staff and consists of HPMS field views of randomly selected sample sections in several counties. The purpose of this review is: To ascertain the current state of HPMS data quality and ensure that any errors found are corrected. To determine if any common problem areas exist and identify subsequent training needs. To determine if any organizational or procedural changes to the HPMS program are warranted. To ensure that communications regarding HPMS are maintained between PennDOT, MPOs and PennDOT District Offices.

Proposed 2024 Action Items include:
- HPMS Training
- Quality Reviews
- Use of PennDOT SharePoint website
- HPMS Mobile

University of Maryland (2023) "Off-line and Real-time Evaluations of Eastern-Shore Sensors with a Generalized Detection Performance Monitoring System"
https://rosap.ntl.bts.gov/view/dot/66973
The primary objectives of this study are to develop a detector performance monitoring system for both off-line and on-line applications, and to implement such a system for the Eastern Shore region's current and proposed sensors, including: evaluate the data quality and reliability of the six sensors deployed in the Eastern Shore region; assess the applicability of the six sensors in the Eastern Shore region for supporting various traffic monitoring and congestion-control strategies; and analyze the data applicability and effectiveness of the proposed 14 more 3 sensors for the Eastern Shore region for traffic monitoring, congestion control, or emergency evaluation, based on their proposed deployment locations. The first product of this study is a set of guidelines for selecting the deployment locations for traffic sensors in the Easter Shore region for different purposes, such as speed monitoring, signal design, or congestion control. The second product is an innovative, multi-stage control model for traffic professionals to efficiently assess the quality of massive speed and flow rate data produced from a deployed detector. Based on the quality assessment results, the responsible maintenance engineers/staff can better classify the operational status of each deployed detector, including "for speed-monitoring only," "for traffic control and management," "need to replace with new detector," and "need a field calibration to improve the detection accuracy."

International Conference on Transportation and Development (2022)
"Highway Traffic Information Management with Building Information Modeling (BIM)

https://ascelibrary.org/doi/10.1061/9780784484319.010
Geographic information systems (GIS) and building information modeling (BIM) have many common features and functions for data management and data display and illustration. As part of the Highway Performance Monitoring System (HPMS), the statewide traffic data in Indiana is updated and presented through the GIS method. The attributes of highway location, geometry, and traffic information are expressed and displayed using shapefiles. However, the functionalities of shapefiles in GIS are rather limited in comparison with various BIM features and functions. This paper presents a method to establish a BIM model to replace the existing GIS model in order to improve the effectiveness of traffic information management. The existing GIS traffic information model displays the traffic volumes recorded with portable and temporary traffic data collection devices at the selected sample spots on the Indiana highway network. However, not included in the GIS model are the important traffic attributes recorded with weigh-in-motion (WIM) and automatic traffic recorder (ATR) devices, such as vehicle types, speeds, and axle weights. This paper presents the process of converting the existing GIS model to a BIM-based traffic information management model. The traffic data was expanded to include the WIM and ATR recorded traffic data so that vehicle types, speeds, and axle weights can also be stored and illustrated through the BIM platform. An automatic transformation method was developed and presented in this study. The BIM system has demonstrated strong advantages over the GIS system with respect to traffic data storage, representation, and management.

Journal of Transportation Engineering, Part A: Systems (2021)
"Comparative Assessment of Geospatial and Statistical Methods to Estimate Local Road Annual Average Daily Traffic"
https://ascelibrary.org/doi/10.1061/JTEPBS.0000542
Collecting traffic data and/or estimating and reporting annual average daily traffic (AADT) is important for planning, designing, building, and maintaining the road infrastructure. However, AADT is not available for most local functionally classified roads (referred to as local roads in this paper), which comprise a major proportion of the roads in the United States. The AADT of a local road depends on geospatial data such as road density, socioeconomic and demographic characteristics, and proximity to the nearest nonlocal road. The suitability of these explanatory variables for modeling local road AADT has not been widely explored, nor have methodological approaches been comprehensively compared in the past. Therefore, the focus of this research is on exploring geospatial and statistical methods and conducting a comparative assessment to estimate local road AADT. The AADT based on traffic counts collected at 12,899 stations on local roads in North Carolina during 2014, 2015, and 2016 was considered in model development and validation. The road, socioeconomic, and demographic characteristics based on the data gathered from the North Carolina Department of Transportation (NCDOT) for 2015 were considered as the explanatory variables. Five different modeling methods were examined and compared to estimate AADT on local road links. They include traditional ordinary least squares (OLS) regression, geographically weighted regression (GWR), and geospatial interpolation methods such as kriging, inverse distance weighting (IDW), and natural neighbor interpolation. The model development and validation results showed that the GWR model performed better compared with the other considered geospatial and statistical methods. The GWR model can better capture the effect of geospatial variations in the data, by geographic location, when estimating local road AADT. Local road AADT estimates help practitioners in planning and prioritizing road infrastructure projects for future improvements and air quality estimates, in addition to Highway Safety Improvement Program (HSIP) and Highway Performance Monitoring System (HPMS) reporting.

Berkely Institute of Transportation Studies (2020)
"Improving the Traffic Census and Highway Performance Monitoring System (HPMS) Programs"
https://escholarship.org/uc/item/64g416gb
The objective of this research study was to support the Traffic Census and Highway Performance Monitoring System (HPMS) Programs in identifying locations for motorized traffic

data collection on public roads in California. The study analyzed the traffic census count locations for each District to determine at which Census count locations the automated and continuously collected Caltrans Performance Measurement System (PeMS) data could be used in lieu of manual traffic counts. Next, this research identified and evaluated count locations for motorized traffic data collection on non-State Highway System Routes to help meet Federal Highway Administration (FHWA) requirements for the Caltrans Highway Performance Monitoring System (HPMS) program. Lastly, this research reviewed and summarized the emerging traffic data collection technologies and data sources appropriate for Caltrans HPMS and/or Census reporting purposes. Data collection cost savings and reduction in system redundancies can be obtained by integrating Caltrans PeMS traffic volume data into the Census and HPMS data collection and reporting procedures, as was noted and recommended in section 3 of this report. Additionally, there are continuous count stations in Districts 1 and 2 that are not connected into the Caltrans PeMS system. We recommend that Caltrans investigate the feasibility of adding these Districts and traffic count stations to the set of PeMS stations, along with any other continuous count stations monitored by the Districts. Additionally, we recommend that Caltrans put careful thought into the decision process prior to expanding their physical infrastructure (i.e., in pavement loops or other local data collection technologies) if the primary need is to collect Census or HPMS total vehicle count data. Installing in-pavement loops and/or other permanent count stations are costly and should be considered a long-term investment. Specialty vehicle count data (like weigh-in-motion (WIM) data and vehicle classification count data) are a separate issue, as these are currently not available from any of the commercial vendors. We also recognize that local real-time traffic data are required for support of on-ramp metering and other operational traffic control systems, and these needs and cases lie outside of the just-stated recommendation.
We recommend that Caltrans seriously consider and investigate the feasibility of using third party or commercially available traffic data as an additional data source to help meet their Census and HPMS traffic count data needs.

Transportation Research Board (2020) 5 “Highway Traffic Monitoring – Understanding Tomorrow’s Problems to Better Serve the Public”
https://onlinepubs.trb.org/onlinepubs/centennial/papers/ABJ35-Final.pdf
Best Practices, A mix of unique and common approaches are used by states to manage their traffic monitoring programs. The unique approaches include: Customized guides and manuals that explain the policies, organization structure, business processes, and technology tools (including traffic databases) that support and manage traffic monitoring programs. Data business plans and self-assessment tools to improve management of traffic monitoring programs. Traffic data programs that leverage operations and ITS data collection or local data collection. Examples include collecting both traffic data for the traffic monitoring staff and speed data for the ITS staff and collecting data from regional agencies around the state. Emerging trends that include complete or partial privatization of traffic monitoring programs and coordination with asset management and ITS programs regarding maintenance of traffic monitoring program equipment. Current Issues, Needs, and Research Gaps State and municipal DOTs face challenges concerning traffic monitoring despite the increasing availability and use of private sector traffic data sources due to the following issues. Ability to respond in a timely manner to changes in federal guidance or mandates (3,10,11) that may impose different data collection or reporting requirements. Business practices deeply embedded in the culture of the agency (e.g., continued use of manual processes and “that’s the way it’s always been done” mindset). Business area silos that inhibit sharing of traffic data and information across or between business units (e.g., ITS data and traffic monitoring data). Agency structure that impacts traffic monitoring program management practices such as use of staff resources to maintain data collection field equipment and lack of coordination with ITS staff for maintenance of both ITS and continuous count station equipment. Lack of specific traffic monitoring program data business plans (or updated traffic monitoring program manuals and handbooks). Knowledge transfer and training challenges posed by retirements and integration of new staff. Lack of formal protocols for sharing

of traffic data between the state DOT and local government agencies. Identification of the advantages and challenges to full or partial privatization of traffic monitoring programs. Summary of Trends and Emerging Issues, Privatization of traffic monitoring programs and coordination with asset management and ITS programs to maintain traffic monitoring equipment. Incorporation of visualization into data analysis procedures. Collection of traffic data once for multiple-purpose use. Increasing the pace of incorporating new WIM sensor technologies, expanding use of WIM data in new applications, and improving WIM program management and operations. Increasing the pace of incorporating new pedestrian and bicycle sensor technologies, particularly as other mobility devices emerge (e.g., e-scooters and hoverboards), expanding use of nonmotorized data in new applications (e.g., health measures, route choice, and near-miss metrics), and improving nonmotorized program management and operations. Utilization of structured and unstructured data for quality control purposes. Incorporation of the relative pavement performance impact factor (RPPIF) and the annual total truck load (ATL) traffic-loading summary statistics to monitor pavement distress. Determining how counting programs can efficiently use connected vehicle data, while recognizing that bicyclists and pedestrians may not be "connected". Considering how travel behaviors, wayfinding, data collection, and storage capabilities may be impacted through changes in information technology, social media, and advanced mobile devices Standing Committee on Highway Traffic Monitoring (ABJ35) 15 Fusion of historic estimates, nearby real-time counts, and adjustments based on models relating real-time speed estimates with those from other volume sources. Need for Big Data analytics tools. Future Priorities, Initiatives, and Challenges: Novel methods and technologies for characterizing truck flow: axle loads, commodities, on-board weight, portable WIM. Best practices for managing traffic monitoring program equipment and related assets. Methods to visualize traffic data from traffic signal systems. Accuracy requirements of traffic counts for different applications. Advanced messaging requirements for connected vehicles to meet traffic monitoring and operations needs. Big Data analytics for extracting value from connected vehicle data without compromising privacy. Validation of methods to assign short-duration counts to factor groups. Detection and validation of abnormalities and unusual trends observed through short-duration counts. Using probe data to estimate traffic volume. Standard definitions for travel time concepts that address inconsistencies, ambiguities, errors, failure states, and performance measures. Developing methods to integrate data streams for intermodal systems analyses.

Transportation Research Record (2019) "Coupling National Performance Management Research Data Set and the Highway Performance Monitoring System Datasets on a Geospatial Level"
https://journals.sagepub.com/doi/10.1177/0361198119838983
Integration of various datasets is crucial given the emphasis placed on holistic reporting of performance measures of various variables related to road transportation by the Moving Ahead for Progress in the 21st Century (MAP-21) Act. None is more confounding than the merger of geospatial datasets, which is necessary, for example, to combine vehicle travel time and volume information for road segments. Such a merged dataset is released through the National Performance Management Research Dataset (NPMRDS). The NPMRDS is supposed to exclusively cover the National Highway System (NHS) and Strategic Highway Network (STRAHNET) sub-selected from the Highway Performance Monitoring System (HPMS). However, one finds that the coverage is not perfect. There are not only many extra road segments included in the NPMRDS, but also some NHS/STRAHNET roads segments are not fully covered by corresponding NPMRDS segments. Further, one finds very little literature about the method Texas Transportation Institute uses to orchestrate the conflation. Therefore, it was endeavored to create a conflation algorithm which might perform better. The benchmark for the proposed algorithm is the identification of the segments wrongly conflated during the creation of the NPMRDS geospatial dataset. The proposed methodology uses a combination of five measures of similarity between the HPMS and NPMRDS segments. The proposed method successfully identifies significant numbers of mismatched segments: about 5% excess NPMRDS segments, and about 3% HPMS segments without NPMRDS counterpart.

FHWA Office of Policy and Governmental Affairs (2018)
"Developing New Business and Operational Guidance Ensuring Timely and Quality Highway Performance Monitoring System Data Submittal from State Highway Agencies"
https://rosap.ntl.bts.gov/view/dot/57300
Each year, state departments of transportation (State DOTs) assemble data about the extent, condition and performance of all public roads including the Federal-aid highway system in their state and provide that data to the Federal Highway Administration (FHWA). Together, the individual state contributions create the most comprehensive national source of highway data: The Highway Performance Monitoring System (HPMS). This report is a resource for State DOTs to improve the quality and timeliness of HPMS submittals. The checklist will help agencies implement strategies to marshal internal resources and work with Federal-aid partners effectively and efficiently. This report contains the following: Chapter 4 (Task 4) describes the uses of HPMS; describes best practice "take-aways" from HPMS coordinators regarding management processes; introduces the maturity model concept to developing HPMS business practices and provides a self-scoring questionnaire (checklist) for developing an efficient, logical and practical HPMS business process. Chapter 5 (Task 5) provides a self-certifying questionnaire (checklist) for HPMS data collection and use from a business and management standpoint.

TRC (2017)
"Advancing Highway Traffic Monitoring Through Strategic Research"
https://onlinepubs.trb.org/onlinepubs/circulars/ec227.pdf
Traffic monitoring programs within transportation agencies have evolved relatively slowly over the past few years. However, despite increasing availability of private-sector data sources (such as probe speed data), traffic monitoring remains a critical need within state and municipal department of transportations (DOTs). Unique and common approaches are used by states to manage their traffic monitoring programs. The unique approaches are featured in this section as examples of state-of-the-art practices, which include but are not limited to the following: Development of customized guides and manuals for traffic monitoring programs; Use of data business plans to improve management of traffic monitoring programs including use of self-assessment tools; and Integration of traffic data programs to leverage operations and ITS data collection programs or local data collection. Complete or Partial Privatization of Traffic Monitoring Programs, Coordination with Asset Management and ITS Programs Regarding Maintenance of Traffic Monitoring Program Equipment.

Federal Highway Administration (2017)
"Simplified Highway Capacity Calculation Method for the Highway Performance Monitoring System"
https://rosap.ntl.bts.gov/view/dot/57315
The Federal Highway Administration's Highway Performance Monitoring System (HPMS) provides information on the extent, condition, performance, use, and operating characteristics of the Nation's highways. Each year State Transportation Agencies must submit HPMS data to the FHWA. The Sample Panel portion of HPMS provides detailed statistical data on a randomly selected sample of roadway sections on the State's public road system. One data item submitted for sample panels is capacity (Sample Panel Data Item 69). The HPMS Field Manual guidance for capacity is as follows: "The capacity of a roadway facility is the maximum reasonable hourly rate at which vehicles can be expected to transverse a point or a uniform section of lane or roadway during a given time period under prevailing road-way, traffic, and control conditions." Reasonable expectancy is that the stated capacity can be achieved repeatedly. The Highway Capacity Manual (HCM) provides procedures, formulas, graphics, and tables in assessing roadway capacity. This item should be estimated based on procedures consistent with the HCM. The results of the project are the development of: 1. Capacity computation methods that use HPMS data items to the extent possible, and can be used to validate HPMS Sample Panel Item 69; and 2. Simplified Methodologies to Create Generalized Level of Service (LOS) Lookup

Tables. Both of these results use the most recent HCM methodologies. Specifically, it was found that the procedures in National Cooperative Research Program Report 825 ("Planning and Preliminary Engineering Applications Guide to the Highway Capacity Manual") could be easily adapted to the types of data present in HPMS.

Transportation Research Record (2016)
"Integrating Intersection Traffic Signal Data into a Traffic Monitoring Program"
https://journals.sagepub.com/doi/10.3141/2593-08
There are ongoing efforts to leverage the large volume of data collected to support real-time traffic operations for various non-real-time uses. However, adapting data streams to a different purpose can be challenging, especially if different applications use the data in different ways. Although traffic operations and traffic monitoring programs often use similar technology for vehicle detection, they may have different sensitivities to potential errors. Although small errors in traffic counts may not be critical in traffic operations, for which data are refreshed every few seconds, the same error levels could become much more significant in traffic monitoring, for which data, and the corresponding errors, are typically aggregated over longer periods of time. This study investigates if and how traffic volume data from detectors at signalized intersections could be appropriately used in a traffic monitoring program that supports the Highway Performance Monitoring System (HPMS). For this purpose, this study evaluates both the accuracy and representativeness of these traffic signal detector data in comparison to standard HPMS-type traffic count data obtained by portable pneumatic counters under different traffic flow conditions and intersection geometries. The results, although varying by site, indicate that these traffic signal detectors can produce 15-min aggregate traffic counts of comparable quality to results from portable pneumatic tube counters and provide 90% accuracy at a 95% level of confidence for 15-min aggregate counts.