Driver Detention Times in Commercial Motor Vehicle Operations

U.S. Department of Transportation
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FOREWORD

The purpose of the current study was to assess average commercial motor vehicle (CMV) driver detention times by a number of stratification variables, including operation size, operation type, and freight type. Researchers collected data from two different third-party vendors, ultimately obtaining stop time information for 31 different motor carriers. Researchers also developed a literature review on the impact of detention times in CMV operations. The data collected from third-party vendors and the information compiled in the literature review were used to answer a set of specific research questions:

- What are the average detention times incurred by trucking operation and size and type of cargo or delivery consignee?
- What research (foreign and domestic) has been conducted to identify the cause and the potential means to improve operations to reduce driver detention times?
- Do other developed countries or regions have similar experience with long CMV driver waiting times? If so, what strategies or regulations are employed to mitigate this issue? What mechanisms are in place to monitor/track changes in driver detention times?

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16. Abstract

The purpose of this project was to quantitatively identify detention times in the commercial motor vehicle (CMV) industry. Although there is currently no standard definition, the industry commonly defines detention time as "any time drivers have to wait beyond 2 hours, which is the average time it takes to load or unload their cargo." Results indicated that drivers experienced detention time on approximately 1 in every 10 stops for an average duration of 1.4 hours. This represents the length of time the driver was detained beyond 2 hours; thus, he/she was loading/unloading at that delivery location for 3.4 hours in total. Medium-sized carriers (51–500 power units) had similar average detention times as large carriers (more than 500 power units); however, they experienced driver detention about twice as often as large carriers. For example, 19 percent of stops made by medium-sized carriers were accompanied by detention time compared to 9 percent of stops made by large carriers. The calculation of odds ratios (ORs) provided similar results for medium-sized carriers when compared to large carriers. The odds of a driver being detained were 2.17 times greater for medium-sized carriers than for large carriers. Operation type did not have much impact on the average length of detention time; however, operation type influenced how frequently drivers experienced detention time, with for-hire truck load (TL) carriers experiencing detention time more than twice as frequently as for-hire less-than-truckload (LTL) carriers and four times more often than private carriers. The OR analysis also indicated that for-hire TL carriers were worse off than for-hire LTL or private carriers. The odds of a driver being detained were nearly 5 times greater for for-hire TL carriers than for private carriers and 2.6 times greater than for for-hire LTL carriers. The odds of a driver being detained were 6.3 and 1.9 times greater for temperature controlled freight carriers than for dry bulk carriers, and liquid bulk/tank freight carriers, respectively.

17. Key Words	18. Distribution Statement
Detention time, waiting time, commercial motor vehicle, commercial trucking, fatigue, hours of service	**No restrictions**

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Unclassified	**Unclassified**	**66**	

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SI* (MODERN METRIC) CONVERSION FACTORS

TABLE OF APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
In	inches	25.4	Millimeters	Mm
Ft	feet	0.305	Meters	M
Yd	yards	0.914	Meters	M
Mi	miles	1.61	Kilometers	Km
		AREA		
in²	square inches	645.2	square millimeters	mm²
ft²	square feet	0.093	square meters	m²
yd²	square yards	0.836	square meters	m²
Ac	acres	0.405	Hectares	Ha
mi²	square miles	2.59	square kilometers	km²
		VOLUME	1000 L shall be shown in m³	
fl oz	fluid ounces	29.57	Milliliters	mL
Gal	gallons	3.785	Liters	L
ft³	cubic feet	0.028	cubic meters	m³
yd³	cubic yards	0.765	cubic meters	m³
		MASS		
Oz	ounces	28.35	Grams	G
Lb	pounds	0.454	Kilograms	Kg
T	short tons (2000 lb)	0.907	megagrams (or “metric ton”)	Mg (or “t”)
		TEMPERATURE	Temperature is in exact degrees	
°F	Fahrenheit	5 × (F-32) ÷ 9 or (F-32) ÷ 1.8	Celsius	°C
		ILLUMINATION		
Fc	foot-candles	10.76	Lux	Lx
Fl	foot-Lamberts	3.426	candela/m²	cd/m²
		Force and Pressure or Stress		
Lbf	poundforce	4.45	Newtons	N
lbf/in²	poundforce per square inch	6.89	Kilopascals	kPa

TABLE OF APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
Mm	millimeters	0.039	inches	In
M	meters	3.28	feet	Ft
M	meters	1.09	yards	Yd
Km	kilometers	0.621	miles	Mi
		AREA		
mm²	square millimeters	0.0016	square inches	in²
m²	square meters	10.764	square feet	ft²
m²	square meters	1.195	square yards	yd²
Ha	hectares	2.47	acres	Ac
km²	square kilometers	0.386	square miles	mi²
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	Gal
m³	cubic meters	35.314	cubic feet	ft³
m³	cubic meters	1.307	cubic yards	yd³
		MASS		
G	grams	0.035	ounces	Oz
Kg	kilograms	2.202	pounds	Lb
Mg (or “t”)	megagrams (or “metric ton”)	1.103	short tons (2000 lb)	T
		TEMPERATURE	Temperature is in exact degrees	
°C	Celsius	1.8c + 32	Fahrenheit	°F
		ILLUMINATION		
Lx	lux	0.0929	foot-candles	Fc
cd/m²	candela/m²	0.2919	foot-Lamberts	Fl
		Force & Pressure Or Stress		
N	newtons	0.225	poundforce	Lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in²

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003, Section 508-accessible version September 2009.)

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Definition
ATIS	Advanced Traveler Information System
ATRI	American Transportation Research Institute
CMV	commercial motor vehicle
CoR	chain of responsibility
CI	confidence interval
CSA	Compliance, Safety, Accountability
EU	European Union
FMCSA	Federal Motor Carrier Safety Administration
GAO	Government Accountability Office
GPS	Global Positioning System
HVNL	Heavy Vehicle National Law
HOS	hours-of-service
LTL	less-than-truckload
LCL	lower confidence limit
MCES	Motor Carrier Efficiency Study
NHTSA	National Highway Traffic Safety Administration
NHVR	National Heavy Vehicle Regulator
NTSB	National Transportation Safety Board
OR	odds ratio
OOS	out-of-service
POA	period of availability
reefer	refrigerated trucks
RSRT	Road Safety Remuneration Tribunal
SD	standard deviation

Acronym	**Definition**
TL	truckload
UK	United Kingdom
UCL	upper confidence limit

EXECUTIVE SUMMARY

INTRODUCTION

Detention time refers to the time commercial motor vehicle (CMV) operators may experience at shipping and receiving facilities because of excessive delays associated with the loading and unloading of cargo. Although there is currently no standard definition, the industry commonly defines detention time as "any time drivers have to wait beyond 2 hours, which is the average time it takes to load or unload their cargo."(1) The purpose of this project was to quantitatively identify detention times in the CMV industry.

RESULTS

Operation size subgroups included the following:

- Small (1–50 trucks).
- Medium (51–500 trucks).
- Large (more than 500 trucks).

Operation type subgroups included the following:

- For-hire truckload (TL).
- For-hire less-than truckload (LTL).
- Private carriers.

Freight type subgroups included the following:

- Dry bulk (i.e., dry bulk, such as flour and phosphates).
- Liquid bulk/tank (i.e., liquids and oils).
- Mixed freight (i.e., three or more types of freight being hauled).
- Reefer (i.e., temperature controlled goods, usually meats, dairy, or produce).
- Van (i.e., dry van, not temperature controlled).
- Van/flatbed (i.e., dry goods or metal fabrication and capital goods).
- Van/reefer (i.e., dry goods or refrigerated goods).

Unfortunately, the third-party vendor was unable to separate the final two combined freight types (van/flatbed and van/reefer) to determine which stops were linked to which freight type. This was the labeling provided by the carrier.

The filtered data set included 31 different carriers. Two were small carriers, which contributed 271 stops (0.02 percent of the total stops). Twenty-three of the carriers were considered medium carriers, which contributed 277,667 stops (20.58 percent of the total stops). Finally, 6 of the carriers were large carriers, which contributed 1,070,959 stops (79.4 percent of the total stops).

Stop Time Data (Loading/Unloading and Waiting)

Stop time includes all values in the data set between the lower bound of 30 minutes and the upper bound of 10 hours; thus, stop time includes loading/unloading time and any waiting time drivers may have experienced. Stop times reflect the time the vehicle spent at one location. As can be seen in Figure 1, which shows the distribution of stop times, the data is positively skewed, with the bulk of the data falling in the lower stop time categories.

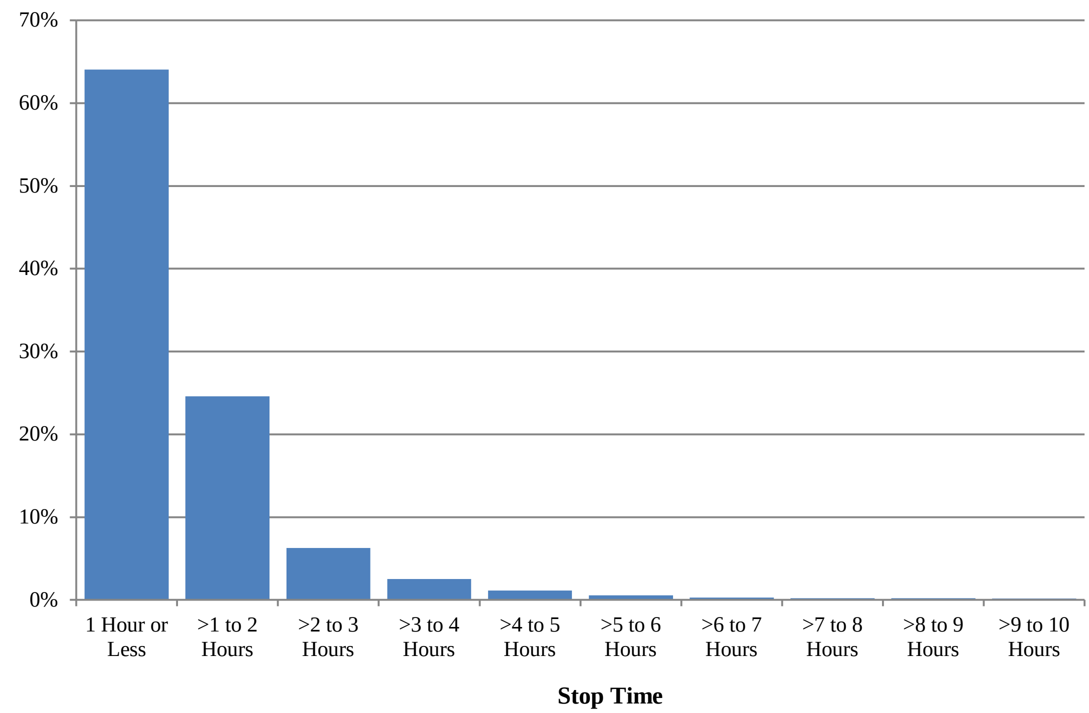

Figure 1. Bar chart. Distribution of all stop times between 30 minutes and 10 hours.

Detention Time

The average detention time overall was 1.4 hours (standard deviation [SD] = 1.57) with a median of 0.85 hours. This represents the length of time a driver was at a stop location in addition to the 2 hours considered by the industry to be the standard loading/unloading time. Thus, a driver detained for 1.4 hours was actually at that shipping/receiving facility for 3.4 hours. Medium-sized motor carriers had the longest average detention times (mean = 1.54, SD = 1.77), followed closely by large motor carriers (mean = 1.33, SD = 1.46). Limited data on small carriers were collected; however, these carriers only experienced seven stops with detention time during this study. Therefore, results relating to detention times for small carriers are not representative of this segment of the industry and need to be interpreted with caution. Results for small carriers are presented in Appendix A.

All operation types had average detention times between 1 and 1.7 hours. Specific detention times for each operation type were as follows:

- For-hire TL (mean = 1.47, SD = 1.67).
- For-hire LTL (mean = 1.51, SD = 1.75).
- Private (mean = 1.21, SD = 1.23).

For-hire TL carriers experienced the majority of the stops. The average detention times varied from as low as 0.5 hours to almost 2 hours depending on the type of freight a driver was delivering. Reefer (mean = 1.74, SD = 1.87) and van (mean = 1.63, SD = 1.66) freight types had the longest average detention times, which were more than half an hour longer than the rest of the freight types. Carriers (for hire and private) of mixed freight had the shortest average detention time at 0.5 hours; however, this calculation was based on only four stops.

Although the mean detention times are informative, the likelihood of a stop being detained is also important. Table 1 shows the number and percentage of stops, by operation size, that were or were not detained. For example, the mean detention times for medium carriers and large carriers were relatively similar; however, Table 1 shows that medium carriers were twice as likely as large carriers to be detained.

Table 1. Stops when drivers experienced detention time by operation size.

Operation Size	Detained (Number)	Detained (Percent)	Not Detained (Number)	Not Detained (Percent)	Total
Medium	51,468	18.54%	226,199	81.46%	277,667
Large	101,628	9.49%	969,331	90.51%	1,070,959

Table 2 shows the number and percentage of stops, by operation type, that were or were not detained. As shown in Table 2, for-hire TL drivers were far more likely than for-hire LTL and private drivers to be detained. For-hire TL drivers were more than four times more likely to be detained than private drivers and more than two times more likely to be detained than for-hire LTL drivers.

Table 2. Stops when drivers experienced detention time, by operation type.

Operation Type	Detained (Number)	Detained (Percent)	Not Detained (Number)	Not Detained (Percent)	Total
For-hire TL	108,302	20.98%	407,846	79.02%	516,148
For-hire LTL	4,323	9.27%	42,321	90.73%	46,644
Private	40,478	5.15%	745,627	94.85%	786,105

Table 3 shows the number and percentage of stops that were or were not detained, by freight type. As shown in Table 3, reefer and van freight types were the most likely freight types to be detained, and dry bulk and mixed freight types were the least likely to be detained. Limited data on a freight type labeled “mixed” were collected; however, these carriers only experienced four stops with detention time during this study. Therefore, results relating to detention times for the “mixed” freight type need to be interpreted with caution. Results for the “mixed” freight type are presented in Appendix A.

Table 3. Stops when drivers experienced detention time, by freight type.

Freight Type	Detained (Number)	Detained (Percent)	Not Detained (Number)	Not Detained (Percent)	Total
Dry Bulk	1,335	5.71%	22,033	94.29%	23,368
Liquid Bulk/Tank	10,476	16.70%	52,261	83.30%	62,737
Reefer	14,330	27.69%	37,422	72.31%	51,752
Van	61,787	25.50%	180,471	74.50%	242,258
Van/Flatbed	3,623	11.85%	26,962	88.15%	30,585
Van/Reefer	11,241	1.75%	630,928	98.25%	642,169

DISCUSSION

This was the first study (of which the authors are aware) that collected objective measures of detention times in CMV operations. At this time, it is difficult to conclude if 1.4 hours of detention time is problematic, as there is limited information available to make comparisons. Cross-modal comparisons are not appropriate, as the rail and maritime industries measure detention times over longer periods, and the types of freight (and their aggregate volumes and mass) and the processes and equipment used in loading and unloading are considerably different. The overwhelming majority of stops in the current study were completed in 1 hour or less (64.07 percent), followed by stops of 1–2 hours (24.58 percent). Based on these data, detention times in excess of 2 hours appear to be unusual. It is difficult to quantify the costs associated with detention times in the current study, as the analysis would need to differentiate waiting and unloading/loading time. Assuming that unloading/loading time is part of normal operations, the waiting time could be used to determine the costs of inefficiencies associated with detention times. Unfortunately, the current study was unable to separate waiting times from unloading/loading times.

Results indicate that drivers experienced an average duration of 1.4 hours of detention time on approximately 1 in every 10 stops. This represents the length of time the driver was at a shipper’s or receiver’s facility beyond the standard 2 hours of unloading/loading time; thus, the driver was physically at that delivery location for 3.4 hours in total. Concerning operation size, the results of the current study also showed that medium-sized carriers had similar average detention times as large carriers; however, they were detained about twice as often as large carriers were. For example, 19 percent of stops made by medium-sized carriers were accompanied by detention time as compared to 9 percent of stops made by large carriers. The calculation of odds ratios

(ORs) provided similar results for medium-sized carriers when compared to large carriers. The odds of a driver being detained were 2.17 times greater for medium-sized carriers than for large carriers.

Operation type did not have much impact on the average length of detention time, with all three operation types having fairly similar average times (i.e., the average detention time for-hire TL and for-hire LTL carriers was 1.5 hours, and the average detention time for private carriers was 1.2 hours). However, operation type influenced how frequently drivers experienced detention time, with for-hire TL carriers experiencing detention time more than twice as frequently as for-hire LTL carriers and four times more often than private carriers. The OR analysis also indicated that for-hire TL carriers were worse off than for-hire LTL or private carriers. The odds of a driver being detained were nearly 5 times greater for for-hire TL carriers than for private carriers and 2.6 times greater than for for-hire LTL carriers.

Refrigerated (reefer) trailer drivers experienced longer and more frequent detention times than other freight types; however, the current study also found that van freight carriers were almost on par with reefer carriers for duration and frequency of detention time. Reefer and van freight types had the longest average detention times at 1.7 hours and 1.6 hours, respectively. Carriers of these freight types were detained on more than a quarter of the stops they made (28 percent for reefer freight and 26 percent for van freight). The odds of a driver being detained were 6.3, 1.9, and 6.22 times greater for reefer freight carriers than for dry bulk carriers, liquid bulk/tank freight carriers, and mixed freight carriers, respectively. Similarly, the odds of a driver being detained were 5.65 and 1.71 times greater for van freight carriers than for dry bulk freight carriers and liquid bulk/tank freight carriers, respectively. Dry bulk and liquid bulk/tank freight types had an average detention time of around 1 hour with liquid bulk/tank freight types experiencing detainment on 17 percent of their stops and dry bulk freight types experiencing detainment on only 6 percent of their stops. Unfortunately, a sizeable portion of the freight type data was combined in such a way that it could not be separated out and attributed to a single freight type, which made interpretation difficult.

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1. INTRODUCTION

1.1 BACKGROUND

The commercial trucking industry plays a vital role in America's economy and standard of living. Consumers, businesses, and industries rely heavily on the trucking industry for deliveries: around 70 percent of goods are delivered by truck,(2) which equals an annual value of slightly more than $8 trillion.(3) Freight volume in the United States is expected to increase by as much as 20 percent over the next decade to 16.6 billion tons in 2023.(4) In addition, the livelihoods of millions of Americans depend on trucking: the industry employs more than 5.5 million commercial motor vehicle (CMV) drivers, as well as administrative staff, managers, technicians, mechanics, depot workers, and dispatchers.(5) The safety, efficiency, and reliability of an industry that forms such an integral part of society should be of the utmost importance.

Given that the CMV population shares the roads with millions of other vehicles, the safety of the trucking industry and its drivers is often in the spotlight. CMVs have a much lower annual crash rate than light vehicles (112.8 crashes per 100 million vehicle miles traveled for CMVs, versus 186.4 crashes per 100 million vehicle miles traveled for light vehicles). However, CMVs have a higher fatal crash involvement rate than light vehicles (1.1 fatal crashes per 100 million vehicle miles traveled versus 0.9 fatal crashes per 100 million vehicle miles traveled, respectively).(6) This is presumably due to the much greater forces at play when a large truck is involved in a crash. Traffic safety data released by the National Highway Traffic Safety Administration (NHTSA) in 2010 show that 76 percent of the fatalities in crashes involving large trucks were occupants of other vehicles.(7) However, the number of fatal and injury CMV crashes has decreased substantially in recent years. The number of fatal CMV crashes declined from 4,472 in 2007 to 3,757 in 2011.(8) Fatal crashes decreased for all types of vehicle crashes across that same period, but CMV mileage has risen faster than that of other vehicle types; therefore, the decrease in crash and fatal crash involvement rates has been much greater for CMVs than for other vehicle types.(9) However, CMV crashes are still an economic burden, costing around $50 billion per year.(10)

The Federal Motor Carrier Safety Administration (FMCSA) regulates the interstate CMV industry. The primary goal of FMCSA is to reduce the number of crashes, injuries, and fatalities that involve CMVs. One of the key regulations that FMCSA enforces is the prescriptive hours-of-service (HOS) regulation, which ensures that CMV drivers have adequate time to obtain rest by limiting the number of hours per day and week a driver can drive or work.(11) Numerous studies have demonstrated that fatigue can lead to involvement in a crash. For example, in 1990, the National Transportation Safety Board (NTSB) studied 182 fatal-to-the-driver large-truck crashes.(12) NTSB's in-depth investigations revealed that fatigue was the principal cause in 31 percent of these crashes, making it the largest single cause of truck crashes in the study. Additionally, in a 1994 study entitled "Crashes and Fatalities Related to Driver Drowsiness/Fatigue," researchers found that CMV drivers were asleep at the wheel in 4 percent of all heavy-vehicle crashes.(13) Separately, FMCSA found that fatigue was a contributing factor in 13 percent of serious CMV crashes (i.e., involving serious injury and/or fatalities).(14) Furthermore, FMCSA estimated that fatigue is involved in 15 percent of all fatal, large-truck-related crashes (directly involved in 4.5 percent of these crashes and indirectly involved in an additional 10.5 percent due to the mental lapses and inattention associated with fatigue).[15] Regardless of discrepancies related to exactly how much fatigue contributed to these CMV crashes, experts believe that detention time contributes to fatigue-related truck crashes.

Detention time refers to excessive delays that truck drivers may experience at shipping and receiving facilities when loading/unloading cargo. Although there is currently no standard definition, the industry commonly defines detention time as "any time drivers have to wait beyond 2 hours, which is the average time it takes to load or unload their cargo."[16] This includes waiting time and loading/unloading time. Current HOS regulations limit the number of hours a driver can work per day to 14 hours; thus, CMV drivers who experience detention time may be more inclined to drive faster to reach their destinations within the HOS limits[17] or to operate beyond the HOS limits and improperly log their driving and duty time to make deliveries on time.[18] The primary goal of HOS regulations is to reduce driver fatigue and fatigue-related crashes. If detention time is affecting drivers' abilities to follow these Federal requirements, then it may also affect driver safety. Unfortunately, the quantitative contribution of detention time to HOS violations and crashes has not been studied, but interviews with drivers and industry representatives indicate that detention time is a regular, problematic occurrence in the CMV industry.[19]

1.1.1 Research Objectives

The purpose of this project is to better understand the nature of detention times in the CMV industry and to develop strategies to mitigate driver risks. Detention times can have safety and operational impacts, including HOS violations; however, there has been very little research conducted to quantify the problem.

1.1.1.1 Phase I: Problem Identification and Data Set Development

In Phase I, the research team assessed average detention times by the type of trucking operation (for-hire truckload [TL], for-hire less-than-truckload [LTL], or private) and the size of trucking operation (small, medium, or large). The research team developed a literature review on the impact of detention times in CMV operations (domestic and foreign). Additionally, the research team developed a methodology for evaluating the safety and operational implications of driver detention times on work hours (e.g., fatigue), HOS violations, out-of-service (OOS) violations, and crashes.

1.1.1.2 Phase II: Impact of Driver Detention on Safety and Operation

Phase II will implement the methodology developed in Phase I to assess the safety and operational impacts of driver detention time on work hours, HOS and OOS violations, and crashes. This second phase will also include focus groups to assess driver, carrier, and shipper opinions and perceptions regarding detention times and potential means that could be used to reduce detention times.

The objectives in Phase I of the current research effort were to conduct a descriptive analysis of detention times by type and size of carrier and a literature review on the impact of detention times in CMV operations. A set of specific research questions addressed during this phase are as follows:

- *Research Question 1:* What are the average detention times incurred by trucking operation and size and type of cargo or delivery consignee?
- *Research Question 2:* What research (foreign and domestic) has been conducted to identify the cause and the potential means to improve operations to reduce driver detention times?
- *Research Question 3:* Do other developed countries or regions (Canada, the United Kingdom [UK], the European Union [EU], and Australia) have similar experience with long CMV driver waiting times? If so, what strategies or regulations are employed to mitigate this issue? What mechanisms are in place to monitor/track changes in driver detention times?

1.2 LITERATURE REVIEW SUMMARY

The current literature review focuses on both domestic and international research, incorporating evidence from government and non-government sources in Canada, the UK, the EU, and Australia. Key lessons can be drawn from other countries and regions around the world regarding experiences with CMV driver detention times, as well as any strategies or regulations that may be employed to mitigate this issue.

1.2.1 The Nature of the Problem

Regardless of the industry, time spent waiting is unproductive and inefficient. CMV drivers typically work tight schedules; thus, any disruption can affect the schedules of other drivers who are waiting at the same facility to load or unload.(20) Inefficiency in the transport industry is costly, not only for carriers and their drivers who bear the expense of waiting times, but also for society. According to a recent report, U.S. carriers could gain $3.08 billion annually (and society as a whole could gain $6.59 billion annually) by eliminating loading and unloading inefficiency.(21) Detention times have reportedly been plaguing the industry for years. Considering their economic impacts, along with the operational and potential safety implications, detention times are clearly an important issue that requires further investigation. All of the available evidence supporting the contention that detention times are an issue for CMV drivers in the United States is self-reported data acquired through interviews with drivers, safety managers, and other expert respondents. At the time this study was conducted, there were no available studies that had quantitatively measured and assessed detention times.

The results of a 2003 study examining effective safety management techniques for commercial trucks and buses indicated that the problem of detention times has existed in the industry for at least a decade. Using Likert scales, the researchers who completed the 2003 study asked safety managers and other experts to rate the relative importance of 20 CMV transport safety problems. Safety managers rated the item “Delays associated with loading and unloading (e.g., resulting in long working hours, tight schedules, and fatigue)” as the fifth most important problem, and other experts rated it as the fourth most important. Overall, about half of the respondents considered detention times to be 1 of the top 5 problems out of all 20 presented.(22)

Similarly, the Motor Carrier Efficiency Study (MCES) conducted workshops with representatives from the motor carrier industry, technology vendors, and other experts to discuss transport inefficiencies, defined as "any practices, procedures, incidents, or events that produce waste, incur unnecessary expenses, require excess effort, do not generate revenue, and/or do not contribute to the safe, secure, and timely transportation of cargo from the point of origin to the point of destination."(23) Excessive waiting times for loading and unloading (i.e., detention times) were the most frequently cited "high-priority" inefficiency across the stakeholder groups. TL, LTL, and intermodal carriers also listed detention times as their top inefficiency concern.(24)

A recent report by the U.S. Government Accountability Office (GAO) adds further weight to the claim that detention times are an issue in the CMV industry. Of the 302 drivers interviewed in the study, 68 percent reported being detained in the last month and 59 percent within the last 2 weeks.(25) Of those who reported being detained, 65 percent also stated they had lost revenue as a result of being detained, with the amount of reported detention time ranging from less than 2 hours to more than 8 hours. Though this data was self-reported, when considered along with the opinions of motor carrier representatives and safety managers, it gives a clear indication that driver detention is a significant problem in the CMV industry.

1.2.2 Link to HOS Regulations and Safety

Excessively long driving or working hours have been recognized as a factor that may increase CMV crash risk. The CMV industry has been subject to limits on driver on-duty time since the 1930s, when the first HOS regulations were introduced (limiting drivers to an on-duty time of 15 hours in every 24-hour period). These regulations have been updated a number of times to rectify certain deficiencies that contradicted current knowledge of human sleep needs and the human body's 24-hour circadian rhythms. The current HOS regulations include the following:

- An 11-hour driving limit after 10 consecutive hours off duty.
- A maximum on-duty period of 14 hours following 10 consecutive hours off duty.
- A minimum off-duty requirement of 10 hours.
- A 60- or 70-hour on-duty limit over 7 or 8 consecutive days, respectively.
- A total of split sleeper-berth off-duty periods of 10 hours.
- A "restart" provision, permitting drivers to restart a working period of 7 or 8 consecutive days after 34 hours off duty. This provision is limited to one use every 168 hours with the 34-hour off-duty period comprising two periods between the hours of 1 a.m. and 5 a.m.

The regulations also require drivers to take a rest break of at least 30 minutes after a maximum of 8 hours of driving (or before, if they choose).(26)

Since the driver has a driving window of no more than 14 consecutive hours, with actual driving time limited to 11 hours, detention time can greatly reduce both the driving window and driving time. For example, if a driver is detained for 6 hours, then that driver can only drive for 8 additional hours (at most) before being required to take 10 consecutive hours of off-duty time (i.e., rest time). This could put the driver behind schedule for other deliveries and might result in the driver choosing to violate HOS regulations to make up for lost time.(27) A small amount of evidence suggests a link between detention time and HOS compliance. Results from a GAO survey of CMV drivers revealed that 80 percent of drivers who reported experiencing detention time stated that it reduced their driving time, making it more difficult for them to meet HOS regulations. An additional 4 percent of drivers admitted to having driven beyond the HOS limits and subsequently misrepresenting their hours in their log books.(28) However, because this data was self-reported, it is likely that more than 4 percent of the drivers had violated HOS regulations and simply did not want to admit to breaking the law.

Although FMCSA collects data from roadside inspections, which provide information about HOS violations, they do not collect, nor are they required to collect, information to assess the extent to which detention time contributed to these violations.(29) This lack of data makes it difficult for the Agency to quantify the impact of detention times on HOS violations and subsequent driver safety. One of the primary goals in the current study is to address this lack of data, allowing for a quantitative evaluation of the safety and operational impacts of driver detention on work hours, HOS violations, and crashes.

Detention times have also been shown to negatively affect driver retention, which may also have implications for driver safety. Drivers have routinely identified the amount of non-driving work, which includes time lost waiting at customer locations, as an important element in whether to stay with or leave a carrier.(30) A study commissioned by FMCSA revealed that a driver's crash risk begins to rise when he/she averages more than two jobs with different employers each year for 2 years or longer. This increase was found to be gradual at first, but it accelerated as job change rate increased. Improving working conditions for long-haul drivers was identified as an area where specific changes could improve driver retention and safety.(31)

Figure 2 shows a simple timeline of crash risk, cause, and occurrence, illustrating how detention times may contribute to (or increase the risk of) a crash. Figure 2 illustrates that there is an extended period prior to the experience of imminent crash threats during which pre-trip and pre-crash-threat decisions can reduce crash risk. Loading and unloading delays (i.e., detention times) do not cause crashes; rather they are pre-trip events that raise crash risk before the trip even begins. For example, excessive delays may contribute to crash risk by increasing driver fatigue, driver frustration, and trip schedule pressure.(32)

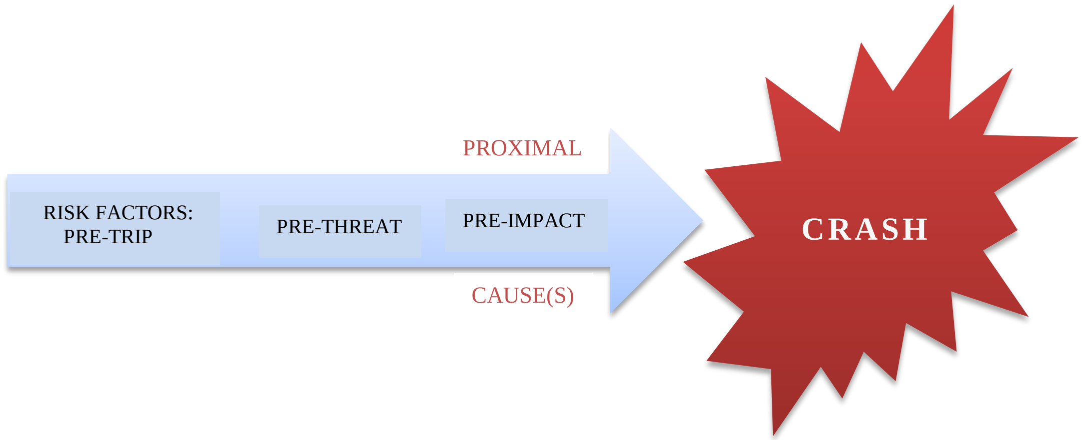

Figure 2. Diagram. Risk-cause crash timeline with extended pre-crash risk segments.

Source: Knipling et al., 2011.

1.2.3 Factors that Contribute to Detention Time

Detention time is caused by a number of factors, including facility limitations, arriving for a scheduled pickup and finding the product not ready for shipment, poor service provided by facility staff, and facility scheduling practices.[(33)] Results from driver interviews with the GAO shed more light on each of the factors that contribute to detention time. Of those drivers who reportedly experienced detainment, about 43 percent reported that it was due to facility limitations, including inadequately staffed facilities, insufficient loading and unloading equipment, or an insufficient number of bays for loading and unloading trucks. Facility limitations increase waiting times by creating a backlog of vehicles that need to be loaded or unloaded. About 39 percent of drivers reported that they had been detained because the product was not ready for shipment when they arrived for pick-up.

There are a number of reasons why a shipment might not be ready, such as delays on a production line, misplaced cargo documentation, or weather-delayed harvests. About 39 percent of drivers also reported that they had been detained due to poor service by facility staff. A number of drivers stated that facility staff members were indifferent to the drivers' schedules and "took their time" before initiating the loading and unloading process. Finally, about 34 percent of drivers who had experienced detention time reported that it was due to some facilities' scheduling practices, such as the "first come, first served" system used at some seaport terminals. Under this system, the vehicles are loaded in the order of their arrival at the facility, resulting in drivers lining up at the gate before the facility opens to make sure they can get loaded or unloaded as quickly as possible. The terminals do not consider time spent waiting outside the gate to be detention time. Other reported factors that contribute to detention time were not under the control of the facility, including drivers' paperwork not being in order, resulting in the facility pushing back its entire schedule or delaying the driver until a later opening was available, and unfamiliarity with the shipper's facilities or the loading and unloading procedures.[(34)] The driver and/or carrier may also contribute to detention times by arriving late or early for a scheduled stop.

Some evidence suggests that detention times may be related to the type of carrier and freight. The MCES report found that the CMV transport operations most affected by detention times were motor carriers of containers (e.g., port drayage operators), regional and long-haul TL carriers, and grocery and agricultural LTL carriers.[(35)] This is another area that requires further investigation and that is addressed in the current study.

There is also evidence to suggest that detention times may have a greater impact on small carriers and owner-operators than on large carriers. There are a number of reasons why this might be the case. First, larger carriers have greater leverage to include detention-time fee clauses in their contracts with shippers if their drivers are detained. In addition, large carriers also tend to have more regular customers with whom they can work closely to establish familiarity with procedures and facilities, thereby reducing detention times. Large carriers may also be able to better handle the logistical challenges presented by extensive detention times. For example, they may be able to adjust the schedules of other trucks to enable the carrier to meet its commitments, thus minimizing the impact of detention times. Smaller carriers and owner-operators may not have the resources to respond in a similar fashion.[(36)] Owner-operators are particularly vulnerable to the impact of detention times because they typically operate under a by-the-mile or by-the-number-of-loads pay structure. This means that if their truck is not moving, they are not earning money.[37] Owner-operators also typically use an intermediary to arrange for cargo, so they have less leverage to charge detention fees or, alternatively, the detention fees are charged and collected by the carrier who leased the owner-operator's contract, but the collected fees are not passed on to the driver.[38]

1.2.4 International Context

1.2.4.1 Australia

A survey of long-distance, heavy-vehicle drivers in Australia more than a decade ago revealed loading and unloading delays to be the most significant contributor to driver fatigue. More than 1,000 long-distance CMV drivers were surveyed or interviewed about their fatigue and its effects on driving. About 56 percent of the drivers reported that waiting for loading and unloading contributed to their fatigue, with just over 48 percent of these drivers indicating that it was the most important factor.[39] The majority of drivers (68 percent) also reported that they were paid in terms of kilometers covered or tonnage carried, which presents the same problem as in the United States: if the truck is delayed in a queue to load or unload, the driver is not getting compensated. Interestingly, a much higher percentage of drivers in Australia reported breaking HOS regulations (57 percent compared to 4 percent in the United States), with the most common reasons given for doing so including "to do enough trips to earn a living" and "as a result of tight schedules." More recently, the Transport Workers Union surveyed more than 700 truck drivers, and the results revealed that more than 50 percent of drivers are spending 1 day a week in unpaid waiting time. This represents 300–500 hours per year working without pay. In addition, 27 percent of drivers feel they had to drive too fast, and nearly 40 percent feel pressured to break HOS regulations because of client pressure.[40] Taken as a whole, these results indicate that driver detainment is an issue in Australia for many of the same reasons it is in the United States: drivers not being paid for time they are detained, resulting in drivers having to engage in risky driving behavior (i.e., speeding) and violating HOS regulations to keep to their schedules and make up lost time.

A number of significant changes made within the Australian trucking industry in recent years may serve as a valuable lesson for the United States. In September 2008, new national road transport heavy-vehicle driver fatigue laws were introduced that set revised work and rest limits for heavy-vehicle drivers. The most important aspect of these new laws is the concept of the chain of responsibility (CoR). Under the new laws, everyone in the supply chain, not just the driver, is responsible for preventing driver fatigue and ensuring drivers are able to comply with HOS regulations. In the event of a road safety breach, authorities can investigate along the supply chain to determine if any actions, inactions, or demands of any person in the CoR contributed to the breach and hold the responsible parties legally accountable. Parties in the CoR include the driver, the driver's employer, the driver's prime contractor, the scheduler of goods or passengers for transport by the vehicle, the scheduler of the driver, both the consignor and consignee of the goods transported by the vehicle, the loading manager, and the loader and unloader of the goods carried by the vehicle. Drivers continue to be held liable even if another party in the supply chain was found guilty in court.[41] The new laws are designed to take some of the pressure off of drivers by making other parties accountable for any unreasonable demands and working conditions that may exist in the industry.

The Road Safety Remuneration Act is another recent development in Australia which came into effect on July 1, 2012. The aim of the act is to promote safety and fairness in the road transport industry by doing the following:

- Ensuring road transport drivers do not have remuneration-related incentives to work in an unsafe manner.
- Removing remuneration-related incentives, pressures, and practices that contribute to unsafe work practices.
- Ensuring road transport drivers are paid for their work, including loading and unloading their vehicles or waiting for someone else to do it.
- Developing and applying reasonable and enforceable standards throughout the road transport industry supply chain to ensure the safety of road transport drivers.
- Ensuring that hirers of road transport drivers and participants in the supply chain take responsibility for implementing and maintaining those standards.
- Facilitating access to dispute resolution procedures relating to remuneration and related conditions for road transport drivers.

Implementation of the Road Safety Remuneration Act has also resulted in the creation of the Road Safety Remuneration Tribunal (RSRT), which came into operation on January 1, 2013. The RSRT comprises both industry members and members of the Fair Work Commission who have the power to make orders relating to remuneration and employment conditions of both employee and independent road transport drivers. Members of the RSRT can solve disputes, approve collective agreements, and make orders relating to minimum pay, entitlements, working hours, payment methods, load limits, and waiting times.[(42)]

In addition to the RSRT, the newly-formed National Heavy Vehicle Regulator (NHVR) is Australia's first national, independent regulator for heavy vehicles (i.e., all vehicles more than 4.5 tons gross vehicle mass). The NHVR currently manages accreditations under the National Heavy Vehicle Accreditation Scheme and design and vehicle approvals under the Performance-Based Standards Scheme. Most importantly, the NHVR will administer the new Heavy Vehicle National Law (HVNL) once it takes effect in 2014. State and territory police would still enforce the law, but the NHVR will ensure that enforcement outcomes and penalties are nationally consistent. The NHVR will also provide a national safety monitoring and reporting system dedicated to heavy vehicles. They will also have a dedicated CoR unit to coordinate complex investigations and prosecutions and to assist jurisdictions with their own investigations and prosecutions. It is hoped that the creation of an independent regulator for the heavy-vehicle industry will increase efficiency, safety, productivity, and compliance by providing a unified strategy and common set of laws for heavy vehicles, as well as a single point of contact for all heavy vehicle regulation in Australia with the ability to respond quickly to changing industry needs.[(43)]

Regarding detention times specifically, the new HVNL includes some strict penalties that apply to certain members of the CoR, including schedulers, loading managers, and consignors and consignees to ensure they do not make demands or loading arrangements that will encourage drivers to exceed the speed limit or drive while fatigued. The maximum penalty for any party found guilty of a breach is $10,000 (Australian dollars).[44] Additionally, the Road Safety Remuneration Act and the RSRT ensure that both employee drivers and independent owner-operators are compensated for delays associated with loading and unloading, thereby reducing the need for drivers to engage in unsafe driving behaviors to make up lost time. Unfortunately, these laws are still fairly new or have yet to be implemented, so it is not possible to assess their impact on industry practice and driver behavior. However, these laws are the first of their kind to be implemented, and the U.S. CMV industry will likely learn valuable lessons from any resulting outcomes.

1.2.4.2 European Union and United Kingdom

As in the United States, CMV drivers in the UK and EU are subject to rules regulating their working and driving hours, so it is assumed that detention times would have the same implications for HOS compliance and safety. Surprisingly, driver detention has not received the same amount of attention in either the UK or EU as it has in the United States and Australia. This does not necessarily mean that detention times are not a problem; it may be that other issues are currently at the forefront in the industry. Detention time experienced at border crossings is mentioned quite frequently and has received a great deal of attention, but this issue is beyond the scope of the current study. The UK Department for Transport and the Health and Safety Executive has released guidelines that address work-related road safety and highlight issues such as giving drivers realistic schedules, ensuring they are not pressured or encouraged to take unnecessary risks (e.g., exceeding safe speeds because of agreed arrival times), and planning journeys that do not contribute to fatigue; however, they do not specifically mention detention or waiting times.[45]

One notable difference between the HOS regulations in the UK and the EU and the HOS regulations in the United States is this: if UK and EU drivers are aware in advance of the duration of a period of waiting time, this time does not count toward their daily working time (i.e., it is exempt from the daily working hour limits). This period of availability (POA) must be clearly recorded as such in daily driving records. The two key elements that define a POA are that the driver must know about the delay in advance, either at the start of the driver's departure or before the start of the POA, and must know its duration. During the POA, drivers are not required to remain with their vehicle, but they must be available to answer calls and start driving upon request. The POA regulation may ameliorate some of the negative effects associated with detention times because the driver is prepared in advance for the waiting time and is able to leave the vehicle and rest (or even nap if the facilities are available).[46]

1.2.4.3 Canada

As in the United States, Australia, the UK, and the EU, CMV drivers in Canada are subject to HOS regulations that dictate the number of hours CMV drivers in Canada can work and drive. As in the UK specifically, there is a lack of research targeted at detention times at dock facilities in Canada, but Canada has attempted to reduce waiting times at border crossings. Border crossing waiting times may impact driver fatigue in a similar manner as waiting times at dock facilities, but this issue is beyond the scope of the current project. To address the problem of waiting times at border crossings between Canada and the United States, both countries have committed to installing Advanced Traveler Information Systems (ATIS) at the 20 busiest border crossings.[47] These systems provide up-to-date border waiting time information so drivers can make informed decisions on when and where to cross the border.

1.3 LITERATURE REVIEW CONCLUSIONS

Although the literature differs in the degree to which fatigue is believed to be associated with CMV crashes, it is widely accepted that reducing CMV driver fatigue is a necessary step in reducing serious CMV crashes. One factor that contributes to CMV driver fatigue is a disruption in a CMV driver's schedule due to excessive detention times. Several studies have found detention time to be a serious problem in the U.S. CMV industry.[48, 49, 50] However, the available evidence is all self-reported data acquired through interviews with drivers, safety managers, and other expert respondents. For example, one self-report study indicated that extensive detention times can impact a driver's HOS by seriously reducing the driving window and driving time. In this study, 80 percent of CMV drivers reported reduced driving time as a result of being detained, and an additional 4 percent reported driving beyond HOS limits and falsifying logbooks.[51]

Determining the factors that contribute to driver detention is an important first step when addressing the issue. Shippers and receivers control the majority of factors that contribute to detention times, including facility limitations, products not being ready on time for a scheduled pickup, poor service by facility staff, and facility scheduling practices.[52] Drivers control other factors that contribute to detention times. For example, a driver's paperwork may not be in order, or the driver may be unfamiliar with a facility's loading and unloading practices. Detention times may also be related to carrier and cargo type. The MCES report found that motor carriers of containers, regional and long-haul TL carriers, and grocery and agricultural LTL carriers were most affected by detention times.[53]

The current literature review revealed four possible solutions to reduce detention time:

- Government regulations charging shippers and receivers detention fines for excessive delays.
- Carriers using contracts that charge shippers and receivers detention fees for excessive delays.
- Equipping trailers with tracking technology.
- Using drop-and-hook operations.

Each of these potential solutions has advantages and drawbacks. The first two solutions use the same strategy of charging shippers for excessive delays. However, carriers and shippers frequently disagree about the actual length of detention time. Furthermore, many carriers (large and small) hesitate to charge detention time fees for fear of losing a customer. The third solution objectively measures the length of detention time by tracking the times when a trailer arrives, departs, is unloaded, and is loaded. This technology also has the capability to wirelessly communicate arrival times to shippers. This could allow a shipper to reschedule dock operations to alleviate truck delays. However, some carriers may find the cost of this technology a hindrance. Finally, the drop-and-hook practice may effectively reduce detention time, but it may be financially unrealistic for many carriers, especially owner-operators. The last three potential remedies are likely not practical options for the smallest carriers.

1.3.1 Other Countries' Efforts to Reduce Detention Time

Australia and the EU have adopted a number of new regulations that are directly related to detention times, as follows:

- Australia introduced new Heavy Vehicle Driver Fatigue laws in 2008. These laws introduced the concept of the CoR, which assigns everyone in the supply chain (not just the CMV driver) responsibilities for preventing driver fatigue and ensuring that drivers are able to comply with HOS regulations. These laws are designed to take some of the pressure off of drivers by making other parties accountable for any unreasonable demands and working conditions that may exist in the industry.
- Australia introduced the Road Safety Remuneration Act in 2012. This act is intended to ensure that drivers are paid for their work, including loading and unloading their vehicles or waiting for someone else to do it. The act also develops and applies reasonable and enforceable standards throughout the road transport industry supply chain to ensure the safety of road transport drivers.
- Australia's Road Safety Remuneration Act created the RSRT, which will begin in 2014. Members of the RSRT have the ability to solve disputes, approve collective agreements, and make orders relating to minimum pay, entitlements, working hours, payment methods, load limits, and waiting times.[54]
- Australia's new HVNL will begin later in 2013. This law includes strict penalties for members of the CoR, including schedulers, loading managers, consignors, and consignees, to ensure they do not make demands or loading arrangements that may encourage the driver to exceed the speed limit or drive while fatigued.
- The UK and EU POA rule states that waiting time does not count toward a driver's daily working time if the driver is aware in advance of the waiting time's duration. The two key elements that define a POA are that the driver must know about the delay in advance, either at the start of the driver's departure or before the start of the POA, and the driver must know its duration.

Most of these laws are either fairly new or have yet to be implemented, so it is not yet possible to assess their impact on industry practice and driver behavior.

2. METHODS AND APPROACH

This chapter outlines methods used to collect and analyze the data in the current study.

2.1 RESEARCH DESIGN

The main objective of the current study was to quantitatively assess average driver detention times by the various stratification variables (i.e., type and size of the trucking operation, commodities carried, etc.). Due to the lack of control for exposure (i.e., whether a driver was detained or not), the study followed principles from epidemiology studies.

2.2 DATA COLLECTION PROCEDURES

2.2.1 Detailed Evaluation of Potential Third-party Vendors

The research team evaluated the type of data that was available from third-party technology/data vendors to better understand the restrictions and trade-offs in using these data. Additionally, the research team determined what agreements were needed to collect and analyze the data from carriers. Third-party vendors were limited to those vendors who were able to share anonymous client data without the client's permission. The research team was also restricted to using third-party vendors that could provide the data at a nominal cost (or free of charge).

Two third-party vendors agreed to participate in the study. One of the vendors (Vendor A) agreed to provide its entire client database, whereas the other (Vendor B) required the research team to obtain written permission from carriers that used their service. Data provided by the third-party vendors for testing purposes included 2,800 general commodity trucks that made approximately 210,000 stops over a 6-month period. Thus, the research team believed the data sets provided by the participating technology vendors would be a representative sample of the general trucking population and would be a sufficiently sized data set.

2.2.2 Identification of Detention Time

Discussions were held with the third-party vendors on how to identify detention times and what variables were available for analysis. Only a subset of the carriers provided the most accurate measure of detention times (i.e., where a driver pushes a button to indicate he/she has arrived/departed the delivery location). As this functionality was only available on a small sample of the carriers, the research team worked with the third-party vendors to create the appropriate algorithms to determine detention times for those carriers that did not use this method. This required the use of Global Positioning System (GPS) technology to identify stop locations for deliveries (and to exclude other locations, such as rest stops and terminals). This approach included some inevitable noise, as in some cases it was unknown if the driver was resting, sleeping, unloading, and/or waiting; however, by cross-referencing driver logbooks, the research team was able to eliminate much of this noise. Larger carriers with detention time charges written into their contracts with shippers were the carriers that collected the most accurate measures of detention time (as this was how they determined if the detention time threshold was exceeded). The vendors store the data for 6 months; thus, the most recent 6 months of data (at the time of the initial request) were included in the current report (data from Vendor A ran from January to June 2013, and data from Vendor B ran from December 2012 to May 2013).

The research team initially requested the following stratification variables for analysis to determine average detention times:

- Operation type (e.g., for-hire or private; TL or LTL).
- Size of trucking operation.
- Freight type.
- Overall safety performance (Compliance, Safety, Accountability [CSA] scores).
- Driver (company versus owner-operator; union versus non-union).
- Terminal size.
- Disincentives for detention time (yes versus no; various disincentives compared).
- Time of year (limited to the 6-month data collection window).

However, due to the workload at the participating technology vendors, only three variables were provided, including operation size, operation type, and freight type.

2.2.3 Data Filtering

Initial examination of the data revealed the detention time variable contained a large number of unrealistic values that needed to be filtered out. Further investigation of the data led the research team to conclude that lower and upper boundaries were needed. After consulting with industry experts on the minimum time taken to load/unload, the lower bound was set conservatively at 30 minutes. The upper bound was somewhat more arbitrary, but again after discussion with industry experts, it was set at 10 hours. Thus, the initial data set includes loading/unloading time plus waiting time, also referred to as stop time. This gives an indication of how long a driver was stopped at each delivery/pick up location.

For further analysis of the data, specifically focusing on detention time, a second lower bound was also imposed on the data set. In accordance with the standard industry definition of detention time as "any time drivers have to wait beyond 2 hours,"(55) the second lower bound was set at 2 hours (i.e., any value *over* 2 hours was considered detention time). Thus, the data set was filtered for the purposes of the analysis on detention time to only include those stops where the driver was detained for more than 2 hours and up to 10 hours. This would also allow for a comparison of instances where drivers were detained (i.e., any stops lasting more than 2 hours and up to 10 hours) to instances where they were not detained (i.e., any stops lasting from 30 minutes to 2 hours).

Before the filtering process took place, the data set contained 3,516,816 stops. Initial examination of the data revealed the minimum value in the detention time variable was 65,059 hours and the maximum value was 64,660 hours. Further investigation showed that there were 724 values of zero hours or less and 3,914 values of 24 hours or more; thus, the filtering process was required to make sense of the data. After filtering on the lower and upper bounds described above, the data set was reduced by almost two-thirds to 1,348,897 stops.

2.3 DATA ANALYSIS

2.3.1 Analyzing Driver Detention as a Factor of Operation Type, Operation Size, and Freight Type

Researchers analyzed the relationship between driver detention time and operation type, operation size, and freight type using a logistic regression model and odds ratios (ORs). Each stop in the data set was labeled as "detained" or "not detained," depending on the duration of the stop. If the stop was greater than 2 hours long, the stop was labeled "detained." If the stop was 2 hours or less (with a lower bound of 0.5 hours) in duration, the stop was labeled "not detained." Analyses investigated how driver detention time, as a categorical variable (detained or not detained), changed across the variables of operation type, operation size, and freight type.

2.3.2 Logistic Regression

A logistic regression model was built to determine how the variables of operation type, operation size, and freight type were related to driver detention time. Logistic regression models investigate the relationship between continuous or categorical explanatory variables and a categorical response.(56) In this study, the categorical response was driver detention ($Y = 1$ if detained, $Y = 0$ if not detained). The response probability to be modeled is shown in Figure 3.

$$\pi(x) = P(Y = 1|X = x) \text{ or } \pi(x) = P(Y = Detained|X = x)$$

Figure 3. Formula. Model for the logistic regression.

In this study, a logistic regression model with a logit (or log odds) link function was used (see Figure 4). Where *alpha* is the intercept parameter and *beta* is the vector representing the explanatory variables.(57) The explanatory variables included in this model were operation type, operation size, and freight type, each with several categorical levels.

$$\log\left(\frac{\pi(x)}{1-\pi(x)}\right) = \alpha + \beta x$$

Figure 4. Formula. Logistic regression model with logit link function.

2.3.3 Odds Ratios

To determine if the variables of operation type, operation size, or freight type were related to a driver being detained, a contingency table (e.g., Table 4) was created and analyzed using ORs and respective 95-percent confidence intervals (CIs). The risk of a driver being detained as associated with a variable level was calculated by comparing the variable level to each of the other variable levels in separate OR calculations. The rows in Table 4 (Level A and Level B) represent the format of this analysis. For example, three tables would be created to compare the levels of the operation size variable: small to medium, small to large, and medium to large. The operation type and freight type variables would be analyzed similarly.

Table 4. Example of a contingency table for driver detention.

Variable	Detained	Not Detained	Total
Level A	n_{11}	n_{12}	$n_{1.}$
Level B	n_{21}	n_{22}	$n_{2.}$
Total	$\mathbf{n_{.1}}$	$\mathbf{n_{.2}}$	$\mathbf{n_{..}}$

The formula[58] for calculating the OR is the cross product as shown in Figure 5. Where n_{11} is the number of stops where the driver is detained and is categorized as Level A of the variable, n_{12} is the number of stops where the driver is not detained and is categorized as Level A of the variable, n_{21} is the number of stops where the driver is detained and is categorized as Level B of the variable, and n_{22} is the number of stops where the driver is not detained and is categorized as Level B of the variable.

$$(n11 * n22) / (n12 * n21)$$

Figure 5. Formula. Formula for calculating the OR.

The formula[59] for calculating the CI is shown in Figure 6. Where e is a constant and the base of natural logarithms, OR is the odds ratio, z is the z-score value corresponding to the chosen alpha (1.96 for a 95-percent CI), and SE is the standard error of the natural logarithm of the OR. The interpretation of the OR and 95-percent CI is similar for all analyses performed using different variable levels. An OR is considered statistically significant if the 95-percent CI does not include "1." If the OR for the contingency table is greater than 1.0, Level A of the variable is associated with statistically significant greater odds of being detained than Level B of the variable. If the OR for the contingency table is less than 1.0, Level A of the variable is associated with statistically significant lower odds of being detained than Level B of the variable. If the OR is equal to 1.0 or if the CI includes 1.0, the two levels (A and B) do not have statistically significant differences in the odds of being detained.

$$OR \times e^{\pm z * SE_{OR}}$$

Figure 6. Formula. Formula for calculating the CI.

3. RESULTS

This section outlines the results from the data collected by the research team.

3.1 OVERVIEW OF THE DATA

As mentioned earlier in this report, two third-party vendors provided all of the data for this study. The data provided by both vendors was for a 6-month period. As indicated above, the data sets comprised only three of the stratification variables initially requested. The data from both vendors contained variables related to the type and the size of the trucking operation; however, only Vendor A was able to provide commodity information.

3.1.1 Summary of Filtered Data Set

The filtered data set comprises information from 31 different carriers. Operation size subgroups included: small (1–50 trucks); medium (51–500 trucks); and large (more than 500 trucks). Operation type subgroups included: for-hire TL, for-hire LTL, and private. Freight type information was only available in the data set provided by Vendor A; thus, the total number of stops associated with this variable was reduced. Freight type subgroups included: dry bulk (i.e., dry bulk, such as flour and phosphates); liquid bulk/tank (i.e., liquids and oils); mixed freight (i.e., three or more types of freight being hauled); refrigerated trucks/reefers (i.e., temperature controlled goods, usually meats, dairy, or produce); van (i.e., dry van, not temperature controlled); van/flatbed (i.e., dry goods or metal fabrication and capital goods); and van/reefer (i.e., dry goods or refrigerated goods). The final two combined freight types (i.e., van/flatbed and van/reefer) could not be separated out by the third-party vendor to determine which stops were linked to which freight type.

Table 5 provides a breakdown of the filtered data set by operation size. Listed in this table are the number of carriers in each subgroup and the number and percentage of stops in the data set attributed to each subgroup. As can be seen in Table 5, the majority of the carriers were of medium operation size, 80 percent of the stops in the data set were from large carriers, and only two carriers were from the small operation size.

Table 5. Summary of data by operation size.

Operation Size	Number of Carriers	Number of Stops	Percentage of Stops
Small (1–50 Trucks)	2	271	0.02
Medium (51–500 Trucks)	23	277,667	20.58
Large (>500 Trucks)	6	1,070,959	79.40
Total	**31**	**1,348,897**	**100.00**

Table 6 provides a breakdown of the filtered data set by operation type. Listed in this table are the number of carriers in each subgroup and the number and percentage of stops in the data set attributed to each subgroup. As can be seen in Table 6, the majority of the carriers were for-hire TL, although almost 60 percent of the stops in the data set were from private carriers.

Table 6. Summary of data by operation type.

Operation Type	Number of Carriers	Number of Stops	Percentage of Stops
For-hire TL	18	516,148	38.26
For-hire LTL	6	46,644	3.46
Private	7	786,105	58.28
Total	**31**	**1,348,897**	**100.00**

Table 7 provides a breakdown of the filtered data set by freight type. Listed in Table 7 are the number of carriers in each subgroup and the number and percentage of stops in the data set attributed to each subgroup. As can be seen in Table 7, the majority of carriers hauled van, reefer, and van/reefer freight with the bulk of the stops in the data set attributed to van/reefer freight and van freight. A very small percentage of the stops was attributed to the one carrier of mixed freight; thus, subsequent results related to this subgroup need to be interpreted with caution.

Table 7. Summary of data by freight type.

Freight Type	Number of Carriers	Number of Stops	Percentage of Stops
Dry Bulk	2	23,368	2.22
Liquid Bulk/Tank	3	62,727	5.96
Mixed	1	69	0.01
Reefer	6	51,752	4.92
Van	8	242,258	23.01
Van/Flatbed	3	30,585	2.90
Van/Reefer	5	642,169	60.99
Total	**31**	**1,348,897**	**100.00**

3.2 STOP TIME DATA (LOADING/UNLOADING AND WAITING)

Stop time includes all values in the data set between the lower bound of 30 minutes and the upper bound of 10 hours; thus, stop time includes loading/unloading and any waiting time the drivers may have experienced. As can be seen in Figure 7, which shows the distribution of stop times, the data is positively skewed, with the bulk of the data falling in the lower stop time categories. Around 89 percent of the total number of stops were between 30 minutes and 2 hours, and thus would be classified as typical loading/unloading with no detention time. However, approximately 11 percent of the stops were more than 2 hours long (up to a maximum of 10 hours), which would be considered detention time.

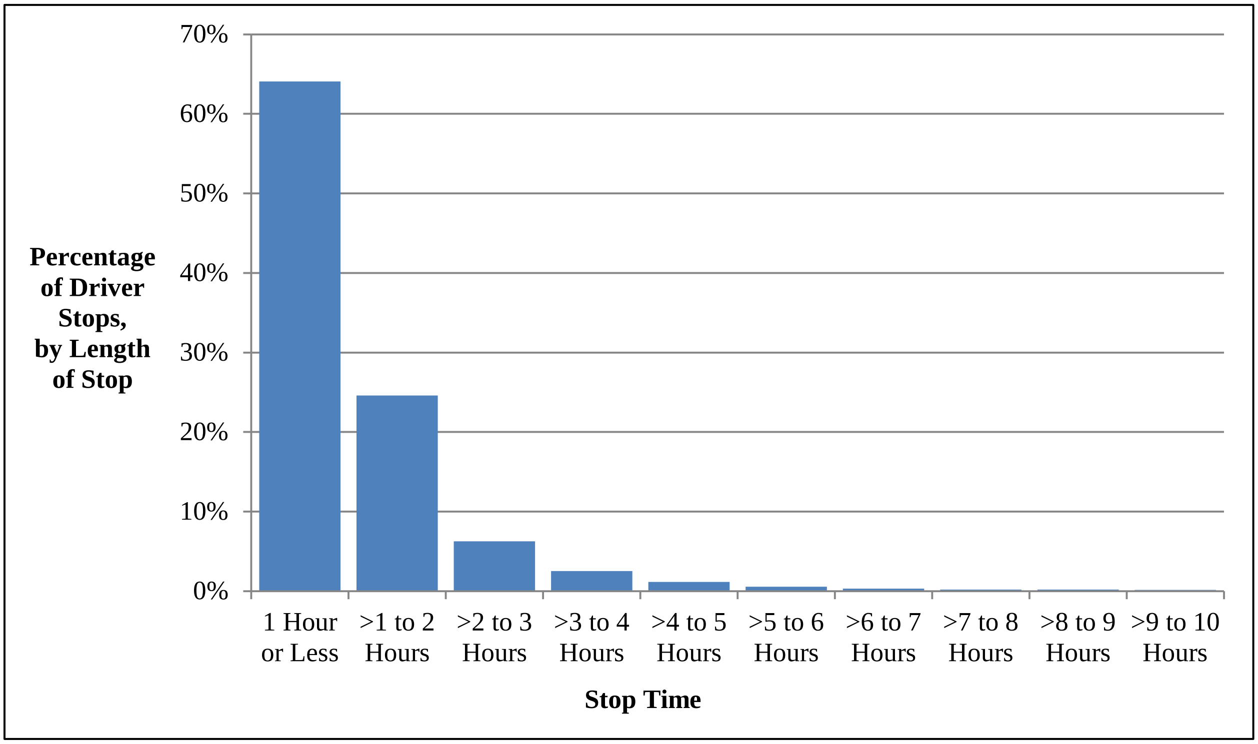

Figure 7. Bar chart. Distribution of all stop times between 30 minutes and 10 hours.

3.2.1 Stop Time by Operation Size

Figure 8 shows the distribution of stop times by operation size. As can be seen in Figure 8, the majority of stops for both operation sizes fell within the two categories under 2 hours. Medium-sized carriers appear to be the subgroup that experiences longer stop times more frequently, with more than 18 percent of their stops taking longer than 2 hours. As shown above, limited data on small carriers were collected; however, these carriers only experienced seven stops with detention time during this study. Therefore, results relating to detention times for small carriers are not representative of this segment of the industry and need to be interpreted with caution. Results for small carriers are presented in Appendix A.

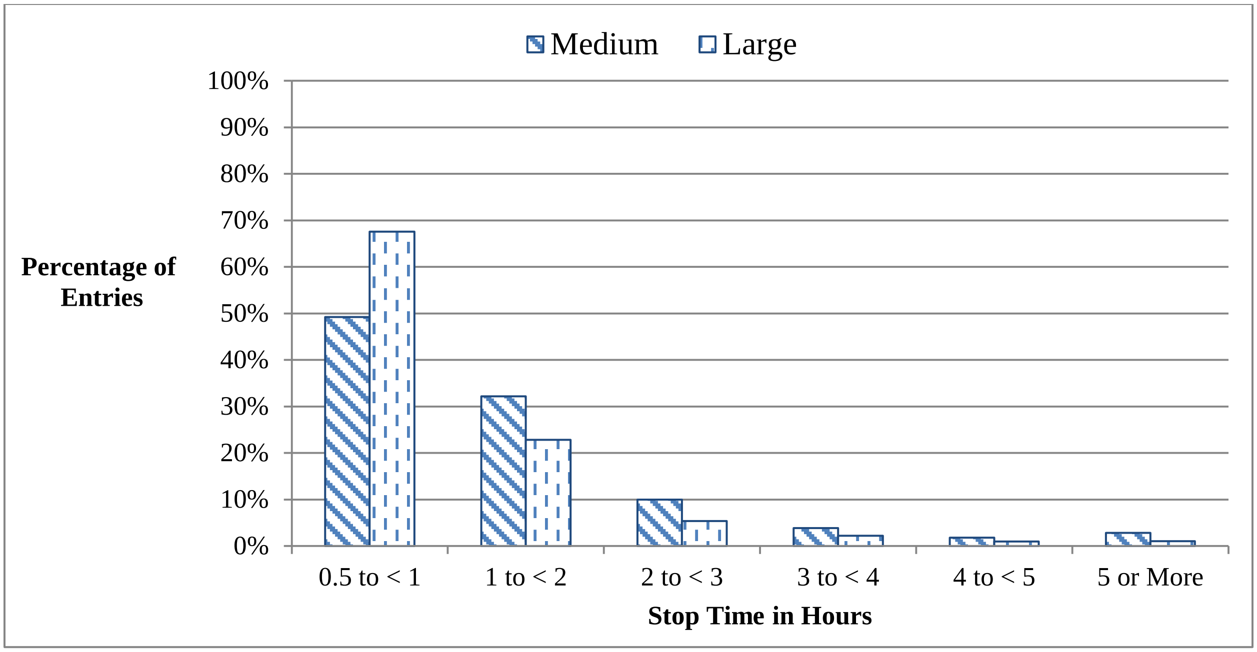

Figure 8. Bar chart. Distribution of stop times by operation size.

3.2.2 Stop Time by Operation Type

Figure 9 shows the distribution of stop times by operation type. As can be seen in Figure 9, around three quarters of stops for private carriers took between 30 minutes and 1 hour, with only about 5 percent of stops taking longer than 2 hours. For-hire TL carriers experienced longer stop times more frequently, with more than 20 percent of stops taking longer than 2 hours. Average stop times were also longer for the for-hire TL carriers (mean = 1.52, SD = 1.31) than for private (mean = 0.93, SD = 0.67) or for-hire LTL carriers (mean = 1.09, SD = 0. 99).

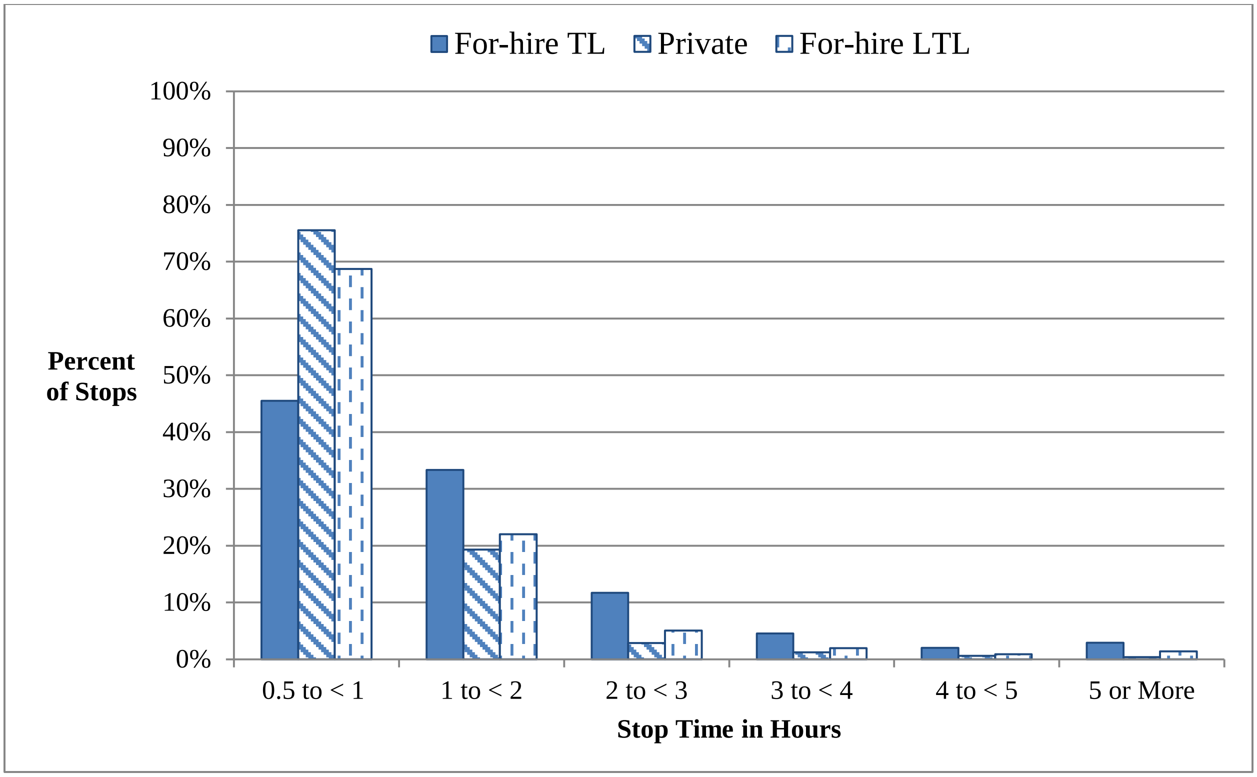

Figure 9. Bar chart. Distribution of stop times by operation type.

3.2.3 Stop Time by Freight Type

Figure 10 shows the distribution of stop times by freight type. As can be seen in Figure 10, the main freight type subgroups that had the longest stop time categories were reefer and van, with more than 10 percent of stops taking longer than 3 hours. Limited data on a freight type labeled "mixed" were collected; however, these carriers only experienced four stops with detention time during this study. Therefore, results relating to detention times for the "mixed" freight type need to be interpreted with caution. Results for the "mixed" freight type are presented in Appendix A. As with previous results, the majority of the stops fell below 2 hours, which is reflected in the average stop times for each freight type:

- Dry bulk: mean = 1.04, SD = 0.68.
- Liquid bulk/tank: mean= 1.39, SD = 1.01.
- Reefer: mean = 1.79, SD = 1.60.
- Van: mean = 1.66, SD = 1.47.
- Van/flatbed: mean = 1.20, SD = 0.90.
- Van/reefer: mean = 0.82, SD = 0.45.

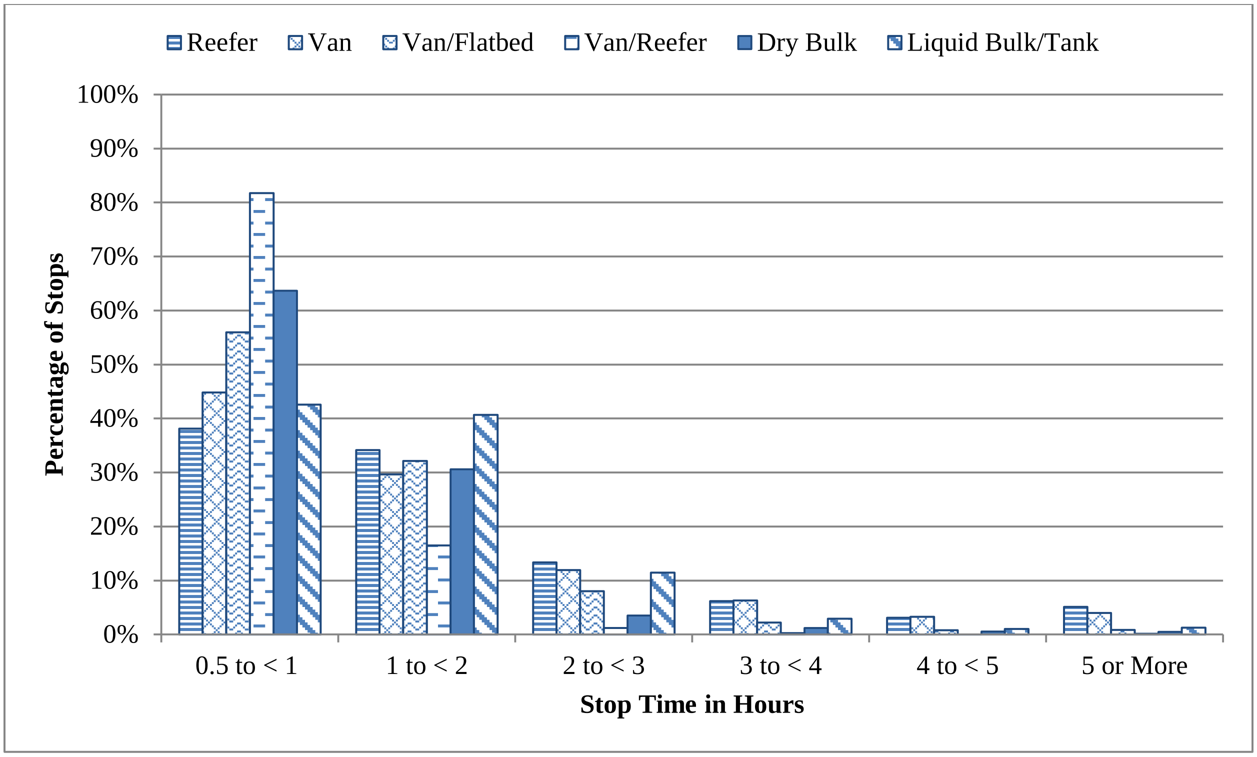

Figure 10. Bar chart. Distribution of stop times by freight type.

3.3 DETENTION TIME

Detention time refers specifically to values in the data set greater than 2 hours and up to 10 hours. As illustrated earlier (see Figure 2), approximately 11 percent of all the stops (n = 153,103) lasted longer than 2 hours and thus would be considered detention time. Average detention time overall was 1.4 hours (SD = 1.57) with a median of 0.85 hours. This represents the length of time a driver was detained beyond 2 hours, that is, in addition to the 2 hours viewed by the industry as standard loading/unloading time. Thus, a driver detained for 1.4 hours was physically at that location for 3.4 hours.

3.3.1 Detention Time by Operation Size

Figure 11 shows the distribution of detention times by operation size. As can be seen in Figure 11, medium-sized carriers have the longest average detention time (mean = 1.54, SD = 1.77), followed closely by large carriers (mean = 1.33, *SD* = 1.46). It appears that small motor carriers experienced the shortest average detention times (mean = 0.62, SD = 0.46). However, small carriers only experienced seven stops with detention times during this study. Therefore, results relating to detention times for small carriers are not representative of this segment of the industry and need to be interpreted with caution.

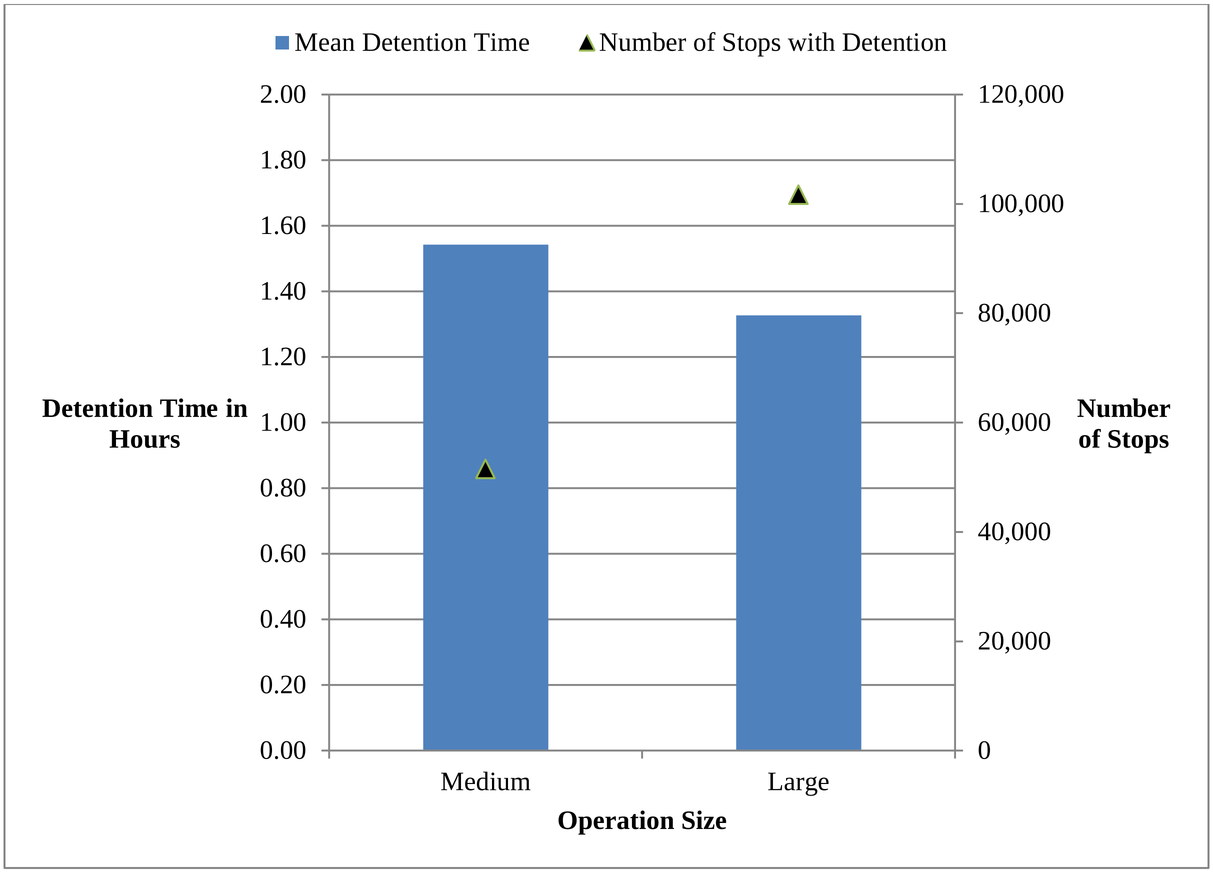

Figure 11. Bar chart. Average detention times and number of stops, by operation size.

Figure 12 shows the percentage of stops where drivers were detained. Despite the fact that the average detention times for large- and medium-sized carriers were quite similar, Figure 12 illustrates that medium-sized carriers experienced detention time about twice as often as large carriers. Drivers were detained on 19 percent of the stops that medium-sized carriers made, while they were only detained on 9 percent of the stops that large carriers made.

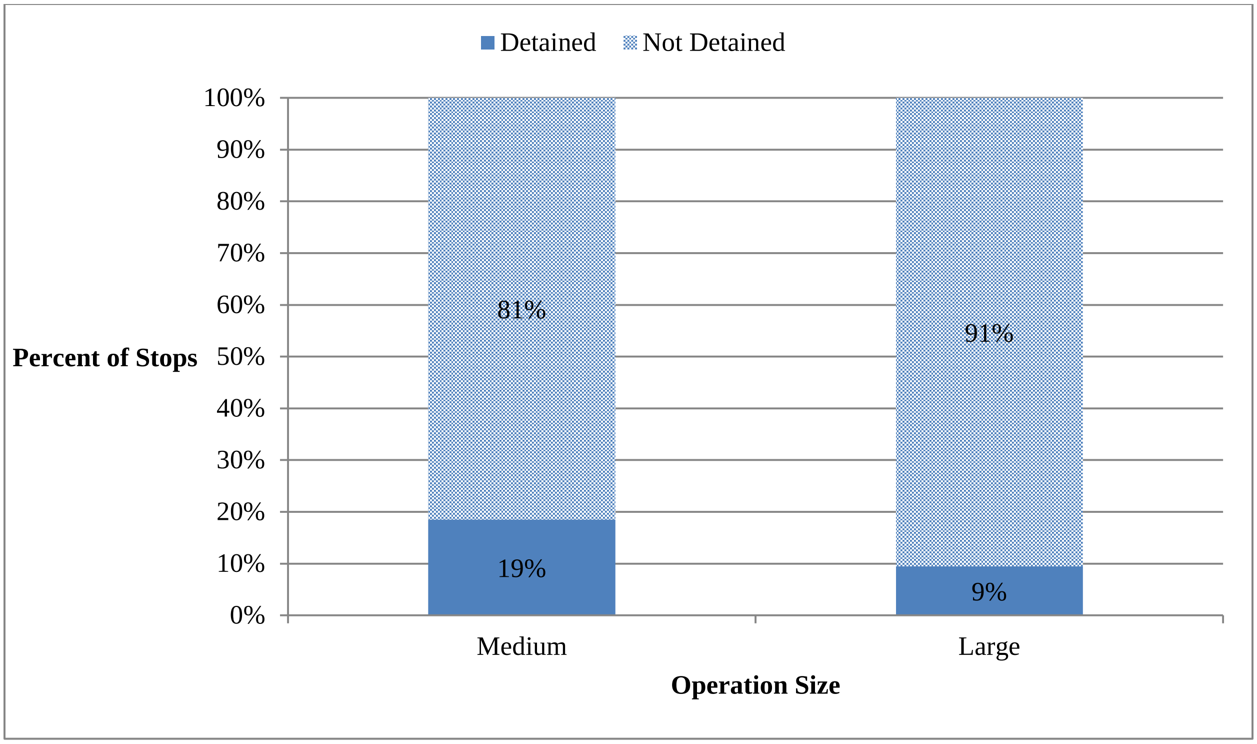

Figure 12. Bar chart. Percentage of stops when drivers experienced detention time by operation size.

3.3.2 Detention Times by Operation Type

Figure 13 shows the distribution of detention times by operation type. All operation types had average detention times between 3 and 3.5 hours (for-hire TL: mean = 1.47, SD = 1.67; for-hire LTL: mean = 1.51, SD = 1.75; private: mean = 1.21, SD = 1.23), with the majority of the stops attributed to for-hire TL carriers.

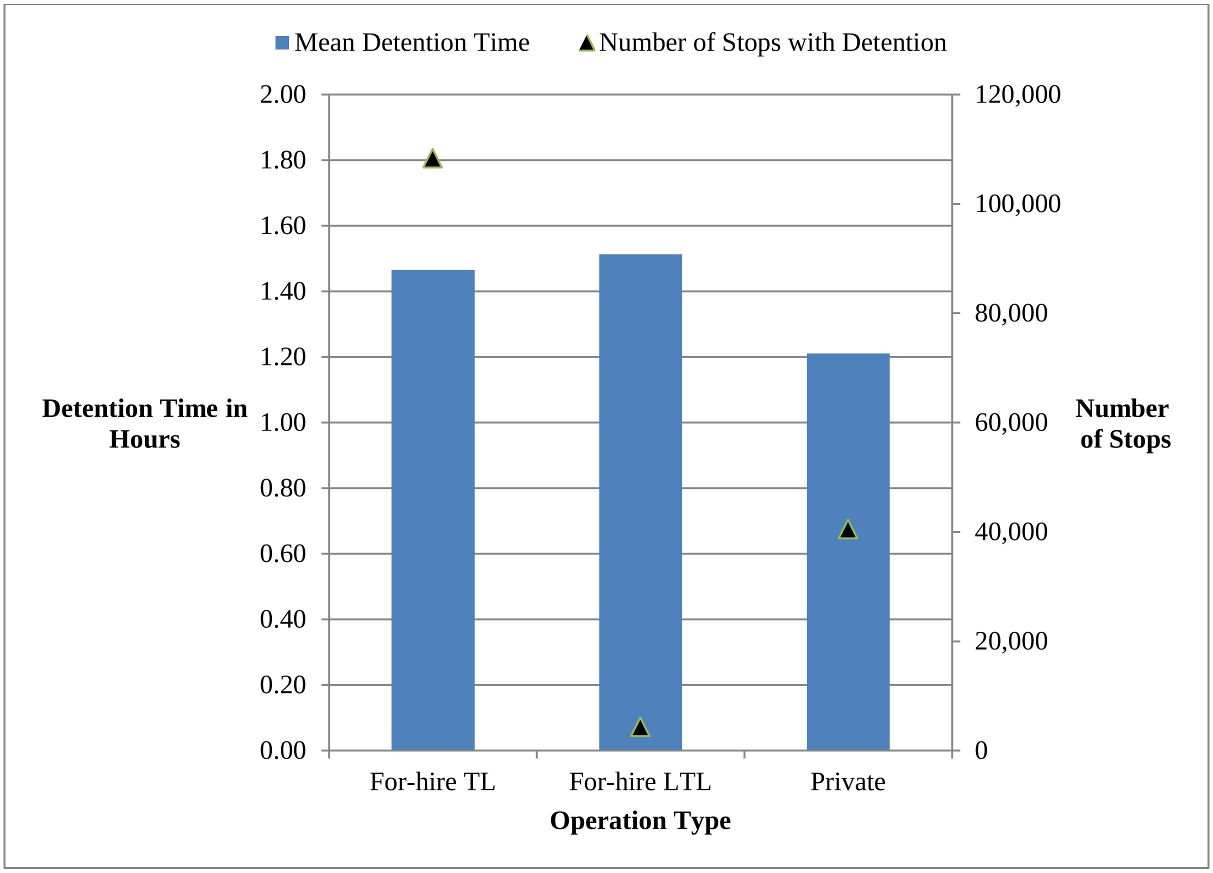

Figure 13. Bar chart. Distribution of detention times by operation type.

However, when considering the percentage of stops when drivers were detained, Figure 14 shows that for-hire TL carriers experienced detention time more than twice as often as for-hire LTL carriers and more than four times as frequently as private carriers.

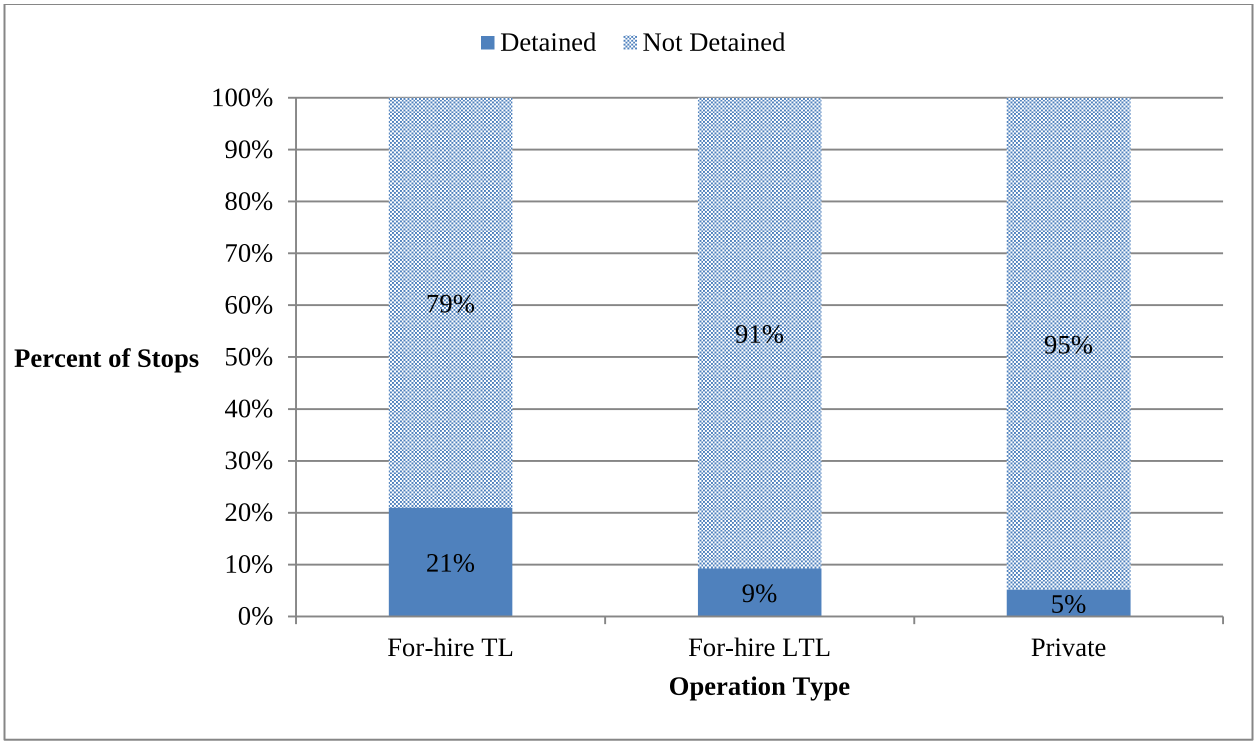

Figure 14. Bar chart. Percentage of stops when drivers experienced detention time by operation type.

3.3.3 Detention Times by Freight Type

Figure 15 shows the distribution of detention times by freight type. As can be seen in Figure 15, the average detention time varied from as low as 0.5 hours to almost 2 hours depending on the type of freight a driver was delivering. Reefer (mean = 1.74, *SD* = 1.87) and van (mean = 1.63, *SD* = 1.66) freight types had the longest average detention times, which were more than half an hour longer than the rest of the freight types. Carriers of mixed freight had the shortest detention time at 0.5 hours; however, this calculation was based on only four stops.

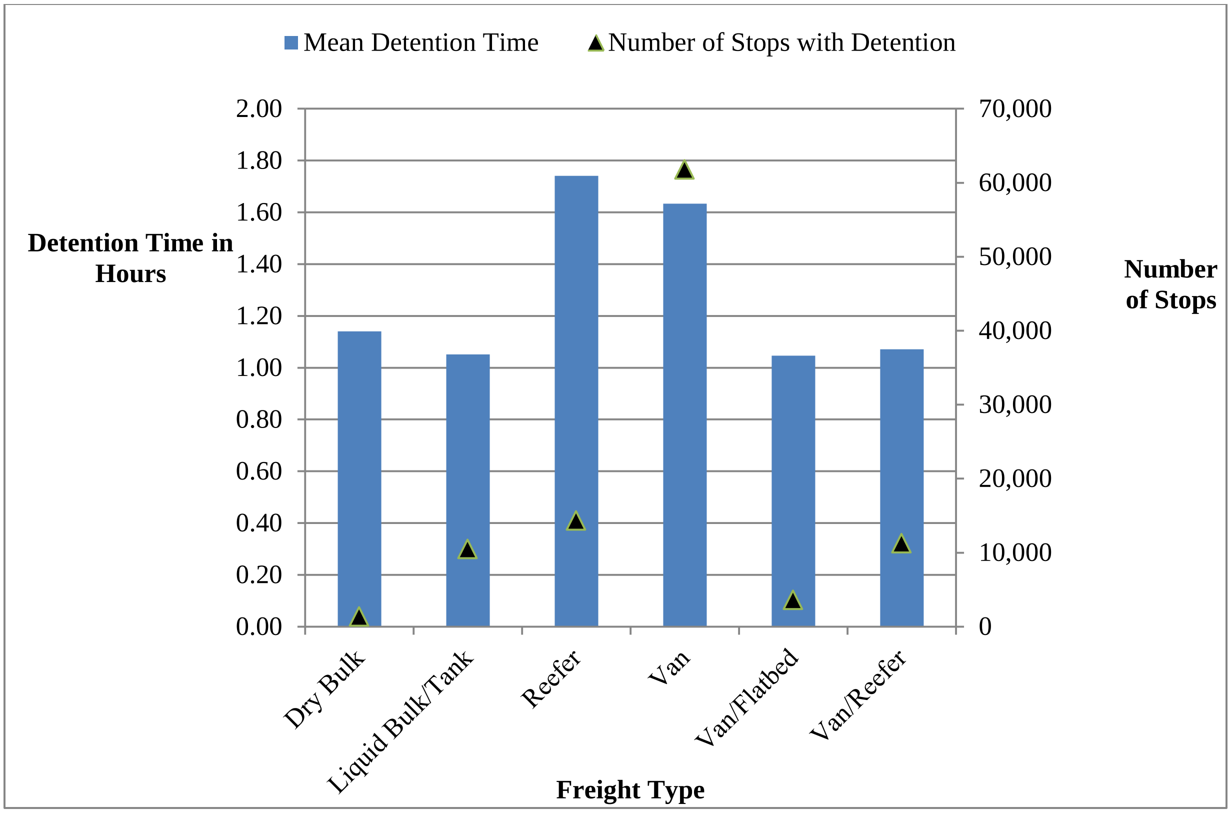

Figure 15. Bar chart. Distribution of detention times by freight type.

Figure 16 shows the percentage of stops when drivers experienced detention time for each freight type. As can be seen in Figure 16, drivers of reefer and van freight types experienced detention time more frequently than drivers of other freight types. Thus, carriers of reefer freight and van freight not only experienced detention time more often, but when they did, it was also for a longer duration than carriers of other freight types. Almost 30 percent of stops by reefer freight carriers and a quarter of stops by van freight carriers resulted in the driver being detained for more than 2 hours.

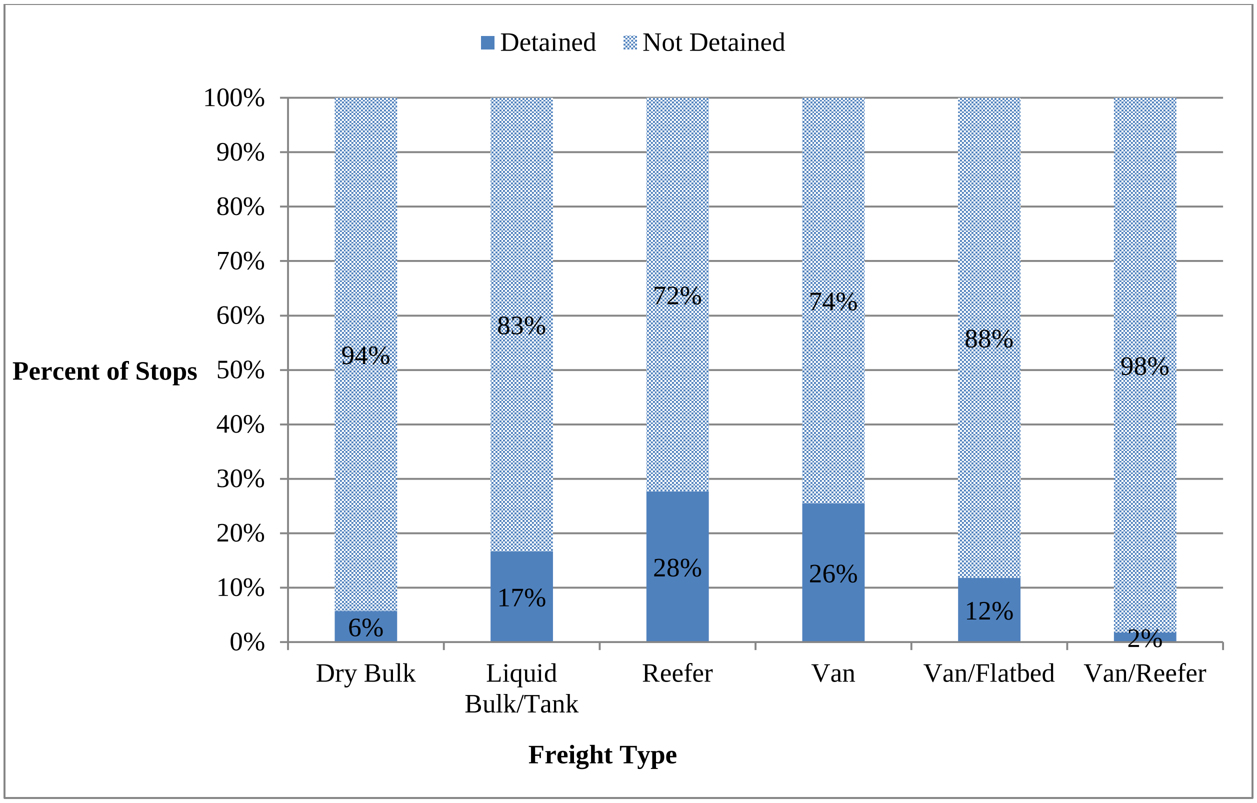

Figure 16. Bar chart. Percentage of stops when drivers experienced detention time by freight type.

3.4 LOGISTIC REGRESSION

A logistic regression model was built to investigate the relationship between the probability of driver detention and the variables of operation type, operation size, and freight type. The analysis of effects, shown in Table 8, revealed that operation size, operation type, and freight type were all significant explanatory variables (p-values < 0.0001). The prediction success of the model was 72.1 percent.

Table 8. Analysis of effects for logistic regression explanatory variables.

Effect	DF	Wald Chi-square	*p*-value
Operation Size	2	189.11	<0.0001
Operation Type	2	7364.47	<0.0001
Freight Type	7	65043.73	<0.0001

The parameter estimates, with standard error, chi-square, and resulting p-values, are shown in Table 9. The explanatory variables of operation size, operation type, and freight type had multiple categorical levels. In the model, these levels were analyzed as “dummy” variables. The intercept represents the combination of the following levels: small operation size, private operation type, and van/reefer freight type. In Table 9, a parameter level marked "statistically significant" was significantly different from the level included in the intercept. For example, the operation type "for-hire TL" has an estimate of 0.4942 and is statistically significant in the model. In the model predicting the log odds of driver detention, the operation type "for-hire TL" was significantly different than the operation type "private" (included in the intercept). All statistically significant results can be interpreted similarly.

Table 9. Analysis of maximum likelihood estimates for logistic regression model.

Parameter	Level	DF	Estimate	Standard Error	Wald Chi-square	*p*-value
Intercept	–	1	-2.3647	0.1374	296.1520	<0.0001*
Operation Size	Large	1	0.3486	0.1940	3.2290	0.0723
Operation Size	Medium	1	0.1853	0.1940	0.9114	0.3397
Operation Type	For-hire TL	1	0.4942	0.0071	4874.3408	<0.0001*
Operation Type	For-hire LTL	1	-0.2732	0.0129	445.7646	<0.0001*
Freight Type	–	1	-0.0639	0.0978	0.4272	0.5134
Freight Type	Dry Bulk	1	-0.4032	0.1007	16.0238	<0.0001*
Freight Type	Liquid Bulk/Tank	1	0.2617	0.0979	7.1440	0.0075*
Freight Type	Mixed	1	0.3836	0.6802	0.3181	0.5728
Freight Type	Reefer	1	1.0815	0.0979	122.1084	<0.0001*
Freight Type	Van	1	0.8525	0.0974	76.5970	<0.0001*
Freight Type	Van/Flatbed	1	-0.3219	0.0987	10.6369	0.0011*

*Denotes statistically significant

3.5 ODDS RATIOS

Driver detention in the levels of each of the variables (operation type, operation size, and freight type) were compared using OR and 95-percent lower and upper CIs and are shown in the tables below. The counts of stops when drivers were detained and stops when drivers were not detained for each level of the variables can be found in Appendix A.

Table 10 shows the ORs and CIs for the levels of operation size. The research team compared the risk of a particular level of operation size with each other level of operation size. As shown in Table 10, the odds of a driver being detained were 2.17 times greater for medium carriers than for large carriers. Statistically significant ORs are marked with an asterisk in Table 10.

Table 10. ORs for operation size.

Operation Size Comparisons	OR	Lower Confidence Limit (LCL)	Upper Confidence Limit (UCL)
Medium versus Large	2.17*	2.15	2.20

*Denotes statistically significant

Table 11 shows the ORs and CIs for the levels of operation type. The risk of a particular level of operation type experiencing detention time was compared with each other level of operation type. As shown in Table 11, the odds of a driver being detained were 4.89 times greater for for-hire TL carriers than for private carriers and 2.60 times greater for for-hire TL carriers than for for-hire LTL carriers. The odds of a driver being detained were 1.88 times greater for for-hire LTL carriers than for private carriers. Statistically significant ORs are marked with an asterisk in Table 11.

Table 11.ORs for operation type.

Operation Type Comparisons	OR	LCL	UCL
For-hire TL versus for-hire LTL	2.60*	2.52	2.68
For-hire TL versus Private	4.89*	4.83	4.95
For-hire LTL versus Private	1.88*	1.82	1.94

*Denotes statistically significant

Table 12 shows the ORs and CIs for the levels of freight type. The risk of a particular level of freight type experiencing detention time was compared with each other level of freight type. All freight type comparisons had statistically significant ORs. The comparison with the greatest OR was reefer versus van/reefer (OR = 21.49 with CI = [20.92, 22.08]). Statistically significant ORs are marked with an asterisk in Table 12.

Table 12. ORs for freight type.

Freight Type Comparisons	OR	LCL	UCL
Dry Bulk versus Van/Reefer	3.40*	3.21	3.60
Liquid Bulk/Tank versus Dry Bulk	3.31*	3.12	3.51
Liquid Bulk/Tank versus Van/Flatbed	1.49*	1.43	1.55
Liquid Bulk/Tank versus Van/Reefer	11.25*	10.94	11.57
Reefer versus Dry Bulk	6.32*	5.96	6.70
Reefer versus Liquid Bulk/Tank	1.91*	1.86	1.97
Reefer versus Van	1.12*	1.09	1.14
Reefer versus Van/Flatbed	2.85*	2.74	2.97
Reefer versus Van/Reefer	21.49*	20.92	22.08
Van versus Dry Bulk	5.65*	5.34	5.98
Dry Van versus Liquid Bulk/Tank	1.71*	1.67	1.75
Dry Van versus Van/Flatbed	2.55*	2.46	2.64
Dry Van versus Van/Reefer	19.22*	18.82	19.62
Van/Flatbed versus Dry Bulk	2.22*	2.08	2.37
Van/Flatbed versus Van/Reefer	7.54*	7.25	7.84

*Denotes statistically significant

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4. DISCUSSION

The current study assessed detention times in CMV operations stratified by a number of different variables, including operation size, operation type, and freight type. Whereas other studies found in the literature review assessed detention times using self-report methods, the current study used real-world data provided by third-party vendors to quantitatively assess detention times.(60, 61, 62) The third-party vendor data comprised stop time data (i.e., loading/unloading plus waiting time) from 31 carriers representing mostly medium and large carriers of different operation types (including for-hire TL, for-hire LTL, and private) hauling a variety of commodities. The data from these carriers was over a period of 3 months and included a total of 1,348,897 stops, of which 153,103 were detained (resulting in 214,267.1 hours of total detention time). One issue with the third-party vendor data was the lack of small carriers. The data set only contained information from two small carriers and only 7 of the 271 stops were detained; thus, any results related to small carriers need to be interpreted with caution.

All of the available evidence supporting the contention that detention time is an issue for CMV drivers in the United States is self-reported data acquired through interviews with drivers, safety managers, and other expert respondents. In addition, only the GAO report(63) focused on the issue of detention time, whereas the other two studies raised it as one of a number of CMV transport safety problems or inefficiencies.(64, 65) Unlike the GAO report, the current study quantitatively measured and assessed detention times over a number of stratification variables. This is the only study known by the authors to obtain objective measures of detention time; thus, it is difficult to directly compare these results to the subjective results obtained in the GAO report.

At this time, it is difficult to conclude if 1.4 hours of detention time is problematic, as there is limited information available to make comparisons. Cross-modal comparisons are not appropriate, as the rail and maritime industries measure detention times over longer periods, and the types of freight (and their aggregate volumes and mass) and the processes and equipment used in loading and unloading are considerably different. The overwhelming majority of stops in the current study were completed in 1 hour or less (64.07 percent), followed by stops of 1–2 hours (24.58 percent). Based on these data, detention times in excess of 2 hours appear to be unusual. It is difficult to quantify the costs associated with detention time in the current study, as the analysis would need to differentiate waiting and unloading/loading time. Assuming that unloading/loading time is part of normal operations, the waiting time could be used to determine the costs of inefficiencies associated with driver detention. Unfortunately, the current study was unable to separate waiting times from unloading/loading times. An FMCSA study estimated that waiting times associated with unloading/loading costs carriers approximately $3 billion and society more than $6 billion annually.(66)

4.1 CONCLUSIONS

Results indicate that drivers experienced detention time on approximately 1 in every 10 stops for an average duration of 1.4 hours. This represents the length of time the driver was detained beyond 2 hours; thus, he/she was physically at that delivery location for 3.4 hours in total. Comparatively, the GAO report suggests that, based on drivers' recollections, about 60 percent of respondents experienced detention time in the past 2 weeks, and more than two-thirds experienced detention time in the last month.(67) Given that data from the current study was presented in a per stop format (i.e., detention time occurs once every 10 stops) and drivers typically make multiple stops in one shift, the GAO figures quoted above seem fairly low. Granted, drivers interviewed for the GAO report were attempting to recall their experiences with detention time; thus, under-reporting should be expected. For example, drivers trying to remember if they were detained at a stop for longer than 2 hours in the last month may not recall instances of detention time unless they were extreme. This is not to say the self-report measures used in the GAO report are useless. The GAO results highlighted that there was a problem; the results in the current study used objective measures to provide further evidence and more detail regarding the nature of that problem.

Medium-sized carriers (51–500 power units) had similar average detention times as large carriers (more than 500 power units); however, they experienced driver detention about twice as often as large carriers. For example, 19 percent of stops made by medium-sized carriers were accompanied by detention time as compared to 9 percent of stops made by large carriers. The calculation of ORs provided similar results for medium-sized carriers when compared to large carriers. The odds of a driver being detained were 2.17 times greater for medium-sized carriers than for large carriers. The GAO report suggested that large carriers may experience less frequent driver detention times due to having more leverage to include detention fee clauses in their contracts with shippers and to collect on those fees if driver detention occurs.(68) Unfortunately, there was no way to tell from the data why this difference may have occurred, as the third-party vendor data did not contain data related to any existing disincentives for detention time that may have been in place. This information may be difficult to obtain, as carriers do not have blanket detention time agreements; rather, they have specific agreements that may or may not address detention time with different shippers.

Operation type did not have much impact on the average length of detention time, with all three operation types having fairly similar average detention times (i.e., the average detention time for-hire TL and for-hire LTL carriers was 1.5 hours, while the average detention time for private carriers was 1.2 hours). However, operation type influenced how frequently drivers were detained, with for-hire TL carriers experiencing detention time more than twice as frequently as for-hire LTL carriers and four times more frequently than private carriers. The OR analysis also indicated that for-hire TL carriers were worse off than for-hire LTL or private carriers. The odds of a driver being detained were nearly 5 times greater for for-hire TL carriers than for private carriers and 2.6 times greater than for for-hire LTL carriers. Somewhat surprisingly, private carriers experienced detention time on 5 percent of the stops they made.

In line with statements by industry representatives in the GAO report, refrigerated trailer drivers experienced longer and more frequent detention time than other freight types; however, the current study also found that van freight (i.e., dry goods, not temperature controlled) carriers were almost on par with reefer carriers for duration and frequency of detention time. Reefer and van freight types had the longest average detention times at 1.7 hours and 1.6 hours, respectively. Carriers of these freight types experienced detention time on more than a quarter of the stops they made (i.e., 28 percent for reefer freight and 26 percent for van freight). The odds of a driver being detained were 6.3 and 1.9 times greater for reefer freight carriers than for dry bulk carriers and liquid bulk/tank freight carriers, respectively. Similarly, the odds of a driver being detained were 5.65 and 1.71 times greater for van freight carriers than for dry bulk freight carriers and liquid bulk/tank freight carriers, respectively. For temperature controlled freight, the industry representatives in the GAO report proposed that this may be due to the temperature controlled trailers being able to maintain their cargo at the required temperature; thus, they can wait for cargo from non-refrigerated trailers to be unloaded.(69) Dry bulk and liquid bulk/tank freight types had an average detention time of around 1 hour with liquid bulk/tank freight types experiencing detention time on 17 percent of their stops, and dry bulk freight types experiencing detention time on only 6 percent of their stops. Unfortunately, a sizeable portion of the freight type data was combined in such a way that it could not be separated out and attributed to a single freight type, which made interpretation difficult.

One further issue worth considering is the potential effect of cumulative stop time. The current study used the industry standard definition of detention time as being any time drivers have to wait beyond 2 hours, which is the average time it takes to load or unload their cargo, according to the CMV industry.(70) Many CMV drivers make multiple stops per shift. If each stop takes just less than 2 hours, although none of the stops qualify as detention time, the cumulative total of all the stops combined accounts for a sizeable portion of a driver's shift. For example, say a driver has to make four scheduled deliveries in a shift and each one takes approximately 1 hour and 50 minutes. Since each individual delivery is less than the 2 hours required to qualify as detention time, no detention fees have to be paid to the carrier and/or driver. However, the cumulative time for loading/unloading in one shift would be 7 hours and 20 minutes, all of which counts toward the driver's HOS daily working limit. Thus, despite the fact that the driver had not been detained at each stop, he/she lost more than half of the allowable working time due to long loading/unloading events. This example would be of particular relevance to owner-operators, as they typically do not get paid for non-driving work.

4.2 LIMITATIONS

Although the data set used in the analyses to assess average detention times was large and provided information for more than one million stops, there were several limitations. First, the third-party vendor data was from a relatively small number of carriers, which may not provide an accurate representation of the entire trucking industry. Second, there was a lack of data from small carriers, with the data set only containing information from two small carriers. This is especially unfortunate given that small carriers and owner-operators are thought to be the ones who would suffer the most due to detention time. The data set contains a large, unidentified number of owner-operators working as contractors for medium and large carriers; however, these do not represent traditional owner-operators, as they are working under the umbrella of the medium or large carriers. The GAO report suggests that the effects of detention time would be worse for owner-operators for a number of reasons. For instance, owner-operators' pay structure is typically based on actual driving time (i.e., they are paid by the number of miles driven or loads delivered), so these drivers do not get paid for time spent waiting to load and unload. Small carriers and owner-operators may also lack the leverage to charge detention time fees to the shippers when they are detained. Alternatively, they may have difficulty collecting such fees even if provided for in the contract due to their reluctance to charge their customers for fear of losing them.(71) Thus, the problem of detention time for small carriers needs to be investigated further.

The measure of detention time used in the current study was dependent on the methods used to identify and calculate detention time. The most accurate method to identify detention time was when the driver pushed a button to indicate his/her arrival and departure from a delivery location; however, this method still relies on the driver remembering to push the button when he or she arrives and later departs the delivery location. The second method, which involves using a GPS to identify stop locations for deliveries, could also include some noise (although in the current study, information obtained via GPS was cross-referenced with driver logbooks to ensure the driver was logged as on-duty at the time). The problem with GPS-collected data is this: drivers have the ability to clock off and change their status to off-duty even when they are still working and loading or unloading. Once drivers are logged as off-duty, the data related to that particular stop would no longer be included in the data set, as it only incorporated data for stops that were logged as on-duty. The only way to keep track of what drivers are doing at any particular stop, regardless of the driving status entered in their logbooks, would be to have a camera in the truck cab.

Despite these issues, the current study provides the first objective measures on detention time in the CMV industry. Given that the researchers do not know what drivers were doing when they were logged as off-duty, the results in the current study are likely an underestimation of detention time; thus, the estimate of detention time in the current study is likely conservative.

4.3 FUTURE RESEARCH

Future research studies should address the limitations noted above, as well as the effects of detention time on safety (such as crashes and HOS violations). As indicated earlier in this report, several of the requested stratification variables were not included in the data set supplied by the participating technology vendors due to time constraints and the need for additional permissions; however, many of these variables are available. Future research should include these variables as they would answer additional research questions regarding what factors are associated with detention time and the probability of being detained, including: overall safety performance scores via CSA, driver (company versus owner-operator; union versus non-union), terminal size (small, medium, large), disincentive for detention time (yes versus no; various disincentives compared), and time of year (limited to the 3-month data collection window in the current study).

As there was a lack of data from small carriers, especially from traditional owner-operators, more attention needs to be paid to this segment of the trucking population. It appears smaller operations are less likely to purchase the services of a third-party monitoring provider. A future study might install electronic HOS logging devices in a large number of tractors from small carriers and traditional owner-operators to collect information similar to the current study to assess detention time.

The current study was unable to differentiate waiting and loading/unloading time. Thus, it is unclear if detention time was primarily the result of waiting time or unloading/loading time. Some carriers used the push button method to note the times they entered and subsequently left a stop location. Instructions could be provided to the drivers of these carriers to push a button based on when they are waiting and unloading/loading. Thus, accurate measures of waiting and unloading/loading time could be obtained.

Although the effect of detention time on performance metrics can be calculated, more information is needed in this area. The current study developed a methodology and analysis approach for Phase II to assess the safety and operational impacts of driver detention time on work hours, HOS and OOS violations, and crashes (using data collected from third-party technology vendors). Phase II will also include focus groups to assess (1) driver, carrier, and shipper opinions and perceptions regarding detention times and (2) potential means that could be used to reduce detention times.

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APPENDIX A: COUNTS OF STOPS WHEN DRIVERS EXPERIENCED DETENTION TIME BY OPERATION SIZE, OPERATION TYPE, AND FREIGHT TYPE

Table 13. Stops when drivers experienced detention time by operation size.

Operation Size	Detained (Number)	Detained (Percent)	Not Detained (Number)	Not Detained (Percent)	Total
Small (1–50)	7	2.58%	264	97.42%	271
Medium (51−500)	51,468	18.54%	226,199	81.46%	277,667
Large (>500)	101,628	9.49%	969,331	90.51%	1,070,959

Table 14. Stops when drivers experienced detention time by operation type.

Operation Type	Detained (Number)	Detained (Percent)	Not Detained (Number)	Not Detained (Percent)	Total
For-hire TL	108,302	20.98%	407,846	79.02%	516,148
For-hire LTL	4,323	9.27%	42,321	90.73%	46,644
Private	40,478	5.15%	745,627	94.85%	786,105

Table 15. Stops when drivers experienced detention time by freight type.

Freight Type	Detained (Number)	Detained (Percent)	Not Detained (Number)	Not Detained (Percent)	Total
Dry Bulk	1,335	5.71%	22,033	94.29%	23,368
Liquid Bulk/Tank	10,476	16.70%	52,261	83.30%	62,737
Mixed	4	5.80%	65	94.20%	69
Reefer	14,330	27.69%	37,422	72.31%	51,752
Van	61,787	25.50%	180,471	74.50%	242,258
Van/Flatbed	3,623	11.85%	26,962	88.15%	30,585
Van/Reefer	11,241	1.75%	630,928	98.25%	642,169

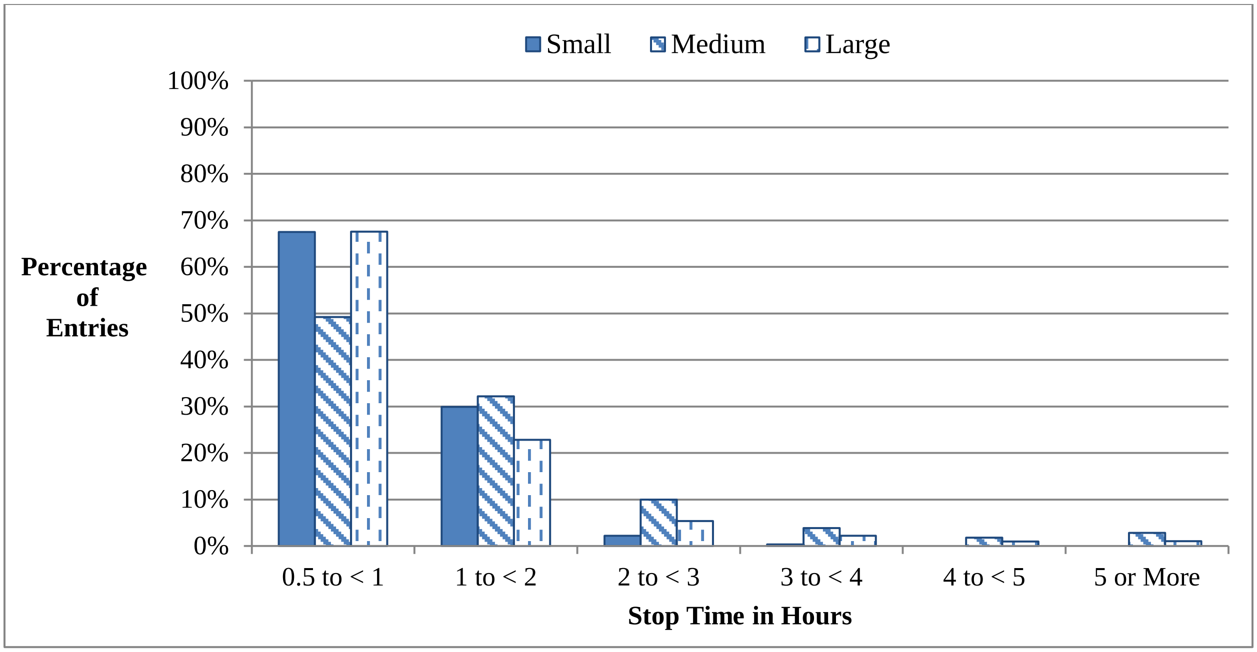

Figure 17. Bar chart. Distribution of stop times by operation size (including small carriers).

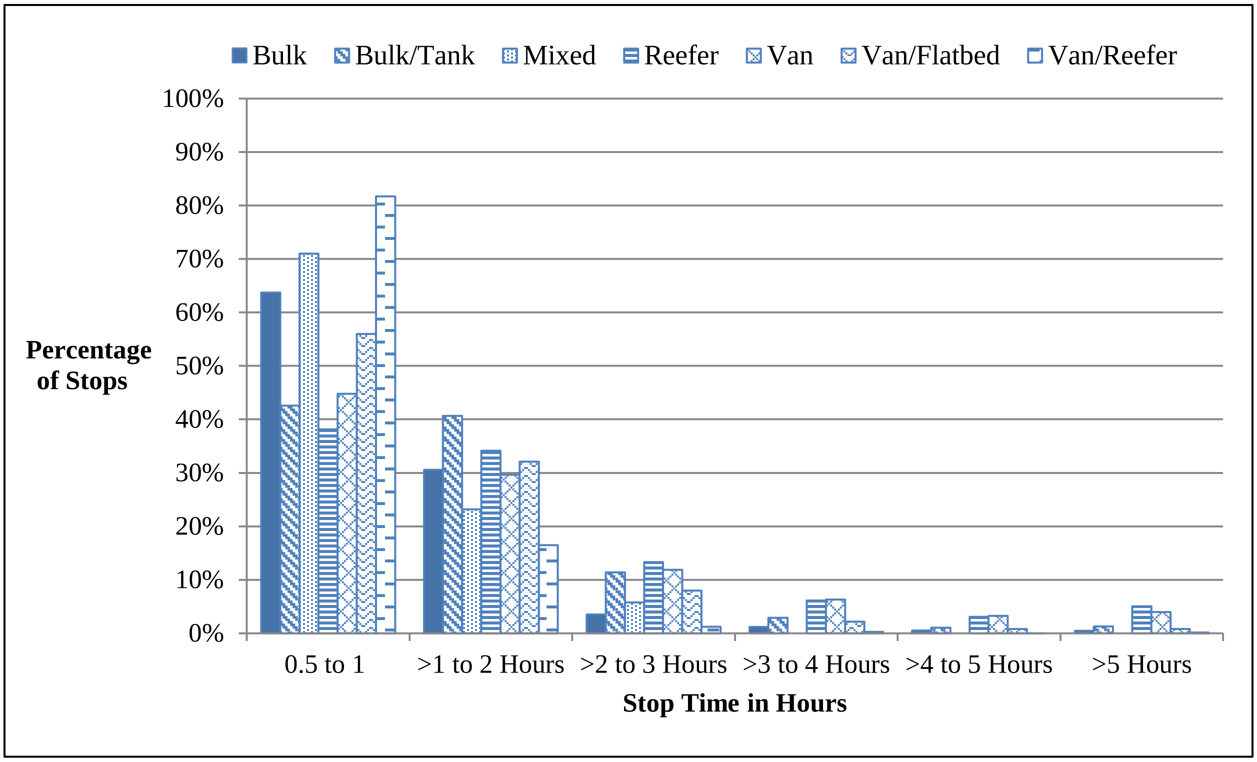

Figure 18. Bar chart. Distribution of stop times by freight type (including mixed freight type).

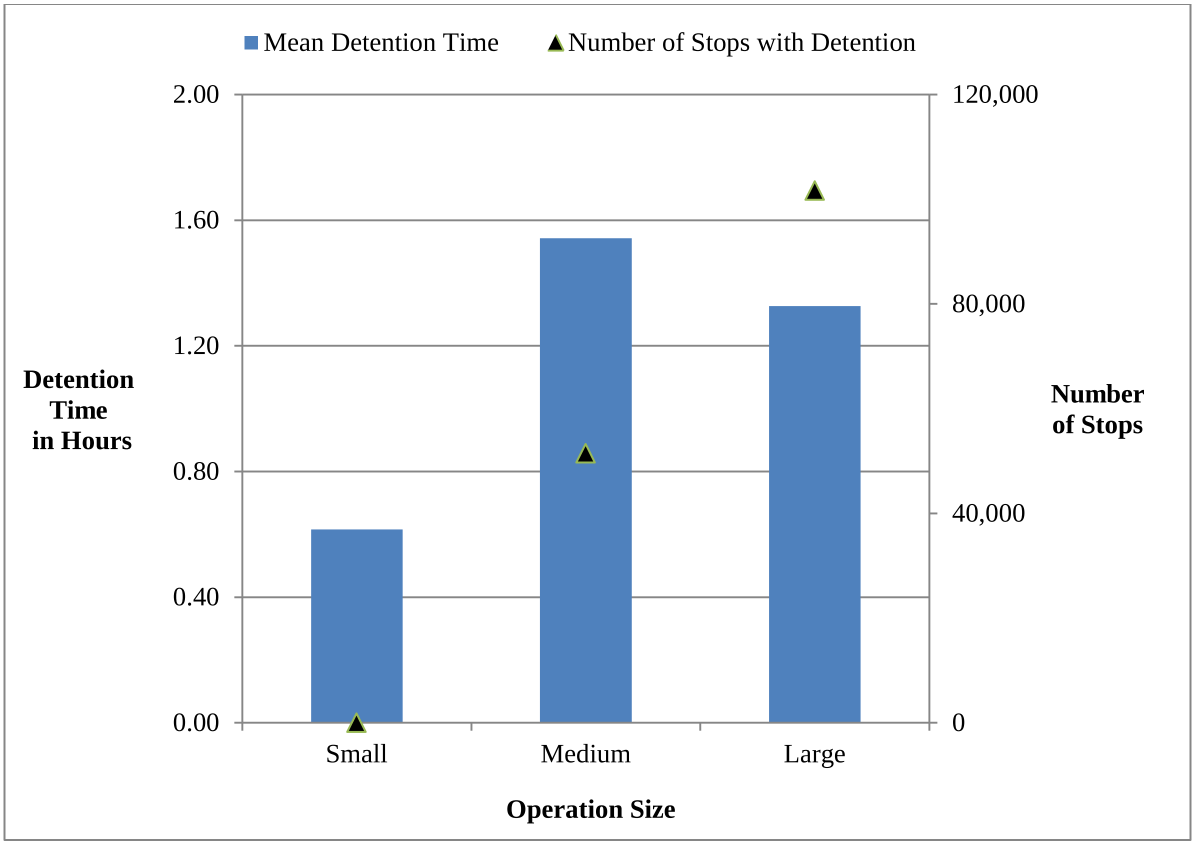

Figure 19. Bar chart. Average detention times and number of stops, by operation size (including small carriers).

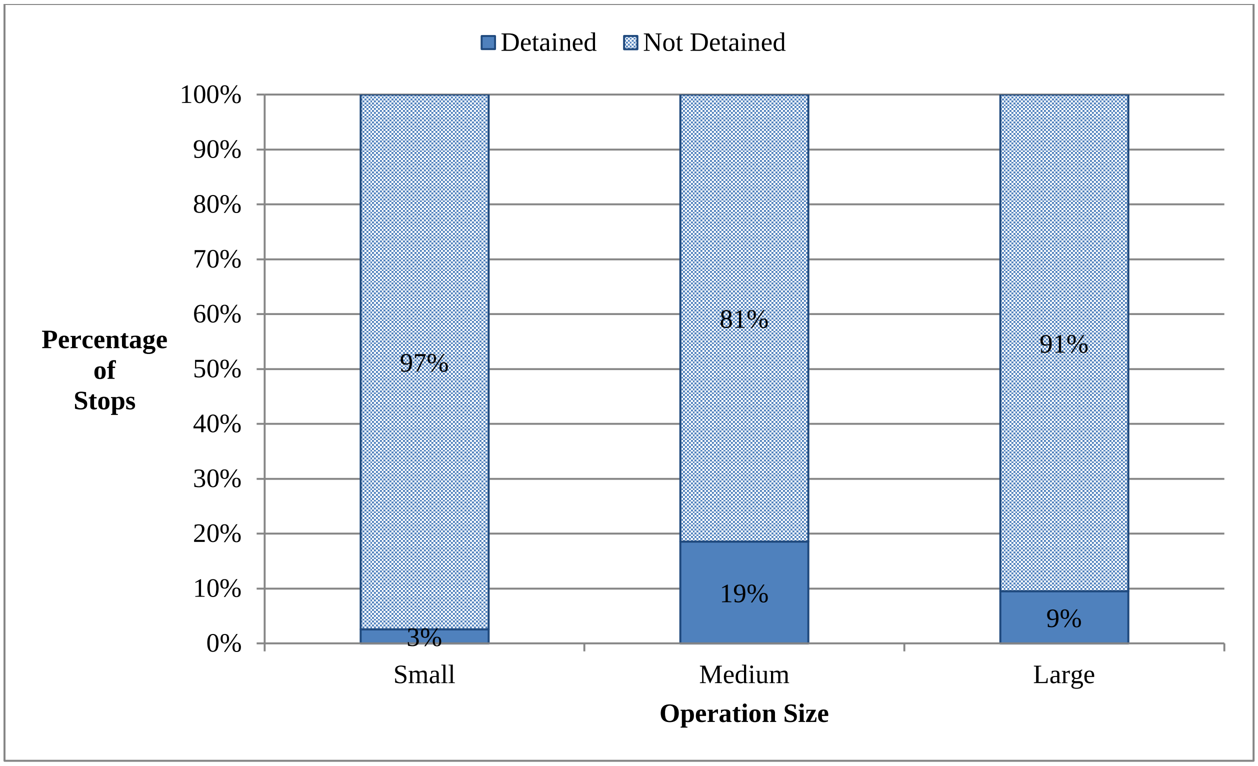

Figure 20. Bar chart. Percentage of stops when drivers experienced detention time by operation size (including small carriers).

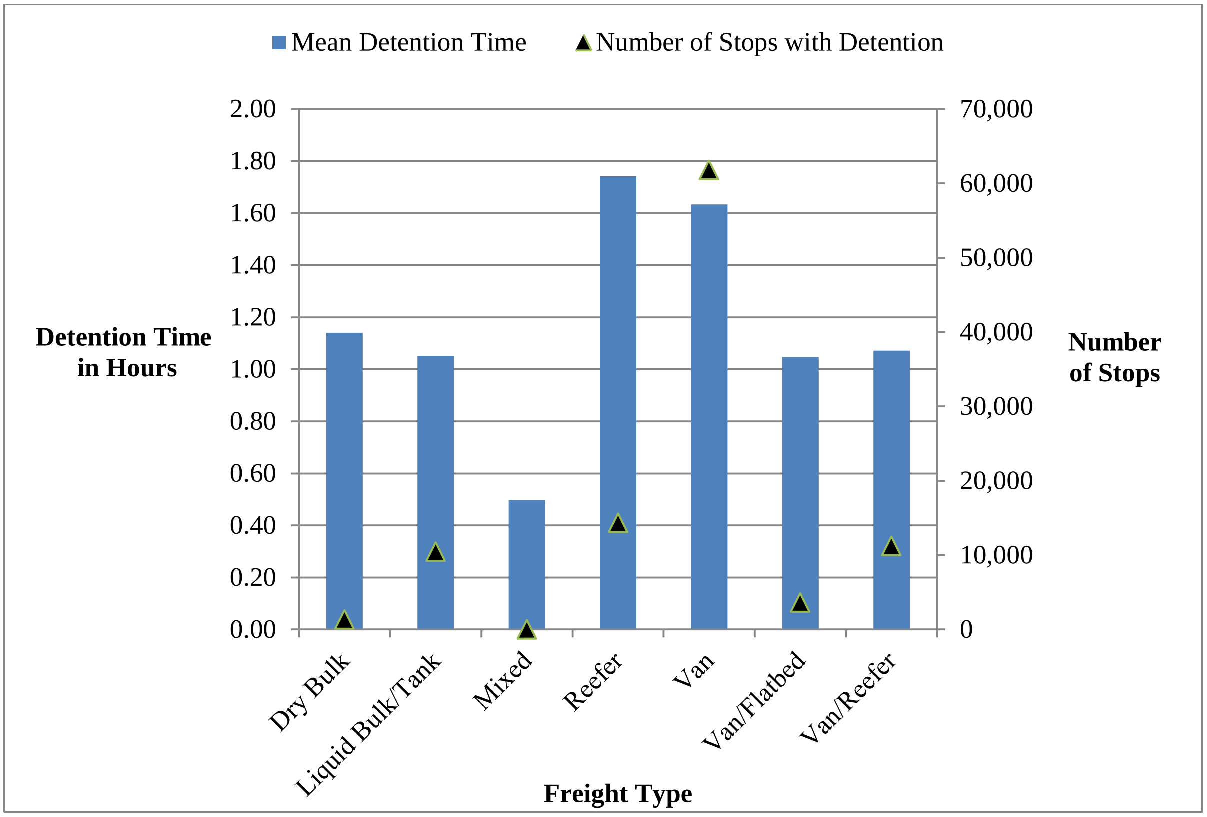

Figure 21. Bar chart. Distribution of detention times by freight type (including mixed freight type).

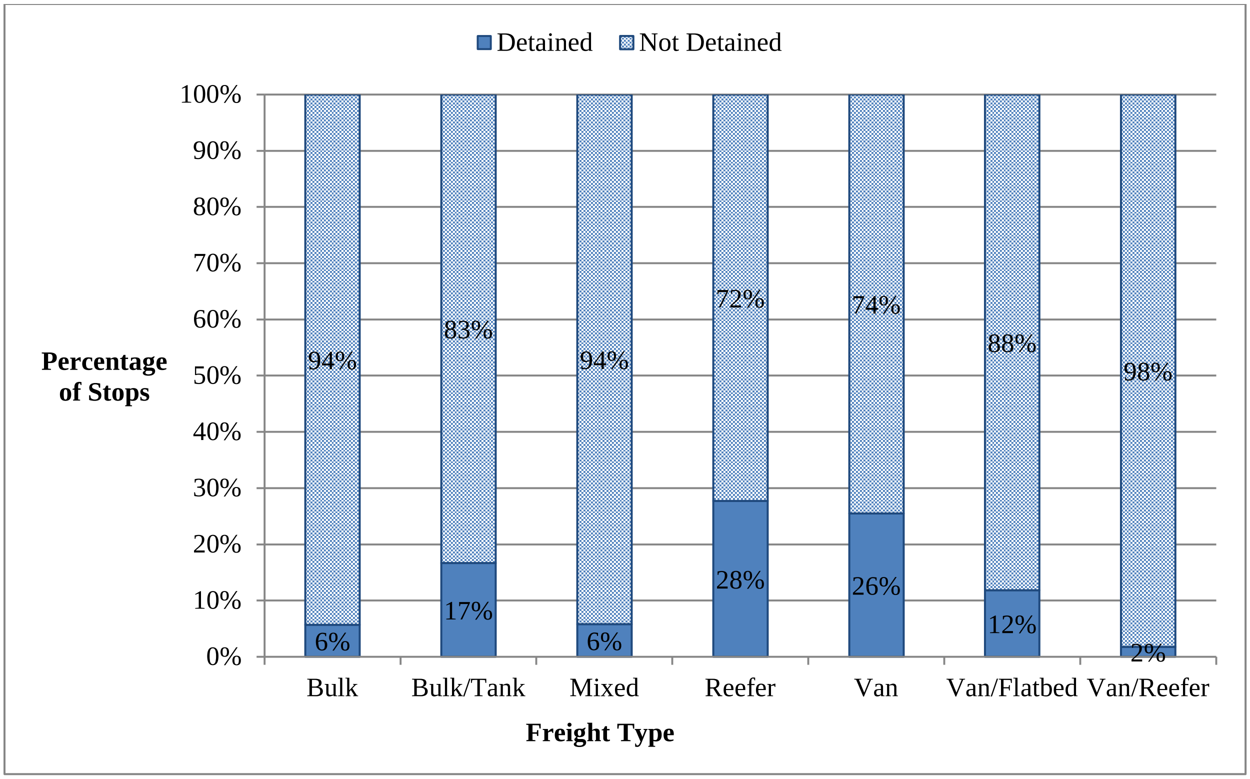

Figure 22. Bar chart. Percentage of stops when drivers experienced detention time by freight type (including mixed freight type).

Table 16. ORs for operation size (including small carriers).

Operation Size Comparisons	OR	Lower Confidence Limit (LCL)	Upper Confidence Limit (UCL)
Medium versus Small	8.58*	4.05	18.18
Medium versus Large	2.17*	2.15	2.20
Large versus Small	3.95*	1.87	8.38

*Denotes statistically significant

Table 17. ORs for freight type (including mixed freight type).

Freight Type Comparisons	OR	LCL	UCL
Dry Bulk versus Van/Reefer	3.40*	3.21	3.60
Liquid Bulk/Tank versus Dry Bulk	3.31*	3.12	3.51
Liquid Bulk/Tank versus Mixed	3.26*	1.19	8.94
Liquid Bulk/Tank versus Van/Flatbed	1.49*	1.43	1.55
Liquid Bulk/Tank versus Van/Reefer	11.25*	10.94	11.57
Mixed versus Dry Bulk	1.02	0.37	2.79
Mixed versus Van/Reefer	3.45*	1.26	9.48
Reefer versus Dry Bulk	6.32*	5.96	6.70
Reefer versus Liquid Bulk/Tank	1.91*	1.86	1.97
Reefer versus Mixed	6.22*	2.27	17.08
Reefer versus Van	1.12*	1.09	1.14
Reefer versus Van/Flatbed	2.85*	2.74	2.97
Reefer versus Van/Reefer	21.49*	20.92	22.08
Van versus Dry Bulk	5.65*	5.34	5.98
Dry Van versus Liquid Bulk/Tank	1.71*	1.67	1.75
Dry Van versus Mixed	5.56*	2.03	15.27
Dry Van versus Van/Flatbed	2.55*	2.46	2.64
Dry Van versus Van/Reefer	19.22*	18.82	19.62
Van/Flatbed versus Dry Bulk	2.22*	2.08	2.37
Van/Flatbed versus Mixed	2.18	0.80	6.00
Van/Flatbed versus Van/Reefer	7.54*	7.25	7.84

*Denotes statistically significant

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