
6th International Symposium on
Heavy Vehicle Weights and Dimensions
Saskatoon, Saskatchewan, Canada June 18 - 22, 2000

Improving Truck Exposure for Safety Analysis: Potential Short-Term and Long-Term Solutions

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Abstract

Truck exposure information is important for program evaluation, highway infrastructure management, safety analysis, resource allocation, traffic engineering, truck size and weight (TS&W) enforcement, and other applications. Transportation agencies have been working to improve travel and accident information for truck safety analysis. While there has been considerable improvement in the quality and availability of truck accident data, this is not the case for truck travel data. The limited availability of exposure data continues to be a significant restriction on the ability to undertake truck safety analysis based on the risk of accident involvement per mile of travel. In an effort to improve truck exposure information for safety analysis, the Federal Motor Carrier Safety Administration (FMCSA) sponsored the University of Michigan Transportation Research Institute (UMTRI) to host a workshop to review critical shortcomings in existing truck travel data, and identify potential solutions.

This paper discusses existing truck exposure data sources, and their strengths and weaknesses for truck safety analysis. The existing exposure and accident data sources are compared to identify common variables for estimating accident risk and rate. Potential short-term and long-term opportunities for improvements that would enhance the capability of these data sources to support accident risk and rate estimates are discussed.

1.0 BACKGROUND

Truck safety is an important issue in the United States. The Secretary of Transportation recently announced an agency goal to reduce truck-related fatalities by 50 percent over the next 10 years. To achieve this goal, it is important to understand the range of factors that increase the risk and severity of truck accident involvement. How does truck configuration affect accident risk? What is the relative risk of different highway types and road classes? How does time of day affect accident risk? What is the role of other traffic on the road? How do different cargo body types and cargo loading affect accident risk on highways with different design characteristics? How much do different truck operation types contribute to accident risk? To the extent that truck design and operations contribute to truck accidents, exposure data is critical to evaluating the risk factors in truck accidents, and in turn to identifying opportunities to lower accident rates.

There are many data sources available for truck safety analysis. Yet, due to problems with the structure, updating, storage, and management of some of those data sources, it is difficult to obtain important information that would allow a safety analyst to develop accident rate or risk estimates. In an effort to improve truck exposure information, the FMCSA sponsored UMTRI to host a workshop on truck travel and safety to review critical shortcomings in existing truck travel data, and identify potential solutions. This paper presents an overview of existing truck exposure and accident data sources in the U.S. The existing data sources are compared to identify common variables for estimating accident risk or rate. Truck "exposure" here includes commercial vehicle registration information (counts of the number of trucks) as well as measures of vehicles miles traveled (VMT). Potential short-term and long-term opportunities for improving the available data sources to support accident risk and rate estimates are also discussed. For a more complete discussion, see the final report, *Plan to Improve Truck Exposure Data for Safety Analysis* (Montufar, Campbell, and Blower, 2000).

2.0 TRUCK EXPOSURE AND ACCIDENT DATA SOURCES

Over the years, the U.S. has spent considerable resources developing databases for truck exposure and accident information. The following discussion presents a general overview of available national truck exposure and accident data sources for truck safety analysis.

2.1 Truck Exposure Sources

The report addresses 10 potential sources for truck exposure information in the United States. Only four are discussed here. However, Table 1 summarizes the strengths and weaknesses of many of the sources reviewed in the full report.

Highway Statistics. The annual Highway Statistics (HS) publication of the U.S. Department of Transportation FHWA contains state level information on many exposure-related items. The sources of the information are various state administrative data systems and FHWA

analysis. In some cases, the FHWA supplements the data supplied by the states with information obtained from other sources such as the Truck Inventory and Use Survey (TIUS) to improve consistency and accuracy. Relevant information in HS includes the number of commercial vehicles, total miles traveled, total fuel consumed, and average fuel consumption. A shortcoming is that the disaggregate figures are approximations and may not support disaggregate analysis.

Truck Inventory and Use Survey (TIUS). The Truck Inventory and Use Survey (TIUS) is designed to measure the physical and operational characteristics of the country's truck fleet. TIUS, which is conducted every five years by the Bureau of the Census, provides the best information on the U.S. truck population. The survey is a probability-based sample of all trucks registered in the 50 states plus the District of Columbia (Campbell, et al, 1997). Relevant information in TIUS includes the company type, principal business, vehicle characteristics and use, and VMT. A shortcoming is that the survey is not conducted more often. The 1997 TIUS data was not available until October 1999.

Motor Carrier Management Information System Census Data File. The Motor Carrier Management Information System (MCMIS) Census file contains the information provided by the carrier at the time of application for a USDOT number. All interstate carriers of property or passengers are required by law to have a USDOT number. The carrier information is provided on Form MCS-150 and includes the address, fleet size for each of several types of companies, and annual mileage for the fleet. The Census file provides a complete census of interstate carriers of property or passengers. For-hire carriers can be distinguished from private, and each can be classified by fleet size. The file also provides counts of straight trucks, tractors, hazardous materials cargo tank trucks; and breakdowns within each power unit type by whether they were owned, term leased, or trip leased. The primary shortcoming is that the information is not updated regularly.

Traffic Volume Data. The measurement of traffic volume is one of the most basic functions of highway planning and management in a transportation agency (FHWA, 1995). Some of the most important uses of traffic volume information include: pavement design, pavement management, bridge design, road maintenance, and road safety analysis.

Each highway agency has its own traffic monitoring program. Three complementary types of traffic counts are usually collected in a traffic monitoring program: (1) permanent counts; (2) control or seasonal counts; and (3) short-term or coverage counts. The combination of information from those three types of counts is what generates traffic estimates in a region. Some states and provinces have reasonably good traffic monitoring programs that could be used to develop truck exposure estimates. The main product from a traffic monitoring program is traffic data by road link. This allows estimation of VMT. Many agencies are expanding the use of automatic vehicle classifiers in their counting systems to be able to develop better estimates of truck exposure data.

2.2 Accident Data Sources

Exposure data must match the variables and code levels in the accident data to be useful. To calculate an accident rate, the numerator (accidents) must be available at the same level of detail as the denominator (exposure measure). Thus, a primary consideration of exposure data used for safety analysis is that the data provide estimates that are compatible with existing national accident data. There are four national accident files (see Table 1 for details) covering medium and heavy trucks in the U.S.

Fatality Analysis Reporting System (FARS). The Fatality Analysis Reporting System is the standard national database of fatal accidents. It contains data on a census of fatal traffic accidents in the United States. To be included in FARS, an accident must involve a motor vehicle traveling on a roadway customarily open to the public and must result in the death of an occupant of a vehicle or non-motorist within 30 days of the accident. The FARS file provides the fullest reporting of variables relevant to highway exposure issues, including roadway function class, following the classification employed in the FHWA travel estimates, route signing (*e.g.*, Interstate, US, and State route), and trafficway flow (*e.g.*, undivided, divided with barrier, and others).

Trucks Involved in Fatal Accidents (TIFA). The TIFA file, which has been available since 1980, is based on the FARS file. TIFA provides coverage of medium and heavy trucks (GVWR over 10,000 pounds) recorded in the FARS file. It includes all accident, vehicle, and driver records from the FARS file, and supplements that data with a detailed description of the truck and some information on the company that operated the vehicle. TIFA supplements the FARS file in two ways. First, TIFA provides a careful identification of all trucks involved in a fatal accident, including vehicles misclassified in FARS as light vehicles and excluding light vehicles misclassified as medium or heavy trucks. Second, TIFA provides extensive detail about the physical configuration of the truck, along with some carrier information and other details.

General Estimates System (GES). The GES file is a nationally representative probability-based sample of police-reported accidents. Police accident reports (PARs) are sampled from 60 geographic sites across the U.S. The selected reports are sent to a data processing contractor, who extracts the required data, codes it into a common format, and creates an electronic data file. Since GES data is obtained from a probability-based sample of police-reported traffic accidents, national estimates can be made from the data. However, sampling errors associated with the estimates for trucks are sometimes large. Some of the information available from GES includes the carrier's DOT number, limited information about road characteristics, and general information about the accident itself. Missing data rates are higher than in the previous two accident files.

Motor Carrier Management Information System (MCMIS) Crash file. The MCMIS Crash file is compiled by the FMCSA from reports submitted by the states through the SAFETYNET system. Data collected in the MCMIS Crash file conforms to the set of data

elements for truck and bus accidents recommended by the National Governor's Association (NGA) in 1990. Accidents reportable through the SAFETYNET system include either a fatality, someone transported from the scene for immediate medical attention, or at least one vehicle towed from the scene due to disabling damage sustained in the accident. Since the Crash file was designed to work in concert with the Census file, the Crash file includes the USDOT number, the ICC number, and State DOT numbers. Each of these provides a means to link to additional information about the carrier.

2.3 Relating Truck Exposure and Accident Variables

For safety analysis it is essential that the variables be present in both exposure and accident data sources and that their definitions be the same. For discussion purposes, variables are grouped as carrier, highway, truck type, and other. Each group will be described briefly.

Carrier information is the first group of variables. It is intended to provide fleet level characteristics. Interstate/intrastate, private/for-hire, and fleet size are in both TIUS and the MCMIS Census file. Less than truckload(LTL)/truckload (TL) is only in TIUS. Carrier Identification Number (ID) is only included in the MCMIS Census file. Of the accident data sources, TIFA has information on interstate/intrastate and private/for-hire carriers. The MCMIS Crash file contains information on interstate/intrastate. The USDOT number of the carrier is now included in all three federal accident files. Carrier ID provides a link variable to attach the carrier variables in the MCMIS Census file to each of the accident files. This recent change appears to provide a means to significantly improve the carrier information in the accident files.

The road type variables exist primarily under traffic monitoring programs and FARS. Highway Statistics has five road categories that distinguish three types of rural roads and two urban types. GES identifies interstate roads, divided roads, and the NHS. The rural/urban variable does not correspond with definitions used in the other sources. Time of day is another important variable describing the operation that is related to trip distance. While time of day is in all the accident files, it is not readily available in most exposure data sources. With some work, day/night information could be obtained from state traffic monitoring programs. This is also the case with month of year information.

All the data sources listed have some form of truck type variable. The Highway Statistics only distinguishes single unit from combination trucks. Traffic monitoring programs may, in some instances, be able to distinguish trucks by major classes (*e.g.*, 5-axle tractor semitrailer, doubles, single unit trucks). The most complete and compatible truck type variables are in TIUS and TIFA, including a gross combination weight (actual at the time of the accident in TIFA and typical in TIUS) and also a VIN-derived gross vehicle weight rating for the power unit. The other sources are essentially limited to single unit, single-trailer combination, and multiple-trailer combination.

Temporal distribution of truck activity is only likely to be obtained from data contained in traffic monitoring programs. With automated vehicle classification capabilities, states are increasingly able to provide real-time (or close to real-time) information about the amount of truck traffic operating on a highway section. Historical information can be retrieved to estimate truck traffic exposure by day/night, and month of year. All four accident data sources contain that same type of information.

3.0 PROPOSED SHORT-TERM AND LONG-TERM OPPORTUNITIES FOR IMPROVED TRUCK EXPOSURE DATA

A workshop on truck travel and safety was held in Washington, D.C. in October 1999 as part of this project. The purpose of this workshop was to review critical shortcomings in existing truck travel data for safety analysis, and to identify potential solutions. Short term, incremental changes to existing sources were of particular interest, as well as longer term solutions where necessary.

A list of proposed short-term and long-term improvements to truck exposure data resulted from the workshop. This was supplemented with discussions with experts concerning each of the available data sources, and professional judgment from the research team.

3.1 Short-term Opportunities

All the proposed short-term opportunities involve the MCMIS Census file.

Update Census File Regularly. One of the shortcomings of the MCMIS Census file is that the data is not regularly updated. The information is updated only when the carrier has a safety or compliance review, amounting about 10,000 records annually out of a total of more than 450,000. By updating the MCMIS Census file periodically, better and more current information would be available for safety analysis. Workshop participants recommended the period be at most every two years to at least every four years. Since the workshop, the U.S. Congress passed the Motor Carrier Safety Improvement Act of 1999 creating a new Federal Motor Carrier Safety Administration (FMCSA) in the Department of Transportation. This Act includes a requirement for the Secretary to amend the regulations to "require periodic updating, not more frequently than once every two years, of the motor carrier identification report, form MCS-150, filed by each motor carrier conducting operations in interstate or foreign commerce." The suggested approach from the workshop is to update a fraction of the carriers each year or month. The fraction would be chosen so that all carrier records would be updated in the desired period, 2 to 4 years. A possible approach would be to let carriers submit updated information through Internet-based forms. Once records are updated, historical copies of the Census file would have to be preserved for each calendar year.

Universal Carrier Number for all Registered Medium and Heavy Trucks. Federal authority covers carriers involved in interstate or foreign commerce. Consequently, intrastate carriers are not required to have an ICC or USDOT number. The lack of information on intrastate carriers poses a problem when conducting truck safety-related analyses at the national or state level because intrastate carriers are a significant component of truck operations. Intrastate carriers *are* included in the MCMIS Crash file and they can file a Form MCS-150 and receive a USDOT number if they wish. However, complete coverage of every carrier that operates a medium or heavy truck in a single national data source such as the MCMIS Census file, is necessary for a comprehensive picture of truck safety issues. Currently, the role of intrastate carriers is largely unknown. A requirement for every operator of a medium or heavy truck to file a Form MCS-150 and get a USDOT number would address this issue. This requirement would be significantly aided by full implementing the Performance and Registration Information Systems Management (PRISM) program. This is currently a voluntary program designed to link commercial vehicle registration to other motor carrier databases. A rulemaking may be required to get full participation by all states. The implementation of PRISM should apply to both interstate and intrastate carriers.

Reconcile Variables between MCMIS Census and TIUS. Our review revealed similar variables that have different definitions across data sources. Reconciling these differences would improve the ability of these files to support safety analysis. In particular, there are several opportunities to coordinate variables between the MCMIS Census file and the Truck Inventory and Use Survey. These include fleet size, truck type, inter/intrastate, and private/for-hire carriers.

Capturing fleet size in a consistent and useful way is difficult. The issues include the fleet size categories to use, the types of vehicles to count, and what locations to include in large companies with several locations and different operating subsidiaries. Both TIUS and the Census file currently include light vehicles in the fleet size count. One approach would be to limit the fleet size count to medium and heavy trucks, over 10,000 pounds GVWR, to be consistent with the vehicle population covered by FMCSR. Both TIUS and the Census file currently distinguish leased from owned trucks. The problem of multiple locations and operating divisions is more difficult. One possibility is to define a fleet as those power units operating under a common USDOT number.

Added Fleet Characteristics. Additional fleet characteristics are also desired. The trucking industry has historically distinguished truck-load from less-than-truck-load carriers due to the fundamental differences in their operations. Less than truckload carriers traditionally take whatever freight is available over regular routes, while a truck load carrier takes each load wherever it needs to go. These differences are thought to have important implications for safety regulations. Even though many industry tabulations include this distinction, there is no corresponding variable in any public accident or exposure data source. If the industry can make this distinction, then it should be possible to incorporate it in public sources. Form MCS-150 seems to be the logical place. A possible additional variable is to distinguish carriers that operate nationally from those that are regional. Other possibilities are the business or product codes from TIUS.

Standard Definition of a Truck. The definition of a truck varies from one data source to the next. This is a critical issue for any analysis that tries to draw on more than one source. Most of the problems are in distinguishing light trucks from medium-duty trucks. The most common definition is a gross vehicle weight rating (GVWR) of the power unit over 10,000 pounds for separating medium-duty from light trucks. The MCMIS Crash file covers any power unit with six tires or more. This definition approximates the 10,000 pound GVWR threshold. The Vehicle Identification Number (VIN) is needed to determine GVWR reliably. Another possibility is to distinguish units with GVWR between 10,000 pounds and 26,000 pounds from those with a GVWR greater than 26,000 pounds. Reconciling the definition of a truck is a critical issue for safety analysis.

3.2 Long-term Opportunities

These opportunities address registration data, truck traffic information, the application of geographic information systems (GIS), and reconciling the estimates from these sources.

Improved Registration Data. Registration data provides the sampling frame for TIUS and is also used to prepare the Nation Vehicle Population Profile (NVPP). The processing of registration data is all done by R.L. Polk, and little information is available about the accuracy of the data. A shortcoming for safety research is that registration data contains no descriptive information beyond what R.L. Polk derives from the VIN. One solution to this is to create a central file to process and maintain truck registration data from every state. In addition, the data elements in the registration record should be expanded. Desirable data elements include the carrier ID, some descriptive data such as GVWR and body type and perhaps odometer readings to reconcile with annual mileage in other data sources.

Improve Truck Traffic Information Systems. Vehicle-miles traveled are typically estimated from traffic counts and highway mileage. This makes traffic volume data a fundamental source for exposure information. However, many traffic monitoring programs fail to specifically address commercial vehicle traffic on the highways. Yet, truck volume information is needed for most of the decisions made by highway and transportation agencies.

Recent research shows that seasonal monitoring and adjustment for trucks and cars must be done separately (Hallenbeck, 1997). This is because truck volume patterns and car volume patterns can be considerably different. Roads that carry significant volumes of through trucks usually have different seasonal patterns than roads that carry mainly regional truck traffic (FHWA, 1999). The current methods used to estimate truck flows vary between states, and in some states, no special methods exist. It would be desirable to conduct pilot projects in one or two states to develop truck traffic information systems. The systems would include the collection of truck traffic data by lane, direction, class, time of day, day of week, and month of year. This would allow the safety analyst to answer questions addressing the geographic variability of truck movements; the time-of-day distribution of truck travel; and VMT by truck type (or all trucks combined). This information could then

be used in conjunction with truck accident information to obtain temporal distributions of truck accident rates/risk by road class, truck type, and others. The pilot projects could initially focus on a limited road network (e.g., the Interstate Highway System), and then possibly expand to a larger network, or to the same road network in other states.

Use of Geographic Information Systems (GIS) for Spatially-Related Analysis. Road safety analysis has historically been limited by the data available from police accident reports. Despite the existence of other data sets such as traffic volumes, geometric design features, and pavement condition, the problem has been matching the location of the accident to the referencing systems used for these other data sets.

Many states have started to introduce the use of GIS as a standard means to deal with transportation-related issues. However, full implementation of GIS has not been achieved in most states for traffic monitoring or safety analysis purposes. Fully introducing GIS as a tool in traffic monitoring programs of states would be a significant improvement. This is particularly the case with truck safety analysis, given that the primary benefit of GIS is the ability to integrate various independent databases, such as collision data, location and traffic volume, to perform any type of analysis.

Reconcile Estimates Across Sources. It is not likely that a single source of data can meet all exposure data needs. Consequently, there is a need to reconcile aggregate estimates across the available sources to increase the quality of all the estimates. Of particular value would be some reconciliation of traffic volume based estimates with registration or survey estimates of truck travel. Improved compatibility of coverage, definitions and common variables should improve consistency. Specific plans could be developed to compare key aggregate figures.

4.0 CONCLUDING REMARKS

Truck exposure information is essential to evaluate truck safety issues. The limited availability of exposure data continues to be one of the most significant restrictions on the ability to undertake truck safety analysis based on comparative collision rates, or risk of accident involvement per mile of travel. This paper summarized a project sponsored by the FMCSA to develop a plan to improve truck exposure estimates. The paper presented an overview of existing truck exposure and accident data sources, and discussed potential short-term and long-term opportunities for improving available truck exposure data for safety analysis. The recommended opportunities resulted mainly from the workshop on truck travel and safety organized as part of this project.

While the recommended items may work for safety analysis at the national level, there is also a need for more disaggregate analyses. Some possibilities include obtaining corridor-specific, region-specific, state-specific, or commodity-specific exposure information. There are many safety researchers and analysts who spend great effort collecting exposure information specific to their jurisdictions. Many lessons could be learned about methods

that are being used to estimate truck exposure for safety analysis from sharing that information with other users.

ACKNOWLEDGEMENT

The authors wish to acknowledge the participants in the Truck Travel and Safety Workshop. Many of the ideas presented here came from them. We also wish to thank Chuck Rombro (FMCSA), sponsor of the project, Russ Capelle (BTS) for assistance in organizing the workshop and Ben Ritchey (Battelle) for providing the facility for the workshop.

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Table 1. Strengths and Weaknesses of Available Data Sources

Data Source	Strengths	Weaknesses
Highway Statistics (HS)	• National and State level statistics • Annual estimates by highway type and vehicle type	• No distinction by carrier type or trip distance is possible. • Source for VM-1 table is admin office, not hwy departments. • Some estimates are derived rather than enumerated.
Truck Inventory and Use Survey (TIUS)	• Large sample size. • Possible to compare from year to year. • VIN number available	• Data represents typical or primary use only. • ICC or DOT number not collected. • Difficult to get travel estimates by operational characteristics.
Motor Carrier Management Information System (MCMIS) Census File	• Can distinguish for-hire and private carriers. • Can classify carriers by fleet size.	• Intrastate carriers not included. • Data is not regularly updated. • No definition of "truck" is provided.
International Registration Plan (IRP)	• Provides information on all trucks used in interstate operations. • Information is reliable due to periodic auditing.	• Only trucks over 26,000 pounds GVW are included • No information for intra-state operations. • Data quality and availability varies between states. • No breakdown by vehicle configuration or body.
Highway Safety Information System (HSIS)	• It contains several data elements. • Databases are in SAS format and there are guidebooks for each state.	• Only 8 states are part of the system. • Commercial flow data is not available for all states. • Traffic data is sometimes coarse.
Traffic Volume Data	• Is the fundamental source for exposure info. • Allows for temporal analysis of exposure. • Myriad of applications.	• Quality depends on the state's traffic monitoring programs. • Monitoring and adjustment for trucks and cars done together. • Truck traffic is difficult to monitor. • Need understanding of trucking activity.
Fatality Analysis Reporting System (FARS)	• Census of all fatal crashes. • Low missing data rates • Good highway and accident variables.	• National Network roads are not identified.
Trucks Involved in Fatal Accidents (TIFA)	• Includes all variables in FARS. • Detailed description of trucks in collision. • Includes operating authority info.	• TIFA is a sample file for 1987 to 1992 and 1994 to 1997 (for all other years, a census of all fatal truck crashes is provided).
General Estimates System (GES)	• Nationally representative data • Trucks are oversampled • Consistent coding	• Does not provide the level of detail as TIFA/FARS • Sampling errors sometimes large for trucks • Missing data is a problem for some variables.
MCMIS Crash File	• Possible to classify trucks by configuration. • File designed to work with MCMIS Census file.	• Data elements are limited. • No information to classify crash as urban or rural.