TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Wisconsin DOT

INSTRUCTIONS:
Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(274)	**Transportation Pooled Fund Program - Report Period:** ☐Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) Quarter 3 (July 1 – September 30) XQuarter 4 (October 1 – December 31)

Project Title: Midwest Freight Pooled Fund – Technology Transfer Agreement		
Name of Project Manager(s): Lori Richter	**Phone Number:** (608) 264-8435	**E-Mail** Lori.Richter@dot.wi.gov
Lead Agency Project ID: 0092-13-10	**Other Project ID (i.e., contract #):**	**Project Start Date:** 11/19/2012
Original Project End Date: 11/18/2014	**Current Project End Date:** 11/18/2014	**Number of Extensions:** 0

Project schedule status:

X On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$40,000	$10,428	50%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
$0; 0%	$0	0%

Project Description:

The purpose of this interagency agreement is to provide the following technology transfer activities and services related for Midwest Freight Research:

1. Attendance at pooled fund research presentations
2. Presentation of pooled fund research findings at Mid-Continent Forum
3. Research documents and communication materials

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

None

Anticipated work next quarter:

None

Significant Results:

n/a

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

n/a

Potential Implementation:

n/a

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): ____

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Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:** ☐Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) ☐Quarter 3 (July 1 – September 30) ☑Quarter 4 (October 1 – December 31)	
Project Title: Wisconsin Study on the Impact of OSOW Vehicles on Complex Bridges		
Name of Project Manager(s): Michael Oliva	**Phone Number:** (608) 231-1470	**E-Mail** oliva@engr.wisc.edu
Lead Agency Project ID: WisDOT 0092-13-11	**Other Project ID (i.e., contract #):** CFIRE 08-03	**Project Start Date:** 8/8/2013
Original Project End Date: 10/7/2015	**Current Project End Date:** 10/7/2015	**Number of Extensions:** 0

Project schedule status:

☑ On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$270,000	$155,870	55%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
13.5%	$36,411	65%

Project Description:

As the freight industry grows, the need to move oversize and overweight loads increases every year. Loads such as pressure vessels, transformers used in power plants, boilers, military hardware, and wind turbine components require vehicles with unusual configurations. These vehicles may also weigh five to six times the normal legal truck weight. The combination of uncommon configurations and carrying loads of these trucks make common bridge evaluation methods inapplicable. Determining the effects of oversize and overweight loads on complex bridges has become a time consuming task for the Wisconsin Department of Transportation. There are no established procedures and the possibility of errors in estimating the impact of oversize and overweight loads on these structures could affect safety and restrict the flow of goods. This study aims to develop a simplified analytic method to determine the effects of oversize and overweight vehicles on a variety of complex bridge configurations, such as steel tied arches, rigid frame, truss, and bascule bridges. The project team will develop analytical models of complex bridges and validate these models using load test data

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

a. Major activities:

One Wisconsin “complex” highway bridge was load tested during this period. The LaCrosse arch bridge was instrumented and tested with the help of La Crosse County in July. A bascule bridge in Marinette was instrumented and load tested in early September. The long span frame bridge in IH-90/94 was instrumented and tested in October. Further work was accomplished in developing analytical bridge models and identifying model improvement necessary to achieve accurate response results.

b. Specific objectives:

The specific objective of the load testing was to provide verification for the analytical modeling techniques.

c. Significant results, including major findings, developments, or conclusions (both positive and negative):

The initial bridge analytical models were accurate but there were some unexplained differences between measured bridge response during load tests and predicted response.

d. Key outcomes or other achievements

A major portion of the project was accomplished by completing all the desired load tests.

Anticipated work next quarter:

• Further refinement of the Marinette Bascule Bridge Model will be performed in order to have higher precision on predicting the displacement of the bascule spans.
• After analyzing the data from the Mirror lake Bridge, the CSiBridge model predictions for the bridge were compared with the test results. Some serious discrepancies were observed. A detailed model of the joint between the frame legs and the main top girders will be prepared to see if that improves the correlation between test and analytic results.
• The researchers will then start work on the remaining finite-element models in the project and adjust each model according to the bridge type.

Significant Results:

• We finalized the testing of the rigid frame Mirror Lake Bridge. This test sequence required significant early planning and cooperation/organization between participating groups such as Sauk County, WisDOT traffic Operations and the State Patrol. Two days were required to install the planned instrumentation beneath the bridge using a State snooper truck. A rolling road block was performed by the State Patrol with the county help in closing three ramps to have an approximately 8 to 9 min gap to perform the test. Because of the high traffic volume of the bridge, Traffic Operations requested that the testing be at midnight. The load test was successfully conducted and semi-permanent instrumentation remains on the bridge.

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

Potential Implementation:

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Wisconsin Department of Transportation

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Transportation Pooled Fund Program Project # *SPR-2563PY14* TPF-5(274)		**Transportation Pooled Fund Program - Report Period:** ☐ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ✓ Quarter 4 (October 1 – December 31)
Project Title: A GUIDEBOOK FOR FREIGHT TRANSPORTATION PLANNING USING TRUCK GPS DATA		
Name of Project Manager(s): **Dr. Sabya Mishra**	**Phone Number:** **901.678.5043**	**E-Mail:** **smishra3@memphis.edu**
Lead Agency Project ID: **0092-14-16**	**Other Project ID (i.e., contract #):** **CFIRE 09-04**	**Project Start Date:** **1/1/2014**
Original Project End Date: **8/31/15**	**Current Project End Date:** **8/31/15**	**Number of Extensions:** none

Project schedule status:

✓ On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$150,000	$136,848.30	90%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
91% and 25%	$36,885.46	90%

Project Description:
One of the main difficulties in freight transportation planning is the lack of accurate and detailed truck trip data. The majority of truck movement data is reported at the inter-county level and is represented by aggregated tonnages that should be split into truck trips. The American Transportation Research Institute (ATRI) in collaboration with the Federal Highway Administration (FHWA) developed the Freight Performance Measures Web-Based (FPMweb) Tool. The FPMweb Tool estimates the operating speed of highway segments using truck GPS devices for 25 interstate corridors. The suggested research will produce a guidebook for TDOT on how truck GPS data can be used for long term transportation planning and for development of operational transportation strategies in the State of TN.

This project has the following objectives: 1) Develop performance measures for transportation facilities (travel times, flows, demand, bottlenecks, etc.); 2) Provide key performance indicators for freight intermodal terminals in TN; 3) Develop truck trip generation rates for different intermodal and transmodal terminals; 4) Analyze TN truck corridors with a particular focus on travel time and flow; 5) Analyze inter- and intra-city truck travel patterns; 6) Provide data to support development, calibration, and validation of TN's State and MPO's travel demand models (both for the freight and passenger components).

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):
• Design of Origin-Destination Identification Algorithm (ODIA) for computing the number of trips between specific areas of interest (i.e., counties, Traffic Analysis Zones TAZs, etc.) and estimating truck trip characteristics (e.g., start trip time, end trip time, trip duration, etc.). OIDA algorithm was implemented to identify truck trips between TAZs within the State of Tennessee (TN), using the GPS data recorded in January and February, 2012. Origin-Destination (OD) matrices were estimated for each day of January and February using OIDA.
• Development of an integrated ArcGIS tool for processing truck GPS data and calculating link FPMs with the ArcGIS environment. The Direction and Outlier Identification Algorithm (DOI), designed for computing link FPMs, was coded in MATLAB 2014a and imbedded into a standalone executable application. Associating of GPS records with links of Freight Analysis Framework (FAF) was performed by calling the "NEAR" function of the Proximity Analysis Toolbox (ESRI ArcGIS 10.0) using PYTHON programming language. The designed ArcGIS toolbox "Link FPM Estimation" will generate all FPMs that were revealed in the literature, related to the truck GPS data processing, for network segments, specified by the user.
• Compiling the project report that outlines the conducted work, including literature review, description of the GPS data use
methodology for processing raw truck GPS data, developed algorithms (DOI, TDA, OIDA), and a new ArcGIS add-on toolb

Anticipated work next quarter:
Preparing final report, incorporating comments on the report and making final presentation.

Significant Results:
• Computed facility FPMs can be used to determine peak periods for each facility, identify facilities that may require future improvements, allocate workforce and equipment, etc. Accuracy of truck turn time prediction models can be improved if more GPS records are provided. Development of freight facility trip generation models is left for the future research due to lack of the data.
• It was found that the majority of trips were originated/destined near large metropolitan areas of TN (i.e., Memphis, Nashville, Knoxville, Chattanooga, etc.). A substantial number of origins and destinations were observed along the major freight corridors (I-40, I-24, I-65, I-75, and I-81). It is more likely that in the latter case truck drivers stopped for refueling, rest, or other activities, not involving commodity pick-up/drop-off. OIDA does not include logical tests for identifying those stops due to a number of reasons (i.e., high GPS signal frequency is required, locations of rest stops should be provided, lack of commodity data, etc.).
• The designed ArcGIS application will assist private and public transportation agencies in computing FPMs for specific freight transportation corridors, identification of segments that require improvement projects, and improving travel time reliability. The user is not required to install any additional software (e.g., PYTHON SHELL, MATLAB), except ESRI ArcGIS.
• All findings have been presented in the final report
d. Key outcomes or other achievements
• Development of procedures for estimating facility FPMs, including truck turn times, facility occupancy, and truck entry/exit volumes.
• Both OIDA and earlier developed Trip Detection Algorithm (designed for analysis of individual truck travel patterns and defining the status for each observation) can be used for a detailed analysis of truck trips based on the available GPS data.
• Design of an integrated ArcGIS application for processing truck GPS data and estimated link FPMs.
• Completed the final project report.

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

No challenges/problems were encountered in the fourth quarter.

Potential Implementation:
The proposed DOI algorithm is a novel approach for estimating link FPMs, and it can be useful for researchers and practitioners. The designed ArcGIS tool will be able to assist the analyst to identify freight transportation corridors that may require future improvement within the ArcGIS domain. The developed OIDA and TDA algorithms will be efficient in a detailed analysis of truck trips based on the available GPS data. The developed algorithms and a new ArcGIS tool may be applied in freight transportation planning, identification of bottlenecks, calculating various FPMs, prioritizing busy freight transportation corridors for improvement projects (based on total truck volumes, average TT, TT reliability, etc.), and achieving MAP-21 objectives.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Wisconsin Department of Transportation

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Transportation Pooled Fund Program Project # *S2458 PP14* TPF-5(274)	**Transportation Pooled Fund Program - Report Period:** ☐Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) ☐Quarter 3 (July 1 – September 30) ☑Quarter 4 (October 1 – December 31)

Project Title:

EFFECT OF PRIMARY AND SECONDARY CRASHES: IDENTIFICATION, VISUALIZATION AND PREDICTION

Name of Project Manager(s): **Sabyasachee Mishra**	**Phone Number:** **(901) 678-5043**	**E-Mail** smishra3@memphis.edu
Lead Agency Project ID: **0092-14-05**	**Other Project ID (i.e., contract #):** **CFIRE 09-05**	**Project Start Date:** **01/01/2014**
Original Project End Date: **8/31/2015**	**Current Project End Date:** **8/31/2015**	**Number of Extensions:** None

Project schedule status:

☑On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$150,000	$149,084.77	99%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
99% and 14%	$20,289.99	99%

Project Description:

Traffic crashes are a major source of congestion on freeway and arterial system. A “Primary crash” leads to reduction of roadway capacity which may result in another crash, known as “a secondary crash”. Earlier studies suggest that up to 15% of reported crashes have occurred partly or entirely as the result of a primary crash. Though a relatively small proportion of all the crashes are secondary crashes, it is important to identify the contributing factors as well as their characteristics because secondary crashes can increase congestion (up to 50% in urban areas), delays, fuel consumption and emissions. Also, United States Department of Transportation (USDOT) estimates that 18% of freeway traffic related fatalities are attributed to secondary crashes. A number of states have proposed various programs to reduce secondary crashes and estimate their benefits in crash reduction. Reducing the occurrence of secondary crashes is also a major concern for traffic incident management (TIM) agencies, especially when dispatching rescue vehicles to clear the affected traffic lanes Therefore, understanding the characteristics of primary and secondary crashes can help decision makers’ select better traffic operation and safety programs.

The purpose of the study is to identify secondary crashes, develop prediction models for incident duration, probability of secondary crash occurrence, associated delays and queue length and apply them to Shelby County, TN. Once the models are established, frameworks will be developed for Hot Spot Visual Tool (HSVT) - to identify the locations which are likely to encounter secondary crashes and Crash Identification Toolbox (CIT) - to obtain specifics of a crash for a set of criteria. Part of the research also will study impact of secondary crashes on freight operations and consequently identify and evaluate strategies that could be used to reduce the impact for hot spots. Identification of the secondary crashes involves extensive literature review to learn different temporal/spatial threshold, methodologies used in the past studies. It also includes developing an algorithm. Developing prediction models would involve identifying the contributing factors using data analysis and based on that, statistical models will be generated that can predict incident duration, probability of secondary crash occurrence, associated delays and queue length.

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

In this quarter static and dynamic identification models were developed. Past studies utilized static and dynamic approaches to identify SCs but a robust methodology had not been proposed to identify SCs with considerable accuracy on large networks. For the static approach, temporal thresholds of 30, 60, 120, 180 and 300 minutes were used along with spatial thresholds of 0.5, 1, 2, 3, and 5 miles. The dynamic approach proposed was based on the shockwave principle and impact area analysis where a crash was identified as secondary if it occurred within the impact area of the PC. The proposed methodology was implemented in Shelby County, TN. SCs were identified for two types of facilities: freeway and arterials to account for the different traffic conditions and data availability of each. Analysis revealed that the static approach consistently under- or over-estimates SC frequencies (depending on the spatio-temporal threshold used). Based on the density of SCs a hotspot map was generated for the study area which shows the locations where SCs are more likely to occur and supports identification of problematic facilities. Future research could focus on identifying primary contributing factors of SCs and development of prediction models for incident duration, probability of SC occurrence, associated delays and queue lengths. Further, in this quarter linear probability, binary logit and multinomial logit models were developed as a measure of prediction. The models are currently being validated. The final report is also being prepared for initial review.

Anticipated work next quarter:

Preparation of final report and incorporating comments. Making final presentation.

Significant Results:

The analysis of the results revealed that the static approach consistently under and overestimated SC frequencies for small and large spatio-temporal threshold respectively. This phenomenon is expected as most SCs have a high probability of occurrence within the 30-60min and 0.5-1miles temporal and spatial threshold respectively and a low probability of occurrence within the 300min and 5miles temporal and spatial threshold respectively. It was observed that characteristics of a facility type and time of day play a crucial role in inducing SCs. Results also revealed that facilities with moderate AADT (such as arterials) are quite likely to encounter large number of SCs. To identify the locations where SCs are more likely to occur, a hotspot map was developed for the study area based on the density of SCs. The proposed methodology can identify SCs and network wide hotspots to assist transportation agencies in the decision making process to mitigate such incidents. Future research could focus on identifying primary contributing factors of SCs and development of prediction models for incident duration, probability of SC occurrence, associated delays and queue lengths.

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

None

Potential Implementation:

The team has also developed "Secondary Crash Hotspots Map" to identify the locations where SCs are more likely to occur which can be a useful visualization tool for various TIM and planning agencies. These locations of the hotpots are of great importance to transportation agencies because studying those locations to a great deal would reveal the primary contributing factors and also the strategies that need to be undertaken to mitigate the secondary crashes. At the end of sta use the data for following implementation:

- Clear set of guidelines and a model to distinguish primary and secondary crashes
- Identifying secondary crash locations by user defined thresholds
- Determining same direction and opposite direction secondary crash
- Visualizing predominant crash locations
- Ability to determine incident duration, secondary crash occurrence and associate delays (based on primary incident characteristics)

Also identifying hotspots is necessary to explore how it can impact freight operation. Hotspots with a higher-than-average incidence involving trucks, hot spots in close proximity to major freight generators and hot spots on designated truck routes may be of great interest for various agencies. The prediction model also can be used to planning purposes to reduce congestion, delay, and safety hazards.