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) X Quarter 3 (July 1 – September 30) ☐Quarter 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.):

Sent 78 WisDOT employees to the 2014 MidContinent Transportation Research Symposium at the Concourse Hotel in Madison, WI on August 21-22.

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
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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) XQuarter 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 & Teresa Adams	**Phone Number:** 608-262-7241	**E-Mail** oliva@engr.wisc.edu
Lead Agency Project ID: 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:

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
$270,000	$119,459	35%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
$86,643, 32%	$64,308	44%

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.):

La Crosse Tied Arch Bridge Load Testing

- The research team load tested the tied arch bridge over the Mississippi River in La Crosse as planned on July 23rd.
- Four undergraduate students were present to help with the instrumentation, gaging, and collecting data using a portable data acquisition system.
- After evaluating the analytical model of the bridge, the second hanger from the end was found to present the highest strains under test truck loading. The testing plan was therefore finalized with two vibrating wire gages placed on the hangers, one set of welded-on uniaxial strain gages at top and bottom at midspan of the floor beam which connects into the second hanger, and two sets of strain gages: one of vibrating wire gages and one of welded-on uniaxial strain gages inside of the box tie girder 4 ft ahead and 4 ft after where the second hanger connects into the girder.
- Two loaded dump trucks were placed parallel with each other, both having the center of the middle and rear axles placed right above the floor beam which connects into the second hanger and as close as possible to the side walk curb. Then the snooper truck drove back along the side walk as close as possible to the dump truck to provide further loading.
- The testing was performed in three stages. First when the traffic was stopped and no live loads were on the bridge, the team took the 'zero' reading. Second, team members directed the dump trucks and the snooper truck into the locations noted above, measured their exact location and then took the 'load' reading. Finally, when all the truck were removed from the bridge, another reading was collected.
- The collected data were then analyzed and plotted in excel for the comparison with that from the analytical model.
- The analytical model built in CSiBridge was refined and adjusted - putting the exact measured truck loads to test its correctness. The modelling of this bridge is still being evaluated.

Double Leaf Marinette Bascule Bridge Testing

- The research team tested the double leaf Marinette bascule bridge on September 11th.
- Three undergraduate students and two graduate students formed the testing team.
- One set of welded-on uniaxial strain gages were applied on the second section of the main girder, another set of this type strain gage were attached to the floor beam near the opening between the two leaves. Two glue-on strain rosettes were used on the tail beam, which contact and supports the bascule

span with the approaching span.

- Surveying equipment with four targets were set up at the four corners of the two bascule leaves at the midspan joint and used to measure the deflection of each span under different loading conditions.
- One loaded dump truck and the snooper truck were used as the loading for this test.
- A Texas Instruments data acquisition system and Lab View were used to collect data.
- The testing was performed in four stages. First, when the traffic was stopped and without any loading on the bridge - the team took the 'zero' reading both for the gages and the surveying equipment. Second, while having only the dump truck on one lane of the bridge and parked as close to the opening and the side curb a second reading was acquired. Third, having the snooper truck parallel to the dumptruck but close to the other side of the bridge - a third reading was acquired. Finally, after both truck were removed a last zero reading was collected.
- Data from the gages were plotted in real time during the testing using LabView, the surveying data were plotted into an EXCEL spreadsheet for further analysis and comparison.
- A preliminary finite-element analytical model was used to predict the field response. The researchers observed the difference between the model and the field test in the deflection of the two bascule spans while loading, especially when there is only one truck loaded. The CSiBridge model is now under further refinement to improve its precision.

Progress Meeting with WisDOT Engineers and Bridge Inspector on September 24th

- A summary of the testing and results of the tie arch bridge over Mississippi River in La Crosse and double leaf bascule bridge Marinette-Menomenee was presented.
- Tabulated results from the model and the field test were shown and the researchers talked about needed refinement to the model.
- We finalized the testing details for the rigid frame Mirror Lake Bridge testing. A rolling road block would be 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 hgih traffic volume of the bridge, Traffic Opeations suggested that the testing be at midnight of Oct 16th. Application of the instrumentation is scheduled on Oct 14th to 15th to avoid the traffic peak on Oct 13th due to the Columbus holiday break.

Anticipated work next quarter:

- The Mirror Lake Bridge testing is scheduled on October 13th to 17th. The researchers are working on the testing plan and instrumentation schedule.
- Further refinement of the Marinette Bascule Bridge Model will be performed in order to have higher precision on predicting the displacement of the bacsule spans.
- After analyzing the data from the Mirror lake Bridge, the CSiBridge model predictions for the bridge will be compared with the test 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:

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).

A new Graduate student Jaime Yanez Rojas was hired in September to work in this project.
Unanticipated costs for county assistance in traffic control at the LaCrosse and Mirror Lake bridges were encountered.
The Mirror Lake extra costs will be incurred in the next quarter. Costs for State Patrol assistance are also anticipated.

Potential Implementation:

n/a

Task	Schedule (July 2013-June 2014)											
	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June
1. Reference Study												
2. Load test schedule												
3. Analytic modeling	First test bridge							remaining bridges				
4. Field test plans											other test bridges	
5. Interim Meeting												
6. Test instrumentation			First test bridge									
7. Analytical verification					First test bridge							
8. Interim Meeting												
9. Simplified analysis												
10. Analysis guides												
11. Final report												

Task	Schedule (July 2014-June 2015)											
	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June
1. Reference Study												
2. Load test schedule												
3. Analytic modeling							remaining bridges					
4. Field test plans												
5. Interim Meeting												
6. Test instrumentation		other bridges										
7. Analytical verification					other test bridges							
8. Interim Meeting												
9. Simplified analysis												
10. Analysis guides												
11. Final report												

Task	Schedule (July 2015-Jan 2015)						
	July	Aug	Sept	Oct	Nov	Dec	Jan
1. Reference Study							
2. Load test schedule							
3. Analytic modeling							
4. Field test plans							
5. Interim Meeting							
6. Test instrumentation							
7. Analytical verification							
8. Interim Meeting							
9. Simplified analysis							
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11. Final report							

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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) ☐ 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:** 09/01/13
Original Project End Date: 12/31/14	**Current Project End Date:** 12/31/14	**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	$98,035.96	80%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
65.35% and 26.4%	$39,601.43	80%

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.):
During this quarter, the research team extended a validation procedure of the Direction Rectification Algorithm (DRA), used for estimating bi-directional link travel speeds (LTS) and other freight performance measures (FPMs). In the previous quarter average LTS, obtained by DRA, were compared with the ones, obtained from the FPMweb Tool, for the I-40 segment using January 3rd GPS data only. To ensure the DRA accuracy throughout the whole year of 2012, the data for the I-40 section in TN were retrieved from the FPMweb Tool for 36 days (3 consecutive weekdays for each month of 2012). The FAF network was used in the analysis. Average LTS over 3 days of each month were computed for four time periods: AM Peak: 6am – 9am, Midday Peak (MD): 9am – 2pm, PM Peak: 2pm – 6pm, and Off-peak (OP) period: 6pm – 6am. Then, average LTS were also estimated using DRA for the same links and time periods. Results of a more extensive comparative analysis indicated that the differences between LTS, provided by the FPMweb Tool, with the ones, calculated by DRA, were not significant for both West and East directions of the I-40 segment (less than 5% on average). Differences were mostly observed on short links (< 3 mi) and could be possibly caused by snapping errors. Other potential reasons, affecting the analysis accuracy could be related to differences between data used in FPMweb Tool and this study (e.g., FPMweb Tool does not provide data for 2012 and contains the average LTS for 3 mi segments, ATRI may use different approach for detecting outliers, link directional bias, the amount of available observations, etc.).

Once the DRA validation was completed, the research team focused on development of Trip Detection Algorithm (TDA) for analysis of individual truck trips within the State of TN using the available GPS data. For each truck trip a set conditions were checked by TDA for each GPS record. The algorithm output included a detailed trip information, specifically: truck status at the given observation, dwell travel time (DTT) at origin, DTT at stops, DTT at facility, DTT at destination, etc. Producing similar output data for individual trucks can be time consuming if performed manually, especially if we consider some trucks that may have more than 200 observations per day. The TDA validation, conducted using Google maps and satellite images, demonstrated the algorithm accuracy. It was found that TDA errors were mostly caused by low frequency of GPS records for a given truck.

During this quarter, the research team designed a standalone executable application, which estimates FPMs for the assigned links of the FAF network. The tool does not require installation of any specific software. However, the input table has to contain not only raw GPS data, but also the nearest link identifier for each observation (determined by ESRI ArcGIS 10.0).

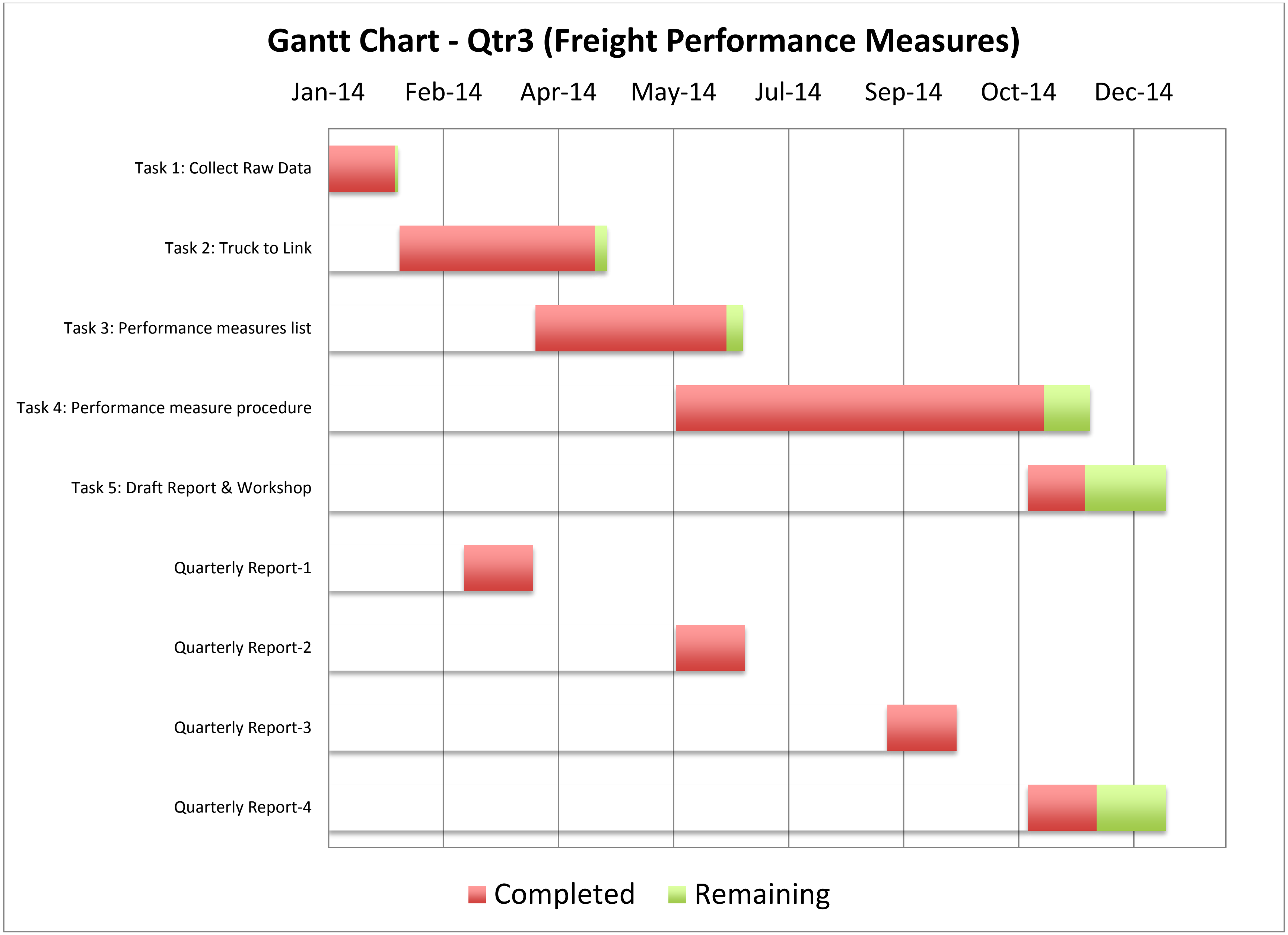
Anticipated work next quarter:
So far, both DRA and TDA algorithms were successfully validated. The methods for estimating FPMs for links of the FAF network (performed by DRA) and analysis of individual truck trips (performed by TDA) were found to be accurate. In the following quarter the research team expects to develop an algorithm to estimate O-Ds between TAZs in TN using the available GPS data and to estimate trip generation rates and turn times in intermodal terminals in the Memphis area. Also, the final report for this project will also be compiled during the 4th quarter.

Significant Results:
An extensive validation procedure was conducted to ensure the DRA accuracy. Performance of the DRA algorithm was evaluated based on a comparative analysis between average LTS, obtained by DRA, with the ones, retrieved from FPMweb tool, using GPS data for 36 days (3 consecutive weekdays for each month of 2012). Results indicated an acceptable DRA accuracy (< 5% difference with thr FPMweb tool speeds). It was found that the DRA accuracy was mostly affected by the link geometry (i.e., shape and length). TDA was designed to analyze individual truck trips. The algorithm output included the truck status for each available record and additional trip characteristics (discussed earlier). The TDA validation, conducted using Google maps and satellite images, demonstrated its accuracy. The TDA performance was mostly affected by frequency of observations for a given truck. A standalone application was developed to estimate FPMs for given links of the FPM network. The tool does not require installation of any specific software, but its input relied on the data, pre-processed by ArcGIS.

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 third quarter.

Potential Implementation:
Both algorithms (DRA and TDA) can be implemented by decision makers in freight transportation planning for computing FPMs at links of a given transportation network and investigating traveling patterns of individual trucks. The accuracy of calculating FPMs will be affected by the link geometry, while analysis of trucks trips will be mainly dependent on the frequency of GPS data (e.g., more frequent signal gives an opportunity to determine the truck status with a higher degree of certainty).


Gantt Chart - Qtr3 (Freight Performance Measures)
Jan-14
Feb-14
Apr-14
May-14
Jul-14
Sep-14
Oct-14
Dec-14
Task 1: Collect Raw Data
Task 2: Truck to Link
Task 3: Performance measures list
Task 4: Performance measure procedure
Task 5: Draft Report & Workshop
Quarterly Report-1
Quarterly Report-2
Quarterly Report-3
Quarterly Report-4
Completed
Remaining

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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: 12/31/2014	**Current Project End Date:** 12/31/2014	**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	$128,794.78	85%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
86% and 39%	$58,500.95	85%

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.):

Previously, 91,325 crashes occurring in Shelby county, TN within the time period of January 1, 2010 to December 31, 2012 were analyzed using the Geodatabase that includes all the necessary attributes of a particular crash. A total of 1,179 secondary crashes were identified using Static and Dynamic approach.

During this quarter, the team analyzed the attributes of those primary crashes that resulted in secondary crashes to identify the primary contributing factors leading to a secondary Crash. This is one of prerequisites for developing prediction models. Also, relevant past studies, reports, journals are reviewed to learn what statistical models (Logit, Probit, Poisson, Negative Binomial, Partial Proportional Odds etc.) can best explain the scenario. The team is currently developing a discrete choice model to predict "Occurrence of secondary crashes". This will allow the Traffic Incident Management (TIM) agencies to assess how likely a primary incident (depending on its characteristics) is going to lead to a secondary crash. Some of the significant explanatory variables used in the prediction models are time of day, collision type, primary incident duration and number of vehicles involved. The team is testing different models while varying parameters to develop a reliable prediction model.

Concurrently, the team is also working on the final report for this project. First few chapters including literature review, methodology are being finalized.

Anticipated work next quarter:

Once the prediction model for occurrence of secondary crashes is finalized, statistical models for incident duration, associated delays and queue length will be generated. The likelihood of secondary crash occurrence is commonly associated with primary incident duration in past studies. It is observed that secondary incidents are more likely to occur if incident clearance times and durations are longer. Past studies showed that reducing the clearance time from 60 minutes to 15 minutes reduces the number of secondary crashes by up to 43%. On the other hand, duration of primary incident is expected to be longer if secondary incidents occurred because of further reduction in capacity, meaning incident duration and occurrence of secondary incidents can be interdependent. Therefore, endogeneity between incident duration and secondary crash occurrence will be tested. Also, it is necessary to develop a correlation between incident duration and secondary crash likelihood, while taking prevailing traffic conditions and incident characteristics into account. All the models will be calibrated and cross-validated using the available data to ensure accuracy and reliability of those models.

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. Also, compilation of final report will continue over the next quarter and is anticipated to be completed in due time with adequate time to incorporate any comments.

Significant Results:

The data analysis revealed that some of the primary contributing factors are: *peak hours, collision type, primary incident duration, facility type, number of lanes blocked, number of vehicles involved, and truck volume.* Peak hour is a very significant factor as the results showed that peak periods account for 59% and 48% of the total number of identified secondary crashes on freeways and on arterials respectively. The arterials exhibited a very prominent PM peak (4pm-6pm) when compared to AM peak. The reason that arterials have only one noticeable peak can be explained by the larger number of primary crashes occurring in the PM peak as compared to the AM peak.

Secondary crashes were classified by the facility types to study how secondary crashes depend on intrinsic characteristics of facilities. The roadway network, used for case study, consists of approximately 285 miles (7.40%) of interstate/freeway facility but encountered 21.10% of secondary crashes during 2010-12, whereas 56.40% of secondary crashes occurred on 972 miles (25.25%) of major arterials. On the other hand, only 0.90% of SCs were identified on 2,163 miles (56.18%) of local/collectors during the same period. Primary reasons are different travelling speed and traffic volume for different facility types. On freeways, interstates, and major arterials the average speed and traffic volume is much higher than on minor arterials and local collectors. Hence a primary crash on high speed and volume facility has a higher potential to induce SCs

Analysis of results showed that moderately congested major arterials experienced larger number of secondary crashes as opposed to heavily congested high-speed facilities. A possible explanation could be lower speeds and higher alertness of drivers for very highly congested roadways reduce the likelihood; whereas on moderately congested facilities, higher speeds and lower alertness increase the probability of a primary crash and also the induced effect to result in a secondary crash.

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

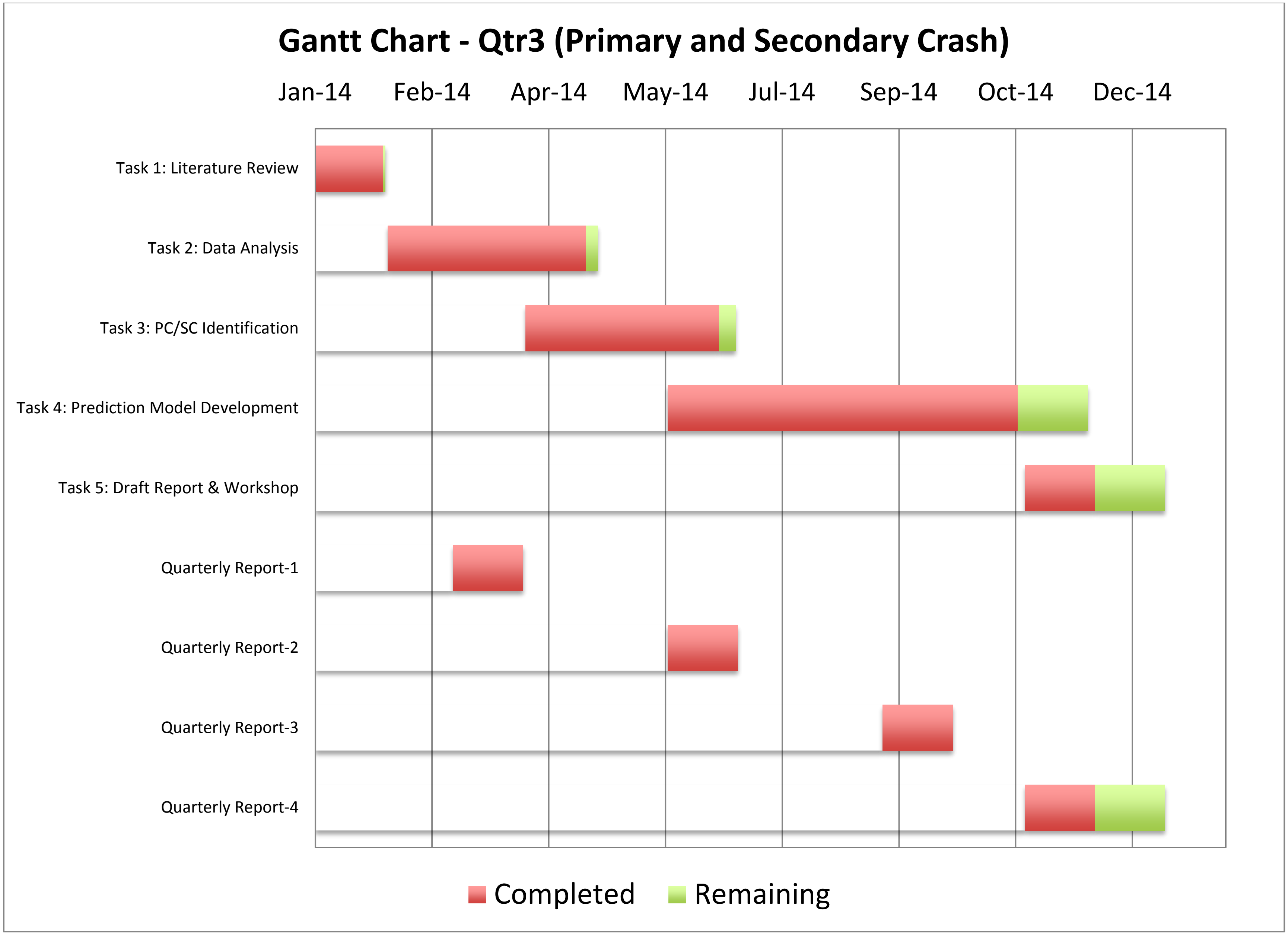
Potential Implementation:

The research team has established a process of collecting crash, exposure, highway geometry, environmental data for any county in the state of TN. All the data are stored in a database and further linked to a shape file for visualization.
At the end of Phase I the state can 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)

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.

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.



Gantt Chart - Qtr3 (Primary and Secondary Crash)
Jan-14
Feb-14
Apr-14
May-14
Jul-14
Sep-14
Oct-14
Dec-14
Task 1: Literature Review
Task 2: Data Analysis
Task 3: PC/SC Identification
Task 4: Prediction Model Development
Task 5: Draft Report & Workshop
Quarterly Report-1
Quarterly Report-2
Quarterly Report-3
Quarterly Report-4
Completed
Remaining