# Development of an Areawide Estimate of Truck Freight Value in the *Urban Mobility Report*

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# EXECUTIVE SUMMARY

## Project Summary

Significant efforts have resulted in improved knowledge about the effects of congestion on the motoring public. The *Urban Mobility Report (UMR)* has been produced for over 20 years detailing the effects of congestion in the United States (*1*). Despite these efforts, and others, less is known about the effect of congestion on urban freight movement.

The freight industry continues to face challenges when trying to transport goods on an increasingly congested transportation system. Very little analysis is performed at the commodity-movement level. Much of the research and modeling focuses on truck movements, for operations purposes, but does not get into truck value moving on the transportation system, which could be useful for planning purposes. Therefore, this research set out to produce truck freight values for inclusion in the *Urban Mobility Report (UMR)* to inform the policy discussion and decisions.

## Research Team

Researchers at the National Center for Freight and Infrastructure Research and Education (CFIRE) collaborated with researchers at the Texas Transportation Institute (TTI) to develop the estimates to include in the *UMR.* Matching funding was also used from TTI's on-going FHWA pooled fund study, Mobility Measures in Urban Transportation, which includes twelve state departments of transportation (California, Colorado, Florida, Kentucky, Maryland, Minnesota, New York, Ohio, Oregon, Texas, Virginia and Washington), two metropolitan planning organizations (Houston-Galveston Area Council, Maricopa Association of Governments), and FHWA.

## Process

Researchers developed a three-part methodology to estimate truck freight value using FHWA Highway Performance Monitoring System (HPMS) and FHWA Freight Analysis Framework (FAF) datasets. Researchers also developed a method to investigate freight value along specific corridors in an urban area. The methodology was tested and results are presented for the Milwaukee urban area. Policy implications of the data are discussed.

## Discussion and Recommendations

This research successfully developed a methodology for incorporating areawide truck freight estimates into the *UMR* by urban area. Researchers estimated truck commodity value traveling in each urban area. Researchers implemented the methodology into the *2010 Urban Mobility Report.* The *2011 Urban Mobility Report,* released in August 2011, used a similar methodology to present the truck freight values. Researchers also present and apply a valuable methodology for estimating truck freight value on specific corridors that is transferable to other metropolitan areas.

# CHAPTER 1: INTRODUCTION

## Introduction

Significant efforts have resulted in improved knowledge about the effects of congestion on the motoring public. The *Urban Mobility Report (UMR)* has been produced for more 20 years, detailing the effects of congestion in the United States (*1*). Despite these efforts, and others, less is known about the effect of congestion on urban freight movement.

The freight industry continues to face challenges when trying to transport goods on an increasingly congested transportation system. While a tractor-trailer occupies the roadway capacity of two to three passenger vehicles, it is hypothesized that the cost of that commercial vehicle in congestion may be a dozen times greater than the passenger vehicles. With the continued evolution of a global economy and just-in-time manufacturing, more freight is being moved on the transportation system. Freight volume is projected to in the next twenty years. Very little analysis is performed at the commodity-movement level. Much of the research and modeling focuses on truck movements, for operations purposes, but does not get into truck value moving on the transportation system, which could be useful for planning purposes.

## Project Objectives

The objectives of this research are to create and test a methodology for generating truck freight values to include in the *UMR*. The *UMR* has developed and refined a methodology over the past two decades to estimate the amount of delay that occurs on the freeways and arterial streets of a region.

## Report Organization

This report is organized into five chapters as described below:

- Chapter 1—Introduction: Provides a brief introduction to the research topic and presents project objectives and report organization.
- Chapter 2—Background and Policy Implications: Provides background information with a focus on the policy implications of the freight value information estimated in this report.
- Chapter 3—*Urban Mobility Report* Truck Value Methodology Development and Results: Discusses the data sources, methodology and results for estimating truck value in the *UMR*.
- Chapter 4—Milwaukee Case Study Application and Results: Discusses the methodology and results for estimating truck value for individual corridors in the Milwaukee region.
- Chapter 5—Conclusions and Future Work: Summarizes the key concluding points of the research as well as future research opportunities.

# CHAPTER 2: BACKGROUND AND POLICY IMPLICATIONS

The freight related factors developed in this study offer policy makers a series of important criteria for helping understand the costs of congestion for the freight industry. This chapter includes a brief literature scan and follows with the authors' observations on the policy considerations related to the *Urban Mobility Report*.

First and foremost, the authors recognize that the costs of congestion are subject to much debate and vary between business and leisure trips, industry-specific supply chain management strategies, and intermodal constraints throughout the system. This chapter aims not to settle such debate but to discuss the applications and emergence of congestion metrics for data-driven decision making.

## Congestion Focused Policy Literature

Congestion on the nation's roads is extremely costly to both individuals and businesses. In 2010, drivers spent an average of 34 hours in traffic expending over $700 worth of fuel in that time. In aggregate, congestion cost the American economy over $100 billion in 2010 (*1*). Economic conditions have suppressed driving but as the economy recovers the expectation is that an increase in the miles driven will lead to greater congestion of America's roads. Current models for elasticity of fuel consumption show that relatively few trips are diverted until the cost of fuel is much greater than it is today. As this study shows, freight costs alone due to congestion in 2010 are estimated to have been $23 billion; this number includes only fuel and delay costs and does not include many other aspects of business including the uncertainty that occurs as a result of delays, loss of inventory, and missed deliveries.

The results of a "what if" analysis projected a congestion cost of $175 billion in 2020, which equates to $1,210 per person and 41 hours (*1*). These projections depend on the economy recovering and achieving growth similar to that of the early 2000s—if that is not the case then these numbers could change significantly. In any case, Americans are spending more and more time in traffic, costing businesses and individuals tremendous amounts of lost productivity and wages as well as other fuel and environmental costs.

Researchers have attempted to characterize the impact of congestion on the traveling public and freight community over the past several years. Other studies by the National Center for Freight and Infrastructure Research and Education (CFIRE) at the University of Wisconsin-Madison (see CFIRE 03-16 and CFIRE 04-19) (*2,3*) have derived values of delay for both shippers and carriers respectively. Congestion affects businesses in a number of ways including missed shipments and increased inventory, as well as increased prices. A 2008 Economic Development Research Group report shines light onto the varied effects that congestion has on businesses and how businesses seek to minimize those effects (*4*). Their work showed that delays from congestion caused businesses to increase their inventory by 5 to 8 percent. Because many businesses depend on a just-in-time approach to shipping they carry only the inventory that they need to move immediately. However, because of the delays and uncertainty that occur as a result of congestion, they are forced to carry more inventory to insure that their shipments go out on time. Some businesses had to take on new employees at shifts previously not filled, such as early morning shifts, because some freight companies start shipping their products as early as 2:00 AM (*4*).

Congestion causes freight companies to shrink the area to which they deliver goods, moving away from larger facilities able to dispense higher volume of goods which reduces the ability to take advantage of economies of scale in the freight industry. Other effects observed by the study include companies having to account for times that employees won't make a meeting on time because of congestion, and negative effects on the supply chain by late or missed shipments due to congestion. A 2009 Reason Foundation analysis held that growing congestion in suburban areas will change the way that those economies operate and have serious effects on businesses located outside of downtown areas (*5*).

The cause of this congestion is a matter of great debate. Economist Joe Cortright contends that congestion is caused by urban sprawl, and not by a lack of roads (*6)*. Cortright insists that policy needs to look into basic urban structures rather than highway utilization and expansion. Cortright's research focuses on urban planning decisions that place importance on the locations of employment, focusing on policies that promote sustainable urban living close to places of employment rather than the suburban model.

A January 2008 Government Accountability Office (GAO) report identified a major problem with current transportation policy that leads to congestion, "In a number of ways, current pricing of freight transportation infrastructure can result in inefficient use by failing to align the capital and operational costs of infrastructure with the fees paid by users" (*7*). This leads to customers overusing the highway system which increases the cost of congestion. The GAO indicated that congestion forces companies to develop redundancy in their supply chains, sending out more than one truck believing that at least one of the trucks would make its destination on time. Such operational changes are costly, and these costs are passed on to consumers through higher priced products.

Three major problems emerge when implementing freight projects at the state level, "First, public planners face challenges in advancing freight projects within a public transportation planning process that is not well suited to the identification and advancement of freight projects. Second, public planners face challenges reaching agreement among the various freight stakeholders on freight needs and solutions. Finally, due to the modal structure of transportation funding, public planners face challenges in accessing funding, even when freight projects merit public sector involvement." Furthermore, due to the nature of the planning of projects, federal money often goes to fund projects with only local or regional interests in mind and without a national focus for the project. Therefore, the freight system does not have an overall focus, as Hecker explains, "…public planners tend to focus on the transportation needs that will directly benefit their constituencies, which can result in significant national freight needs going unaddressed" (*7*). Another error in the current process is how projects get funded; freight projects often take a backseat to passenger projects. This happens because taxpayers and voters are usually only willing to fund projects from which they believe they benefit directly.

Another GAO report from March 2008 backs up this claim with evidence about the decision-making process of state DOTs. In a survey, these organizations were asked what factors they take into account when analyzing which projects to recommend: "…34 said that political support and public opinion are factors of great or very great importance in the decision to recommend a highway project, while only 8 said that the ratio of benefits to costs was a factor of great or very great importance" (*8)*.

Along with flaws in the recommendation process for projects, the report also identified problems in the accountability for reaching the goals set out for various projects. "There are also few formal evaluations of the outcomes of federally-funded projects. As a result, policymakers miss a chance to learn more about the efficacy of different approaches and projects" (*8*). This has severe consequences for which projects are funded and how those projects are run: "states and localities receive the same disbursement regardless of their performance at, for example, reducing congestion or managing project costs. As a result, the incentive to improve return on investment—the public benefits gained from public resources expended—is reduced" (*8*).

This lack of accountability in the funding and evaluation of federally funded transportation projects occurs in part because, "data on key performance and outcome indicators is often absent or flawed" (*8*). Having a proper metric with which to analyze both the projects that show the most need to reduce congestion as well as to analyze the effectiveness of those projects could help to alleviate many of the issues in the report. The Heritage Foundation brings up similar points to this report. In the brief, the authors cite projects being rewarded for political support rather than because of cost-benefit analysis as one of the major problems that leads to inefficient use of highway funds and eventually congestion (*9*).

May 2011 Congressional Budget Office (CBO) testimony identified issues in our transportation funding systems. One issue the CBO identified is related to the way the Highway System is funded through the funding formula, from which 80 percent of highway funds are appropriated to the states (*10*). CBO economist Joseph Kile stated that "formula grants are not closely linked to the performance of the transportation system" (*10*). Furthermore, these grants do not identify the most economically-profitable projects, or the projects that will provide the most benefit for the nation. "For example, the economic benefits of highway spending may be greater in areas with more traffic congestion or in areas of greater anticipated population growth and economic activity, but the current approach may direct federal resources to other areas" (*10*).

Kile recommended a change to the way highway projects are funded, shifting from formulas and recommendations from politicians and towards a system that chooses projects where the benefits outweigh the costs of investment. In his system, "Congress may specify particular projects for reasons it deems appropriate—equity, efficiency, or some other consideration—but to the extent that the selection of those projects gives little weight to efficiency, the federal government could promote efficiency by encouraging the funding of high value projects through more systematic analyses of costs and benefits" (*10*). Kile estimates that the government could spend $209 billion annually on projects whose benefits outweigh their costs. Kile's testimony presents a view that there is still much to be done to reform highway funding. If more direct benefit cost analysis permeated the project selection process, critical data would need to be collected. The areawide freight estimates developed herein make that project selection factor more defensible.

In the draft freight policy framework released in 2008, the U.S. Department of Transportation sought to solve many of the issues raised in the GAO reports (*11*). Among these is recognition that greater collaboration is needed between the various stakeholders in the system to increase investment, align the costs of use of the transportation system better with those who use it the most, and to make the system more accountable and responsive. The framework outlined legislative language requiring that a cost-benefit analysis be conducted before selection of highway projects. This framework also set forth various policy solutions to the problem of congestion including increasing the amount of infrastructure, as well as improving the efficiency of current infrastructure through various pilot programs around the country. Although, as the CBO testimony shows, no current efforts exist to implement this funding framework that takes into account need and potential benefit over other considerations (*11*).

The main policy implications of the *Urban Mobility Report* come into play for project selection and evaluation. In the attempts to address the problems highlighted in the GAO and CBO reports, the *Urban Mobility Report* values and its associated metrics can guide improved freight policy. The numbers on commodity value can be used in calculating the cost-benefit analysis as well as for determining what areas are most critical to national freight transit. The UMR's travel time index can be used to identify which projects show the most need. However, if the DOT transitions to using metrics like the travel time index to identify projects to recommend, they still face a problem with the funding formula. In the March 2008 GAO report Hecker writes, "…most grant funds are instead distributed according to set formulas that typically have an indirect relation to need. As a result, grant disbursements for these programs not only fail to reflect performance, but they may also not reflect need…" (*9*). An opportunity exists to use the metrics and information from the *Urban Mobility Report* in the funding formula for decision-making and to reduce congestion and increase accountability in freight policy. Several states, including Texas and Georgia, have already incorporated the metrics in the *Urban Mobility Report* into their congestion policies (*12*).

A 2008 Congressional Research Service (CRS) report notes that the effectiveness of the *Urban Mobility Report* metrics as policy tools is still up for debate (*13*). The report focuses mainly on the problem of congestion and its effects on society, however it spends a couple of pages dealing with the *Urban Mobility Report*. The report takes issue with the travel time index's use of free flow travel time. It is the author's opinion that free flow time is a theoretical measure and should not be used when it has real world implications. The report also highlights criticisms of outcomes that the travel time index can lead to. They point out an example where a highway is expanded by adding a lane but due to a variety of circumstances, their travel time index is worse off because while they reduced congestion they have not reduced the ratio of travel speeds. However, despite these criticisms, the CRS report acknowledges that the *Urban Mobility Report* at least, "provide[s] the only national picture of road traffic congestion on an annual basis and, hence, are useful for monitoring changes in congestion over time" (*13*). It should also be noted that there are several other congestion measures in the *Urban Mobility Report.*

Possible congestion mitigation policy elements are identified in a letter from the GAO to the Chairman of the House Transportation Committee in November 2008. This letter identifies congestion pricing in addition to several other possible solutions to the problem of congestion. The letter separates various suggestions into two different categories: quickly implementable changes and longer-term changes that involve expanding infrastructure (*14*). Among the quickly implementable suggestions include congestion pricing and extended business hours in return for curbside parking in heavily populated urban areas. On the infrastructure side the suggestions include improving rail capacity to take pressure off of the highway system, building new bridges that allow for a better flow of traffic for multiple modes of freight, and building truck-only lanes into highways.

## Policy Guidance

The second portion of this chapter provides some prospective guidance and context for implementing and including the areawide freight estimates in a larger policy context.

*Performance Metrics to Prioritize Construction for Fix-it-First Policies*

During the past several years, and leading into the recommendations for the authorization of federal transportation policy, the maintenance of the existing system has received renewed focus. The “State of Good Repair” concept relies upon taking advantage of quality data on system condition and performance. The indicators presented herein detailing the costs of freight congestion and congestion overall will help policy makers prioritize the decision making for project selection. This has two sides–first, decisions made about project selection can be based on addressing the greatest needs–namely the areas with the most congestion currently. However, this approach is likely to cause substantial shorter term costs as the congestion will inevitably be intensified during the construction and rehabilitation processes. The costs of congestion can also be used to incentivize the contractor process. The *Urban Mobility Report* can show the size of the problem and give ways to relate the size of the solutions.

*State Infrastructure Banks*

Many state departments of transportation have used federal highway funding to create state infrastructure banks (SIBs), which are essentially revolving loan funds for transportation projects. In general, eligible projects include: highway projects such as roads, signals, intersection improvements, and bridges; transit capital projects such as buses, equipment, and maintenance or passenger facilities; and bikeway or pedestrian access projects on highway right-of-way. Including freight value estimates allows decision makers better information for project evaluation. These metrics provide guidance for what projects state infrastructure banks should fund. This helps avoid the funding of unproductive pet projects. Proposals for state infrastructure banks have highlighted the essential need to accurately assess project viability. Better estimates on the value of removing congestion inform the selection process.

*Public Private Partnerships*

Similar to the evaluation requirements of state infrastructure banks, these freight related metrics can identify which roads are ideal candidates for transformation to a public-private partnership. Use of the travel time index as a measure of accountability to ensure that private company is holding up its share of partnership is a valuable performance measure for the public sector owners on these projects as well. Some performance accountability can be traced annually or upon whatever reporting period the parties agree.

*Pilot Projects*

There is a consensus among economists that congestion pricing represents the single most viable and sustainable approach to reducing traffic congestion. However, there is no consensus on where the projects should be implemented and how. The travel time index computed with freight estimates would also be a valuable selection and evaluation tool for congestion pricing pilot projects. Possible opportunities for expansion of the program can be assessed with data that captures the societal costs of congestion.

*Toll Support*

Toll roads (also tollway, turnpike, toll highway, or express toll route) are privately or publicly built roads that are increasingly being used by public authorities for revenue generation to repay long-term debt issued to finance a toll facility, to reinvest in capacity expansion, to pay for operations and maintenance of the facility, or simply as general tax funds. The values developed herein can also be used to determine whether it would be better to raise or lower tolls to achieve a more efficient flow of traffic in a variable format or to enable the long-term success of the projects.

*HOT/HOV Lanes*

High occupancy toll (HOT) or high occupancy vehicle (HOV) lanes attempt to encourage congestion relief by moving motorists out of the general purpose lanes. The ability to estimate the cost of freight delays in the general lanes is powerful for encouraging behavior change. If there is a published and reasonably confident cost, consumers may support additional congestion relief. In addition these measures can be used to determine where to institute less substantial policy changes including congestion mitigating measures such as HOT lanes, traffic signal timing, and incident management programs. As shown in the Bipartisan Policy Center Report, performance metrics like the travel time index can help compare effectiveness of programs across the country to determine which programs should be emulated and which have failed to produce significant results (*15*).

*Implementation*

The authors make the following recommendations for incorporating the use of the *Urban Mobility Report* information for required (or recommended) benefit-cost analysis.

- Use *Urban Mobility Report* metrics as a measure of accountability in determining what projects have been most successful at reducing congestion. Having a metric that can show the public which projects are working, and how they are improving their lives, will reduce skepticism towards infrastructure projects. It will also help policymakers determine which projects to emulate on a larger scale. The commodity value metric should be incorporated into funding formulas, to ensure that the most important areas for freight transportation in the country receive the necessary funding.
- Incorporate metrics in state long-range transportation plans.
- Base goals in these plans around reducing congestion as defined by the *Urban Mobility Report*.
- Use congestion measures to determine which applications (technology, capacity improvements, accessibility) are the most valuable on particular locations.
- Create incentives on new monies that become available (e.g., gas tax, dedicated funds) for multi-state partnerships to address freight corridors of importance. For example, a tunnel through a mountain in Arizona on a freight corridor that benefits adjacent states in freight movement. This recommendation will require balancing regional stakeholder needs and balancing between both urban and rural interests.

*Transit and Freight Dependencies*

Twenty-nine state-level DOTs said that finding data on the performance of multiple modes of transit was difficult (*8)*. The *Urban Mobility Report* helps clarify what areas need improvement and what areas should be invested in, as well as provides a model for states to develop their own metrics when dealing with multiple modes of transit.

# CHAPTER 3: *URBAN MOBILITY REPORT* TRUCK VALUE METHODOLOGY DEVELOPMENT AND RESULTS

This chapter describes the procedure used to develop and test a methodology for generating truck freight values included in the *Urban Mobility Report.*

## Data Sources

The methodology below uses data from two primary data sources, 1) the Federal Highway Administration's (FHWA) Highway Performance Monitoring System (HPMS), and 2) FHWA's Freight Analysis Framework (FAF).

### *Highway Performance Monitoring System*

HPMS includes national-level data on the condition and performance of the highway system (*16)*. The states provide HPMS data elements to FHWA on a yearly basis for use in federal aid allocation and for producing FHWA's "Conditions and Performance" reports.

Researchers have historically used HPMS data in the development of the statistics in the *Urban Mobility Report.* The following are the specific HPMS-link data elements used in the methodology to incorporate truck freight values into the UMR.

- Average Daily Traffic (ADT)
- Truck percent (percent of ADT that are trucks)
- Link length

### *Freight Analysis Framework (FAF)*

FHWA collects and produces FAF to provide a national snapshot of freight movements throughout the United States, including the metropolitan areas (*17*). The methodology described in this chapter uses truck value data from FHWA FAF 2.2, the latest version of FAF available when the methodology was developed. There are 114 geographic areas for FAF 2.2, corresponding to the regions used for the 2002 Commodity Flow Survey (CFS). FAF 2.2 includes projections for other years in five-year increments. Value of commodities are identified in FAF by the Standard Classification of Transported Goods (SCTG) system.

## *Urban Mobility Report* Truck Value Methodology

Researchers developed a methodology to allocate truck value from FAF to the urban areas within the *UMR* as a proportion of the truck vehicle-miles of travel in each urban area. The following sections describe the methodology and results.

The methodology includes a three-part process to determine the truck values produced in the *UMR*. Each part is described below in more detail.

### *Part 1 Methodology ("Line Method")*

Figure 1 shows a flowchart for Part 1 of the methodology. Part 1 is sometimes referred to as the "Line Method" because it focuses on the value of goods "on the line" connecting two nodes (origin and destination) without focusing on the actual area where the goods originate or are destined. The numbered inputs/steps in Figure 1 of the methodology are described below.

Input 1. *2009 HPMS input*: The methodology begins by using the 2009 HPMS data for the metropolitan areas of interest.

Step 1. *Compute truck VMT for each state and the nation:* Vehicle-miles of travel (VMT) are computed for each state (and then summed for the nation) as the product of average daily traffic (ADT), truck percentage, and average link length (miles). This is produced by sample HPMS data by functional classification.

Step 2. *Estimate truck VMT percent for each state (urban areas and rural):* Relative to the VMT sum for the nation from Step 2, researchers determine the truck VMT percent in each state (and in urban areas and rural areas within each state).

Input 2. *FAF 2.2 data input:* Computing the truck values begins by using the FAF 2.2 data as input.

Step 3. *Interpolate 2009 value for all origin-destination pairs:* Researchers interpolated the 2009 truck freight values between each origin-destination pair for the 2009 year of interest.

Step 4. *Estimate total truck value for the nation.* Researchers summed the value moving between all origin-destination pairs to estimate the truck value for the nation. This step yields a sum of the values "on all the lines" between key origins and destinations.

Step 5. *Estimate truck value in each state and urban area of interest.* Researchers proportioned the total truck value from Step 4 to each state (urban areas and rural) using the truck VMT percentages estimated in Step 2.

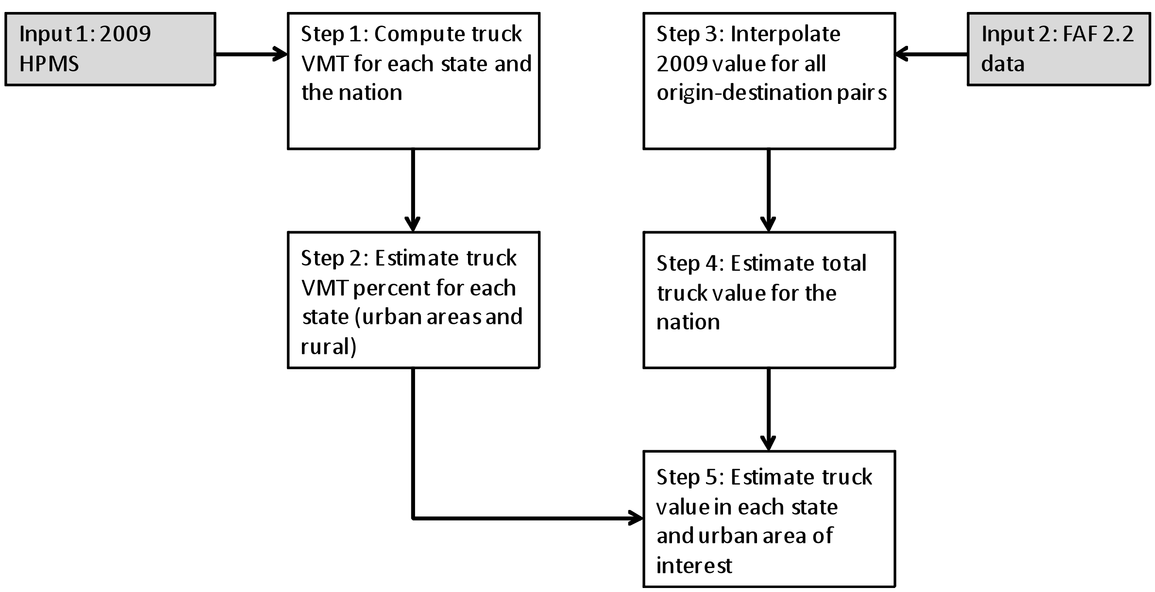


**Figure 1 Methodology for Part 1 ("Line Method") of *UMR* Truck Value Methodology**

The Part 1 methodology ("Line Method") focuses on the sum of the values traveling between each origin and destination. It essentially ignores the origins and destinations. Certainly not all origins and destinations share similar characteristics. For example, port cities such as Los

Angeles/Long Beach, Chicago, or New York/New Jersey should be expected to have more truck value traveling than urban areas where ports play less of a role. In addition, FAF 2.2 does not include truck trips that are less than 50 miles. As such, substantial value of trips that occur in these "port-influenced" urban areas may not be adequately reflected in the Part 1 methodology ("Line Method").

*Part 2 Methodology ("Node Method")*

While the datasets for the Part 2 methodology are the same, the focus is on the origins and destinations to provide more consideration and increased value for port cities. Because of the focus on the endpoints of the trip, this methodology is sometimes termed the "Node Method." The steps that follow describe the methodology in more detail. Figure 2 shows a flowchart of the steps used in this method. The numbered steps and elements in Figure 2 are described in the following steps.

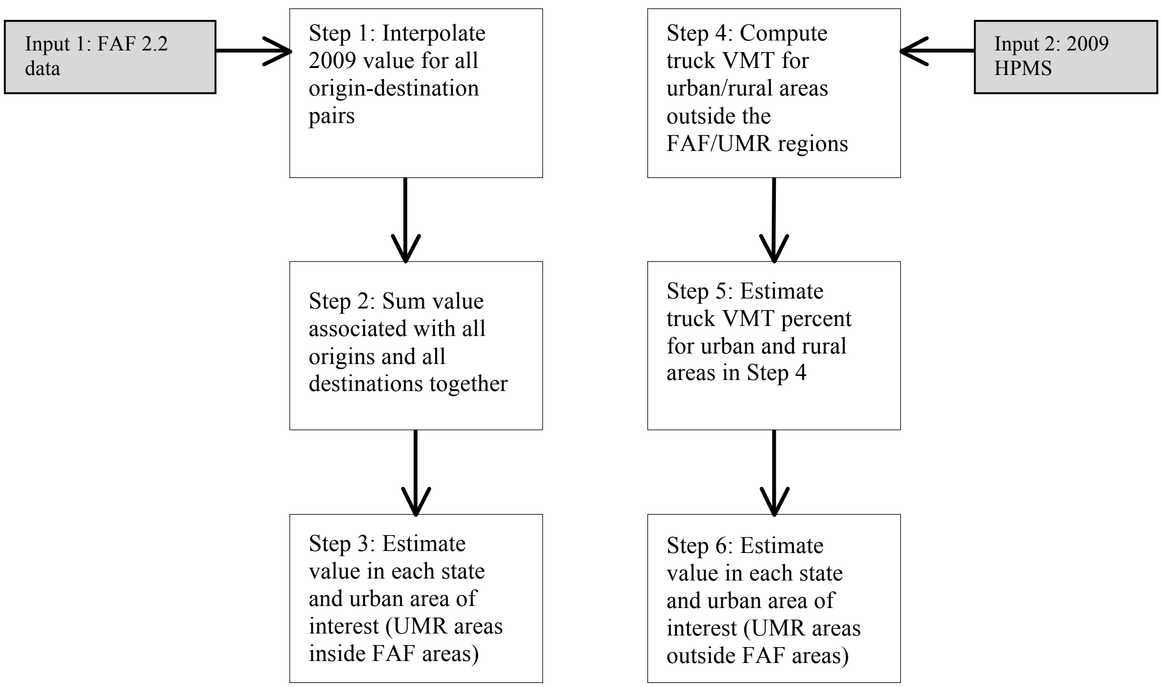


**Figure 2 Methodology for Part 2 Methodology ("Node Method") of *UMR* Truck Value Methodology**

Input 1. *FAF 2.2 data input:* Computing the truck values begins by using the FAF 2.2 data as input.

Step 1. *Interpolate 2009 value for all origin-destination pairs:* Researchers interpolated the 2009 truck freight values between each origin and destination pair for the 2009 year of interest.

Step 2. *Sum value associated with all origins and all destinations together:* Researchers summed the total truck value of all origin and destinations together to provide the "node influence" of this methodology.

Step 3. *Estimate value in each state and urban area of interest (UMR areas inside FAF areas):* For a given FAF area, researchers allocated the proportion of truck value occurring in either the origin or the destination as a percent of the total truck value (sum of all origins and destinations together). These FAF areas typically covered the urban areas of the metropolitan areas of the *UMR*.

Input 2. *2009 HPMS Input*: The Part 2 methodology uses the 2009 HPMS data for the metropolitan areas of interest.

Step 4. *Compute truck VMT for urban/rural areas outside the FAF/UMR regions covered in Step 3:* Researchers computed truck VMT for the relatively urban areas not covered in the FAF regions in Step 3 as well as the rural areas in each state.

Step 5. *Estimate truck VMT percent for urban and rural areas in Step 4:* Researchers computed the percentage of truck VMT for the remaining urban/rural areas.

Step 6. *Estimate value in each state and urban area of interest (UMR areas outside FAF areas)*. For urban/rural areas outside FAF 2.2 areas, researchers allocated truck value based on the relative percentage of truck VMT in each urban/rural area.

*Part 3: Methodology*

Part 3 is the final part of the methodology. Part 1 and Part 2 both provide an estimate of the truck value for each state and urban area in the *UMR*. For Part 3 of the methodology, researchers obtained the final estimate of truck value by averaging the truck value of the Part 1 and Part 2 results for each metropolitan area in the *UMR*.

## RESULTS AND DISCUSSION

Table 1 presents the results of the methodology in terms of truck commodity value aggregated by city size. Delay statistics are also included in Table 1 as computed in the *2011 Urban Mobility Report* (*1*). Table 2 shows the state truck commodity values. Table 1 and Table 2 are the results as presented in the *2011 Urban Mobility Report.*

Table 1 demonstrates a correlation between commodity value and truck delay—higher commodity values are associated with more people; more people are associated with more traffic congestion (*1*). Bigger cities consume more goods, which means a higher value of freight movement. While there are many cities with large differences in commodity and delay ranks, only 15 urban areas are ranked with commodity values much higher than their delay ranking.

Table 1 also illustrates the role of long corridors with important roles in freight movement. Some of the smaller urban areas along major interstate highways along the east and west coast and through the central and Midwestern U.S., for example, have commodity value ranks much higher than their delay ranking. This occurs in both Madison and Milwaukee. High commodity values and lower delay might sound advantageous—lower congestion levels with higher commodity values means there is less chance of congestion getting in the way of freight movement. At the areawide level, this reading of the data is correct, but in the real world the problem often exists at the road or even intersection level.

**Table 1. Truck Commodity Value and Truck Delay, 2010**

| Urban Area | Total Delay | | Truck Delay | | | Truck Commodity Value | |
|---|---|---|---|---|---|---|---|
| | (1000 Hours) | Rank | (1000 Hours) | Rank | Congestion Cost | ($ million) | Rank |
| **Very Large Average (15 areas)** | **187,872** | | **12,120** | | **895** | **206,375** | |
| Chicago IL-IN | 367,122 | 3 | 31,378 | 1 | 2,317 | 357,816 | 3 |
| Los Angeles-Long Beach-Santa Ana CA | 521,449 | 1 | 30,347 | 2 | 2,254 | 406,939 | 2 |
| New York-Newark NY-NJ-CT | 465,564 | 2 | 30,185 | 3 | 2,218 | 475,730 | 1 |
| Houston TX | 153,391 | 6 | 9,299 | 4 | 688 | 230,769 | 4 |
| Washington DC-VA-MD | 188,650 | 4 | 9,204 | 5 | 683 | 95,965 | 17 |
| Dallas-Fort Worth-Arlington TX | 163,585 | 5 | 9,037 | 6 | 666 | 227,514 | 5 |
| Philadelphia PA-NJ-DE-MD | 134,899 | 8 | 8,970 | 7 | 659 | 172,905 | 7 |
| Atlanta GA | 115,958 | 11 | 8,459 | 8 | 623 | 189,488 | 6 |
| Miami FL | 139,764 | 7 | 8,207 | 9 | 604 | 153,596 | 9 |
| Phoenix AZ | 81,829 | 15 | 8,139 | 10 | 603 | 129,894 | 12 |
| San Francisco-Oakland CA | 120,149 | 9 | 6,558 | 11 | 484 | 130,852 | 11 |
| Seattle WA | 87,919 | 12 | 6,296 | 12 | 467 | 150,998 | 10 |
| Boston MA-NH-RI | 117,234 | 10 | 6,227 | 13 | 459 | 128,143 | 13 |
| Detroit MI | 87,572 | 13 | 5,186 | 15 | 382 | 159,328 | 8 |
| San Diego CA | 72,995 | 18 | 4,316 | 17 | 321 | 85,686 | 20 |

Very Large Urban Areas—over 3 million population.
Large Urban Areas—over 1 million and less than 3 million population.
Medium Urban Areas—over 500,000 and less than 1 million population.
Small Urban Areas—less than 500,000 population.

Travel Delay—Travel time above that needed to complete a trip at free-flow speeds for all vehicles.

Truck Delay—Travel time above that needed to complete a trip at free-flow speeds for large trucks.

Truck Commodity Value—Value of all commodities moved by truck estimated to be traveling in the urban area.

Note: Please do not place too much emphasis on small differences in the rankings. There may be little difference in congestion between areas ranked (for example) 6th and 12th. The actual measure values should also be examined.

Also note: The best congestion comparisons use multi-year trends and are made between similar urban areas

**Table 1. Truck Commodity Value and Truck Delay, 2010, Continued**

| Urban Area | Total Delay (1000 Hours) | Total Delay Rank | Truck Delay (1000 Hours) | Truck Delay Rank | Congestion Cost ($million) | Truck Commodity Value ($ million) | Truck Commodity Value Rank |
|---|---|---|---|---|---|---|---|
| **Large Average (32 areas)** | **33,407** | | **2,024** | | **148** | **62,310** | |
| Baltimore MD | 87,199 | 14 | 6,103 | 14 | 449 | 94,943 | 19 |
| Denver-Aurora CO | 80,837 | 16 | 4,324 | 16 | 319 | 76,023 | 22 |
| Minneapolis-St. Paul MN | 78,483 | 17 | 4,073 | 18 | 300 | 95,819 | 18 |
| St. Louis MO-IL | 47,042 | 21 | 3,841 | 19 | 283 | 107,010 | 15 |
| Riverside-San Bernardino CA | 40,875 | 25 | 3,080 | 20 | 229 | 108,218 | 14 |
| Orlando FL | 38,260 | 26 | 2,856 | 21 | 207 | 63,106 | 32 |
| Tampa-St. Petersburg FL | 53,047 | 19 | 2,842 | 22 | 210 | 61,906 | 33 |
| Pittsburgh PA | 41,081 | 24 | 2,755 | 23 | 200 | 69,290 | 25 |
| Portland OR-WA | 41,743 | 23 | 2,546 | 24 | 185 | 64,964 | 30 |
| San Juan PR | 50,229 | 20 | 2,417 | 25 | 174 | 23,130 | 60 |
| Nashville-Davidson TN | 26,475 | 33 | 1,961 | 26 | 142 | 65,449 | 29 |
| New Orleans LA | 20,565 | 39 | 1,859 | 27 | 135 | 34,270 | 50 |
| San Jose CA | 42,846 | 22 | 1,815 | 28 | 133 | 52,079 | 36 |
| Milwaukee WI | 26,699 | 32 | 1,746 | 29 | 127 | 66,629 | 28 |
| Sacramento CA | 29,602 | 30 | 1,688 | 30 | 123 | 51,883 | 37 |
| Cincinnati OH-KY-IN | 23,297 | 35 | 1,660 | 31 | 120 | 64,323 | 31 |
| Indianapolis IN | 20,800 | 38 | 1,657 | 32 | 119 | 83,984 | 21 |
| Kansas City MO-KS | 24,185 | 34 | 1,641 | 33 | 119 | 72,545 | 23 |
| Austin TX | 31,038 | 28 | 1,636 | 34 | 119 | 32,824 | 52 |
| Raleigh-Durham NC | 19,247 | 40 | 1,569 | 35 | 115 | 49,468 | 40 |
| San Antonio TX | 30,207 | 29 | 1,428 | 37 | 105 | 50,600 | 39 |
| Charlotte NC-SC | 17,730 | 43 | 1,383 | 38 | 101 | 68,196 | 26 |
| Virginia Beach VA | 36,538 | 27 | 1,344 | 40 | 98 | 43,056 | 42 |
| Memphis TN-MS-AR | 17,197 | 44 | 1,195 | 42 | 87 | 98,356 | 16 |
| Louisville KY-IN | 17,033 | 45 | 1,170 | 43 | 85 | 55,226 | 35 |
| Jacksonville FL | 18,005 | 42 | 1,158 | 44 | 84 | 41,508 | 44 |
| Las Vegas NV | 27,386 | 31 | 1,141 | 45 | 83 | 35,458 | 49 |
| Cleveland OH | 21,380 | 36 | 1,016 | 46 | 75 | 67,808 | 27 |
| Salt Lake City UT | 18,366 | 41 | 823 | 50 | 61 | 56,160 | 34 |
| Columbus OH | 14,651 | 51 | 727 | 51 | 53 | 69,664 | 24 |
| Buffalo NY | 11,450 | 56 | 698 | 55 | 51 | 48,387 | 41 |
| Providence RI-MA | 15,539 | 48 | 610 | 59 | 45 | 21,633 | 61 |

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Truck Commodity Value—Value of all commodities moved by truck estimated to be traveling in the urban area.

Note: Please do not place too much emphasis on small differences in the rankings. There may be little difference in congestion between areas ranked (for example) 6th and 12th. The actual measure values should also be examined.
Also note: The best congestion comparisons use multi-year trends and are made between similar urban areas

**Table 1. Truck Commodity Value and Truck Delay, 2010, Continued**

| Urban Area | Total Delay | | Truck Delay | | | Truck Commodity Value | |
|---|---|---|---|---|---|---|---|
| | (1000 Hours) | Rank | (1000 Hours) | Rank | Congestion Cost ($ million) | ($ million) | Rank |
| **Medium Average (33 areas)** | **9,513** | | **578** | | **42** | **18,478** | |
| Baton Rouge LA | 14,577 | 52 | 1,519 | 36 | 110 | 32,636 | 54 |
| Bridgeport-Stamford CT-NY | 21,233 | 37 | 1,380 | 39 | 102 | 11,205 | 73 |
| Tucson AZ | 11,412 | 57 | 1,287 | 41 | 92 | 28,654 | 58 |
| Birmingham AL | 15,832 | 47 | 971 | 47 | 71 | 38,401 | 45 |
| Albuquerque NM | 10,477 | 58 | 963 | 48 | 69 | 14,035 | 67 |
| Oklahoma City OK | 16,848 | 46 | 912 | 49 | 66 | 37,779 | 46 |
| Hartford CT | 15,072 | 49 | 716 | 52 | 52 | 42,403 | 43 |
| El Paso TX-NM | 10,452 | 59 | 714 | 53 | 52 | 31,703 | 55 |
| Charleston-North Charleston SC | 9,160 | 62 | 701 | 54 | 51 | 10,552 | 76 |
| New Haven CT | 11,643 | 55 | 676 | 56 | 49 | 8,276 | 86 |
| Allentown-Bethlehem PA-NJ | 9,777 | 60 | 597 | 60 | 43 | 15,827 | 65 |
| Honolulu HI | 15,035 | 50 | 595 | 61 | 42 | 10,125 | 78 |
| Tulsa OK | 9,086 | 63 | 562 | 63 | 42 | 28,827 | 57 |
| Richmond VA | 13,800 | 53 | 530 | 64 | 39 | 37,643 | 47 |
| Oxnard-Ventura CA | 9,009 | 64 | 529 | 65 | 39 | 9,187 | 83 |
| Colorado Springs CO | 11,897 | 54 | 509 | 66 | 37 | 6,546 | 91 |
| Albany-Schenectady NY | 7,467 | 71 | 484 | 67 | 35 | 32,655 | 53 |
| Grand Rapids MI | 7,861 | 68 | 446 | 69 | 32 | 37,551 | 48 |
| Sarasota-Bradenton FL | 8,015 | 67 | 446 | 69 | 32 | 7,591 | 89 |
| Knoxville TN | 7,518 | 70 | 439 | 71 | 32 | 11,989 | 72 |
| Bakersfield CA | 4,005 | 90 | 425 | 72 | 31 | 10,838 | 75 |
| Fresno CA | 5,999 | 78 | 396 | 73 | 29 | 9,474 | 81 |
| Indio-Cathedral City-Palm Springs CA | 5,633 | 80 | 389 | 74 | 28 | 5,455 | 94 |
| Dayton OH | 7,096 | 73 | 382 | 75 | 28 | 33,645 | 51 |
| Springfield MA-CT | 8,305 | 66 | 378 | 76 | 27 | 9,238 | 82 |
| Omaha NE-IA | 9,299 | 61 | 314 | 79 | 23 | 8,668 | 85 |
| Lancaster-Palmdale CA | 6,906 | 74 | 303 | 80 | 22 | 2,728 | 99 |
| Rochester NY | 6,377 | 76 | 295 | 81 | 21 | 26,077 | 59 |
| Akron OH | 6,198 | 77 | 290 | 82 | 21 | 9,828 | 80 |
| Wichita KS | 6,858 | 75 | 280 | 84 | 21 | 7,901 | 87 |
| Poughkeepsie-Newburgh NY | 4,271 | 85 | 272 | 85 | 20 | 13,714 | 68 |
| Toledo OH-MI | 4,223 | 86 | 247 | 90 | 18 | 10,950 | 74 |
| McAllen TX | 2,598 | 96 | 125 | 99 | 9 | 7,678 | 88 |

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Note: Please do not place too much emphasis on small differences in the rankings. There may be little difference in congestion between areas ranked (for example) $6^{th}$ and $12^{th}$. The actual measure values should also be examined.
Also note: The best congestion comparisons use multi-year trends and are made between similar urban areas

**Table 1. Truck Commodity Value and Truck Delay, 2010, Continued**

| Urban Area | Total Delay | | Truck Delay | | | Truck Commodity Value | |
|---|---|---|---|---|---|---|---|
| | (1000 Hours) | Rank | (1000 Hours) | Rank | Congestion Cost ($ million) | ($ million) | Rank |
| **Small Average (21 areas)** | **4,166** | | **288** | | **21** | **12,275** | |
| Columbia SC | 8,515 | 65 | 651 | 57 | 47 | 12,404 | 70 |
| Jackson MS | 5,488 | 81 | 648 | 58 | 47 | 16,984 | 64 |
| Cape Coral FL | 7,600 | 69 | 567 | 62 | 41 | 5,962 | 93 |
| Little Rock AR | 7,345 | 72 | 457 | 68 | 33 | 15,221 | 66 |
| Greensboro NC | 4,104 | 87 | 362 | 77 | 26 | 50,964 | 38 |
| Spokane WA | 4,306 | 84 | 323 | 78 | 23 | 7,230 | 90 |
| Winston-Salem NC | 4,054 | 89 | 287 | 83 | 21 | 8,679 | 84 |
| Pensacola FL-AL | 4,699 | 83 | 261 | 86 | 19 | 6,339 | 92 |
| Worcester MA | 5,639 | 79 | 259 | 87 | 19 | 10,115 | 79 |
| Salem OR | 3,912 | 91 | 256 | 88 | 18 | 3,864 | 97 |
| Madison WI | 3,375 | 93 | 252 | 89 | 18 | 17,361 | 63 |
| Provo UT | 5,056 | 82 | 240 | 91 | 18 | 12,681 | 69 |
| Beaumont TX | 3,814 | 92 | 236 | 92 | 17 | 20,504 | 62 |
| Laredo TX | 2,041 | 99 | 212 | 93 | 15 | 30,799 | 56 |
| Brownsville TX | 2,323 | 98 | 206 | 94 | 15 | 2,380 | 100 |
| Stockton CA | 2,648 | 95 | 203 | 95 | 15 | 10,264 | 77 |
| Anchorage AK | 3,013 | 94 | 183 | 96 | 13 | 4,454 | 96 |
| Corpus Christi TX | 2,432 | 97 | 172 | 97 | 13 | 12,327 | 71 |
| Boise ID | 4,063 | 88 | 137 | 98 | 10 | 4,772 | 95 |
| Eugene OR | 1,456 | 101 | 98 | 100 | 7 | 3,658 | 98 |
| Boulder CO | 1,612 | 100 | 47 | 101 | 3 | 820 | 101 |
| **101 Area Average** | **42,461** | | **2,690** | | **198** | **58,981** | |
| **Remaining Area Average** | **1,582** | | **119** | | **9** | **3,183** | |
| **All 439 Area Average** | **10,987** | | **710** | | **52** | **16,021** | |

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Truck Commodity Value—Value of all commodities moved by truck estimated to be traveling in the urban area.
Note: Please do not place too much emphasis on small differences in the rankings. There may be little difference in congestion between areas ranked (for example) 6th and 12th. The actual measure values should also be examined.
Also note: The best congestion comparisons use multi-year trends and are made between similar urban areas.

**Table 2. State Truck Commodity Value, 2010**

| State | Total Truck Commodity Value ($ million) | Rural Truck Commodity Value ($ million) | Urban Truck Commodity Value ($ million) |
|---|---|---|---|
| Alabama | 225,316 | 140,281 | 85,035 |
| Alaska | 17,161 | 12,082 | 5,079 |
| Arizona | 266,930 | 102,058 | 164,872 |
| Arkansas | 160,049 | 130,440 | 29,609 |
| California | 1,235,308 | 295,145 | 940,164 |
| Colorado | 153,998 | 62,081 | 91,917 |
| Connecticut | 110,515 | 7,578 | 102,937 |
| Delaware | 35,030 | 12,397 | 22,633 |
| Florida | 552,621 | 138,470 | 414,151 |
| Georgia | 417,906 | 182,728 | 235,178 |
| Hawaii | 16,307 | 5,592 | 10,715 |
| Idaho | 57,974 | 47,004 | 10,970 |
| Illinois | 548,431 | 174,621 | 373,810 |
| Indiana | 368,446 | 199,151 | 169,296 |
| Iowa | 157,013 | 130,758 | 26,255 |
| Kansas | 142,534 | 100,076 | 42,458 |
| Kentucky | 222,880 | 146,951 | 75,929 |
| Louisiana | 217,425 | 101,396 | 116,029 |
| Maine | 44,693 | 36,143 | 8,550 |
| Maryland | 205,976 | 51,098 | 154,878 |
| Massachusetts | 164,871 | 10,433 | 154,438 |
| Michigan | 348,470 | 101,493 | 246,977 |
| Minnesota | 189,643 | 86,720 | 102,923 |
| Mississippi | 155,821 | 121,572 | 34,249 |
| Missouri | 297,147 | 150,722 | 146,425 |
| Montana | 41,673 | 39,489 | 2,184 |
| Nebraska | 96,020 | 84,448 | 11,572 |
| Nevada | 78,514 | 37,075 | 41,440 |
| New Hampshire | 38,649 | 23,312 | 15,338 |
| New Jersey | 295,927 | 12,901 | 283,026 |
| New Mexico | 111,128 | 91,403 | 19,725 |
| New York | 482,018 | 111,566 | 370,451 |
| North Carolina | 373,822 | 146,171 | 227,652 |
| North Dakota | 47,109 | 42,718 | 4,391 |

Total Truck Commodity Value—Value of all commodities moved by truck estimated to be traveling in the state.
Rural Truck Commodity Value—Value of all commodities moved by truck estimated to be traveling in the rural areas of the state.
Urban Truck Commodity Value—Value of all commodities moved by truck estimated to be traveling in the urban areas of the state.

**Table 2. State Truck Commodity Value, 2010, Continued**

| State | Total Truck Commodity Value ($ million) | Rural Truck Commodity Value ($ million) | Urban Truck Commodity Value ($ million) |
|---|---|---|---|
| Ohio | 447,564 | 177,760 | 269,805 |
| Oklahoma | 205,346 | 137,892 | 67,453 |
| Oregon | 153,382 | 82,144 | 71,239 |
| Pennsylvania | 443,946 | 195,660 | 248,286 |
| Rhode Island | 21,139 | 3,786 | 17,353 |
| South Carolina | 192,648 | 97,765 | 94,883 |
| South Dakota | 44,693 | 39,879 | 4,813 |
| Tennessee | 349,114 | 156,776 | 192,337 |
| Texas | 1,150,012 | 441,184 | 708,828 |
| Utah | 143,138 | 60,146 | 82,992 |
| Vermont | 24,158 | 21,648 | 2,510 |
| Virginia | 253,058 | 110,587 | 142,471 |
| Washington | 273,611 | 91,855 | 181,756 |
| West Virginia | 85,762 | 62,040 | 23,722 |
| Wisconsin | 326,741 | 190,205 | 136,536 |
| Wyoming | 48,921 | 46,372 | 2,549 |
| District of Columbia | 9,059 | - | 9,059 |
| Puerto Rico | 38,653 | 3,494 | 35,159 |

Total Truck Commodity Value—Value of all commodities moved by truck estimated to be traveling in the state.
Rural Truck Commodity Value—Value of all commodities moved by truck estimated to be traveling in the rural areas of the state.
Urban Truck Commodity Value—Value of all commodities moved by truck estimated to be traveling in the urban areas of the state.

# CHAPTER 4: MILWAUKEE CASE STUDY APPLICATION AND RESULTS

Based on a methodology documented in previous research (*18*), researchers developed estimates of truck freight values for individual roadway corridors in the Milwaukee region. This chapter describes the Milwaukee case study data, methodology, and results.

## Data Sources

The methodology for the Milwaukee case study uses data from two primary data sources, 1) the Federal Highway Administration's (FHWA) Highway Performance Monitoring System (HPMS), and 2) FHWA's Freight Analysis Framework (FAF).

### *Highway Performance Monitoring System*

HPMS includes national-level data on the condition and performance of the highway system (*16*). The states provide HPMS data elements to FHWA on a yearly basis for use in federal aid allocation and for producing FHWA's "Conditions and Performance" reports.

Researchers have historically used HPMS data in the development of the statistics in the *Urban Mobility Report.* The following are the specific HPMS-link data elements used in the methodology to incorporate truck freight values into the UMR.

- Average Daily Traffic (ADT)
- Truck percent (percent of ADT that are trucks)
- Link length

### *Freight Analysis Framework*

For the Milwaukee case study, researchers used FAF version 3 ($FAF^3$). $FAF^3$ is an improvement on FAF 2.2. The updated $FAF^3$ is updated using the 2007 Commodity Flow Survey as input. FAF provides estimates of tonnage and value, by commodity type, mode, origin, and destination for 2007, the most recent year. Forecasts are provided through 2040 in $FAF^3$.

Researchers used the truck mode value forecasts for the metropolitan areas of interest for the methodology that follows. $FAF^3$ provides data for 123 domestic analysis regions.

## Methodology

Figure 3 illustrates a flowchart for the methodology used for the Milwaukee application. The steps shown in Figure 3 are described here.

Input 1. *Wisconsin 2009 HPMS shapefile input:* The methodology begins by using the shapefile supplied by Wisconsin Department of Transportation (WisDOT) staff.

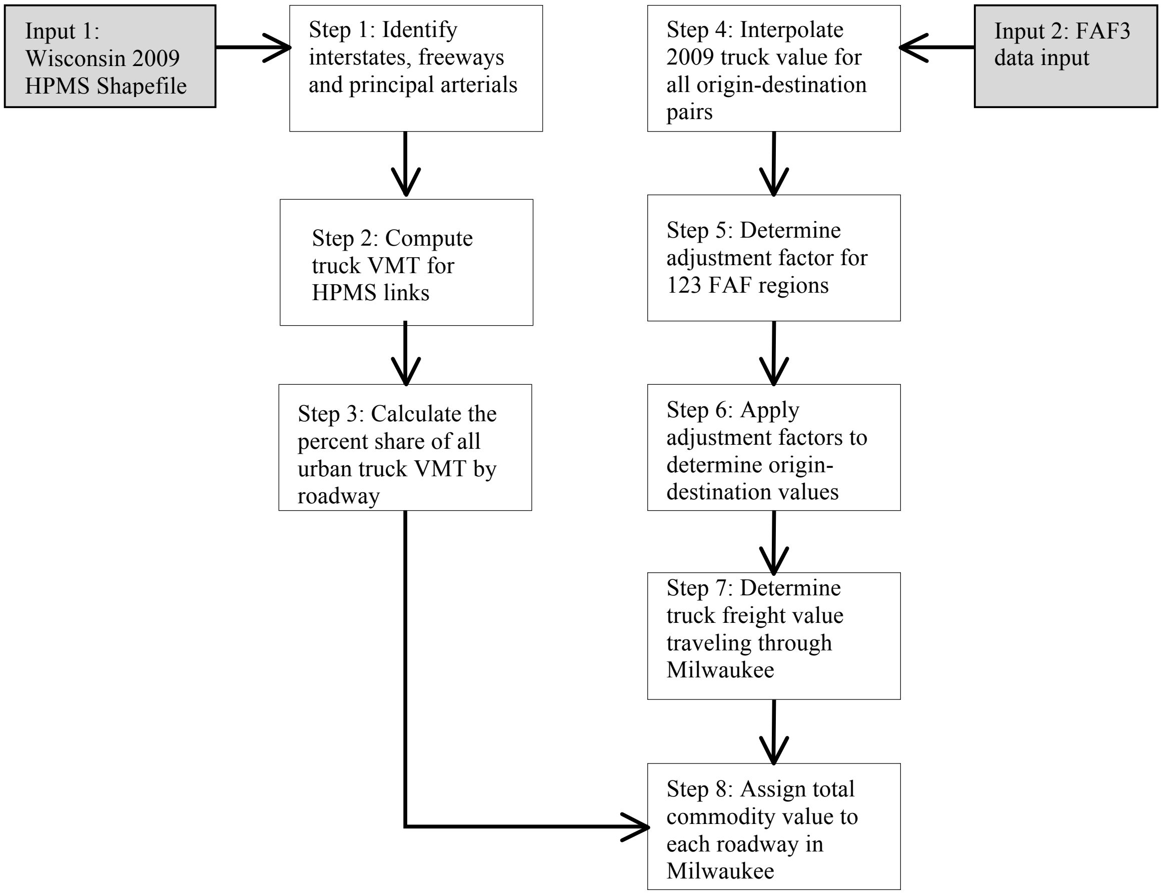


**Figure 3 Methodology for Determining Truck Freight Value along Milwaukee Roadways**

Step 1. *Identify interstates, freeways and principal arterials:* Researchers selected only the interstates, freeways, and principal arterials for the analysis of the Milwaukee urban area. Figure 4 shows the greater Milwaukee highway network.

Step 2. *Compute truck VMT for HPMS links:* For the roadways of interest in the Milwaukee area, researchers computed the truck VMT for the HPMS links.

Step 3. *Calculate the percent share of all urban truck VMT by roadway:* Researchers determined the percentage of truck VMT of each roadway in the Milwaukee area relative to the total amount of truck VMT on all roadways of interest in the region.

Input 2. *$FAF^3$ data input:* Computing the truck values begins by using the $FAF^3$ data as input.

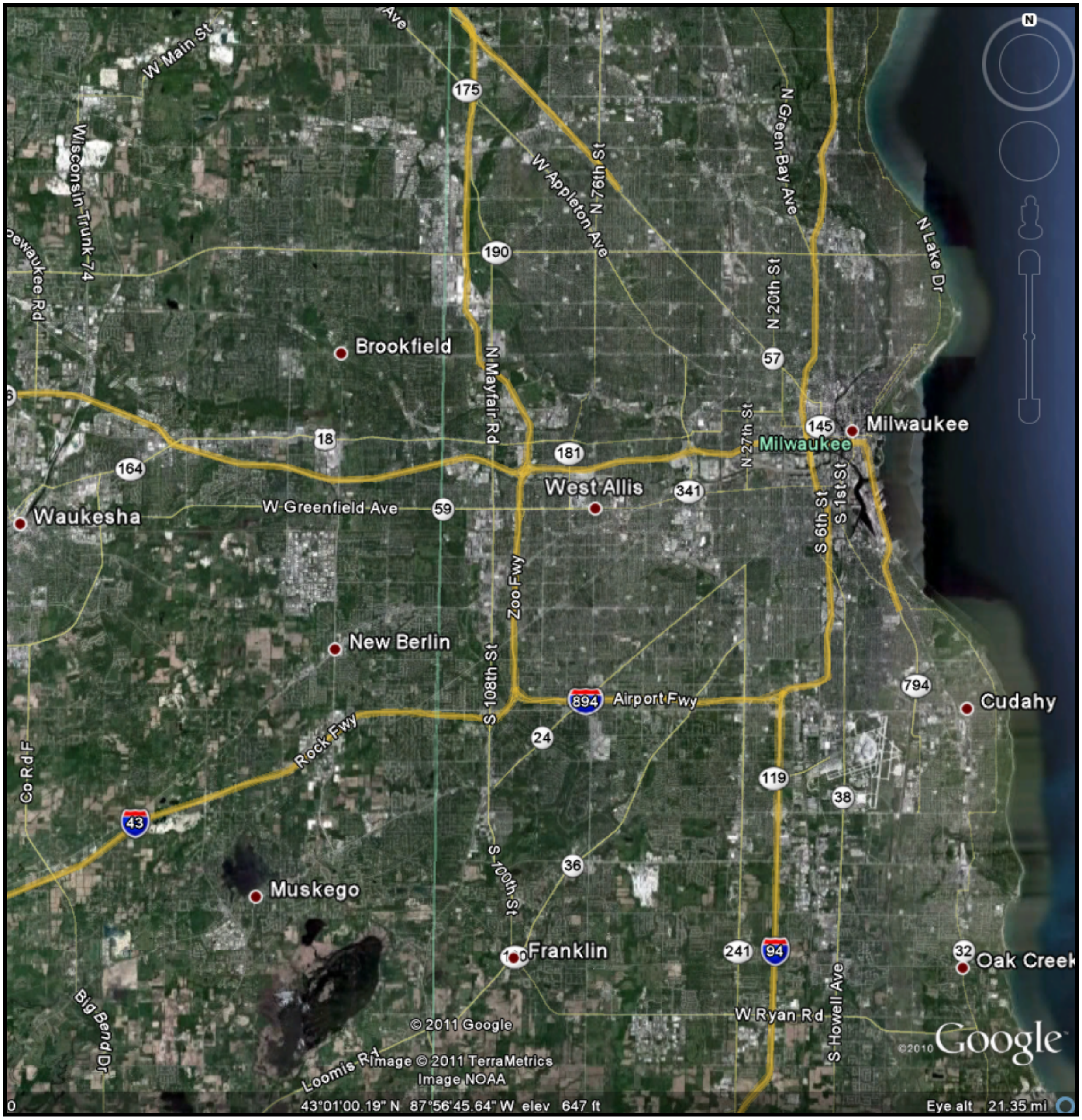


**Figure 4 Greater Milwaukee Area Showing Highway Network (Source: Google Earth)**

Step 4. *Interpolate 2009 truck value for all origin-destination pairs:* Researchers interpolated the 2009 truck freight values between each origin-destination pair for the 2009 year of interest.

Step 5. *Determine adjustment factor for 123 FAF regions:* Researchers used a two-step process as implemented in previous research (*18*). The two-step process estimates the value of commodities moved. First, a proximity matrix was created for each origin-destination pair with percentage factors representing the expectation that a given trip from the origin to the destination would go through Milwaukee. The proximity matrix provides a way to rationally expedite an approximation of through trips. The proximity matrix used for the Milwaukee analysis is shown in Figure 5.

Secondly, researchers created a likelihood matrix for each origin-destination pair with factors based on the likelihood that a trip would pass through the Milwaukee area, considering the existing roadway network connecting the origin to the destination relative to Milwaukee. With the likelihood matrix, the roadway network in the area of interest is considered, along with the possibility that a trip from a given origin or destination would pass through the area. The likelihood matrix is shown in Figure 6.

As an example, consider the origin-destination pair Los Angeles, California to Detroit, Michigan. According to the proximity matrix in Figure 5, there would be a proximity value of 5 percent based on the origin in Los Angeles, and a proximity value of 50 percent for the destination in Detroit. Similarly, there would be a 1 percent value for the likelihood for the origin of Los Angeles (Figure 6), and a likelihood value of 50 percent for a destination in Detroit (Figure 6). Therefore, the adjustment factor for the L.A. to Detroit origin-destination pair is the product of the two proximity matrix values and the two likelihood matrix values (0.0125 percent = 0.05 x 0.50 x 0.01 x 0.50).

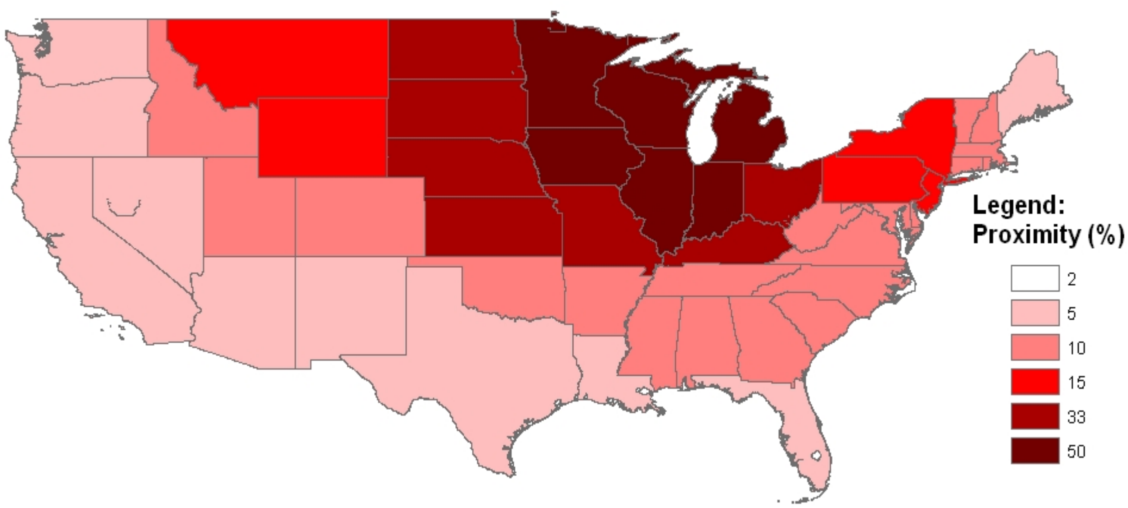


**Figure 5 Proximity Matrix Implemented for Milwaukee Case Study**

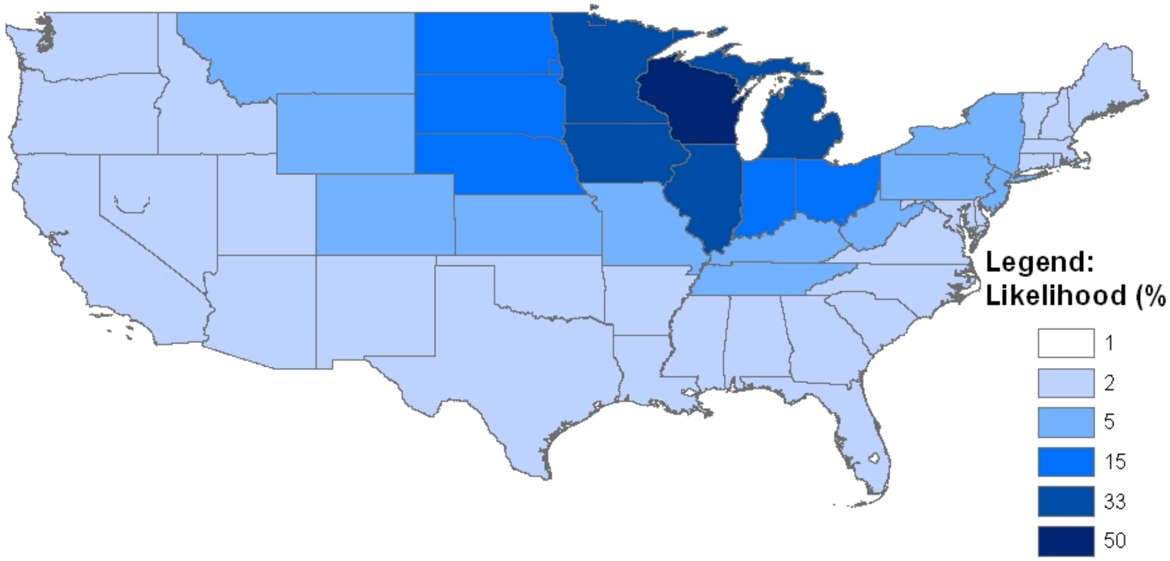


**Figure 6 Likelihood Matrix Implemented for Milwaukee Case Study**

Step 6. *Apply adjustment factors to determine origin-destination values:* Researchers applied the adjustment factors estimated in Step 5 to the values of truck freight between each origin-destination pair. The result is the value of truck freight traveling between any origin and destination that is estimated to travel through Milwaukee.

Continuing the example started in the previous step, consider there is $100,000 worth of commodity goods traveling from Los Angeles to Detroit. The value of goods traveling from L.A. to Detroit that would travel through Milwaukee in this simplified example is $12.50 ($100,000 x 0.000125).

Step 7. *Determine truck freight value traveling through Milwaukee:* Researchers summed the adjusted values from each origin-destination pair determined in Step 6 to determine the total value of truck freight traveling in the Milwaukee region. This total truck commodity value was approximately $74 billion.

Researchers calibrated the proximity and likelihood percentages shown in Figure 5 and Figure 6 using professional judgment such that the total truck commodity value resulting in this step (approximately $74 billion) was within 10 percent of the estimate for Milwaukee shown in Table 1.

Step 8. *Assign total commodity value to each roadway in Milwaukee:* Using the percent share of all urban truck VMT by roadway from Step 3, researchers allocated the total commodity value (approximately $74 billion) to each roadway in Milwaukee.

## MILWAUKEE CASE STUDY RESULTS AND DISCUSSION

Table 3 presents the results of the Milwaukee case study analysis. For each of the highways and interstates of interest in the Milwaukee region, Table 3 presents the truck VMT percent and the commodity value in millions of dollars.

Intuitively, the results in Table 3 show that the four interstates in the Milwaukee region account for the largest commodity value of any roadway type. The interstates combine for 48 percent of the commodity value traveling in the region in 2009.

Researchers estimated the total truck commodity value traveling through Milwaukee as $70.3 billion as shown in Table 1 using the areawide *UMR* method. The total value of the goods shown in Table 1 is $74 billion. This value is approximately 6 percent more than the $70.3 billion of truck commodity value estimated in Table 1 for the areawide *UMR* method. This appears to be reasonable for an urban area analysis such as this.

**Table 3 Truck VMT Percentage and Commodity Value for Roadways in the Milwaukee Region**

| | Truck VMT Percent | Commodity Value ($millions) |
|---|---|---|
| ***Interstate Highways*** | | |
| IH43 | 22 | 16,368 |
| IH94 | 23.1 | 17,186 |
| IH794 | 1.6 | 1,190 |
| IH894 | 1.2 | 893 |
| *Interstate Highway Subtotals=* | *48* | *35,638* |
| ***US Highways*** | | |
| US 18 | 3.7 | 2,753 |
| US 41 | 6.3 | 4,687 |
| US 45 | 9.8 | 7,291 |
| *US Highway Subtotals=* | *20* | *14,731* |
| ***State Highways*** | | |
| SH 16 | 5.2 | 3,869 |
| SH 24 | 0.045 | 33 |
| SH 32 | 1.0 | 744 |
| SH 33 | 0.2 | 149 |
| SH 36 | 1.3 | 967 |
| SH 38 | 1.7 | 1,265 |
| SH 57 | 1.2 | 893 |
| SH 59 | 3.4 | 2,530 |
| SH 60 | 0.5 | 372 |
| SH 67 | 1.0 | 744 |
| SH 74 | 0.9 | 670 |
| SH 83 | 1.1 | 818 |
| SH 100 | 3.2 | 2,381 |
| SH 119 | 0.2 | 149 |
| SH 145 | 0.9 | 670 |
| SH 164 | 2.8 | 2,083 |
| SH 167 | 0.8 | 595 |
| SH 175 | 0.8 | 595 |
| SH 181 | 0.9 | 670 |
| SH 190 | 3.7 | 2,753 |
| SH 241 | 1.2 | 893 |
| SH 341 | 0.2 | 149 |
| *State Highway Subtotals=* | *32* | *23,990* |

Note: when roadways are signed with two highway numbers, preference is given to the through road (higher classification).

# CHAPTER 5: CONCLUSIONS AND FUTURE WORK

This research was successful in developing a methodology for incorporating areawide truck freight estimates into the *UMR* by urban area. Researchers estimated truck commodity value traveling in each urban area. Researchers implemented the methodology into the *2010 Urban Mobility Report*, which was released in January 2011. The *2011 Urban Mobility Report,* released in September 2011, used the same methodology to present the truck freight values. Researchers used the $FAF^3$ data in the methodology for the *2011 Urban Mobility Report.*

The methodology for performing the Milwaukee analysis is transferable to other metropolitan areas. For such analyses, there is a need to develop new proximity and likelihood matrices to perform such analyses in other areas. Building from prior work (*18*), this research further demonstrates the rational and efficiency of using the proximity and likelihood matrix to estimate through travel between origin-destination pairs in the FAF data set for areawide analysis.

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